PROCEEDINGS

of the

FELINE HEALTH SYMPOSIUM

at the

New York State College of Veterinary Medicine
Cornell University
Ithaca, N. Y.

on

June 5, 1976

A continuing education program sponsored by the Cornell Feline Research Laboratory

About the Laboratory—

On February 12, 1974, the Board of Trustees of Cornell University, Ithaca, New York, approved the formation of the Cornell Feline Research Laboratory (CFRL) as a unit of the New York State Veterinary College at Cornell University. This formalized a program started in 1964 by Dr. James H. Gillespie to study the infectious diseases of the cat. The formation of the Laboratory expands this program to study not only the infectious diseases but all diseases which pose a significant threat to the health of cats.

The purposes of the Cornell Feline Research Laboratory are (1) to promote and conduct research on diseases of the domestic cat in order to prevent or cure these diseases; (2) to provide continuing education on feline diseases to feline practitioners and cat owners; (3) to aid feline practitioners when new or unknown diseases occur.

The Laboratory has access to the talents of twenty-four professionals at the College on a regular basis and to other specialists as needed. From its inception, the laboratory has been supported by a combination of state funds, Federal grants, and gifts. Of necessity, the latter are becoming increasingly important to continued operation of the laboratory.

Already the efforts of the Laboratory staff have been fruitful in the elucidation of a cause of feline urolithiasis and a better understanding of respiratory diseases. With your help we look forward to further discoveries for the improvement of feline health.

Sincerely,

Fredric W. Scott

Fredric W. Scott, D.V.M., Ph.D.
Director

FWS:lr

FELINE HEALTH SYMPOSIUM

James Law Auditorium

New York State College of Veterinary Medicine

a statutory college of the state university

at

Cornell University, Ithaca, New York

Sponsored by the

CORNELL FELINE RESEARCH LABORATORY

Morning Session

Dr. F. W. Scott, presiding

8:00 a.m. - Registration
9:00 a.m. - Welcome - Dr. F. Scott
9:10 a.m. - Feline nutrition - Dr. F. Kallfelz
10:00 a.m. - Feline urolithiasis - Mrs. C. Fabricant
10:50 a.m. - Break
11:10 a.m. - Feline leukemia virus infections - Dr. J. Post
12:00 p.m. - Lunch

Afternoon Session

Dr. Grant Kaley, presiding

1:30 p.m. - Presentation of Founders Plaque - Dr. E. C. Melby, Jr.
1:40 p.m. - Reproductive diseases - Dr. D. Lein
2:30 p.m. - Skin diseases - Dr. D. Scott
3:20 p.m. - Break
3:35 p.m. - Respiratory diseases - Dr. F. Scott
4:20 p.m. - Tour of laboratory facilities

Practices and Problems in Cat Nutrition

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Nutrition of the Feline

Introduction:

In many respects the nutritional requirements of the cat are very similar to those of most other species. All species, including the cat, require the five major nutrients for growth, maintenance, reproduction, etc. These five classes of nutrients are protein, energy, minerals, vitamins and water. If these nutrients are supplied in proper amounts the normal healthy cat can be expected to grow and maintain itself adequately. One of the problems confronting those interested in the area of feline nutriton, therefore, is to determine the optimal levels of the various nutritional requirements for the cat. While the nutritional requirements of the cat for some nutrients are very similar to those of other species, the cat has a number of peculiarities which make its nutritional requirements somewhat different from those of other species (Table 1). In addition, one of the major principles of nutrition, which is frequently neglected is that no matter how expensive nor how complete in nutrient content a food may be, it is worthless if it is not consumed. This principle is possibily of greater importance in the cat than it is in some other species since the cat has historically been known to be a "finicky" eater and cat owners are frequently frustrated in their efforts to find a ration that is adequate in its nutrient content and also palatable and well accepted by the cat. The purpose of this talk is to review the nutrient requirements of the cat as they are known, to discuss the various feeding practices and formulations that are used in the nutrition of the cat, and to discuss common disease problems in cats that have nutritional significance.

The protein requirement of animals will vary depending upon many factors among which are the type of protein that is used in the ration and the ratio of the protein in the ration to other energy sources. For example it is well known that animal source protein (meat, certain meat by-products, and dairy products) have a higher content of essential amino acids, a better ratio of various amino acids and hence are more utilizable by the animal than are many vegetable source proteins which may be limiting in one or more of the essential amino acids. Therefore, the protein requirement of animals can generally be met by a lesser quanity of animal source proteins than of vegetable source proteins. Also, the utilization of proteins by the body for nitrogen requiring functions such as increase in muscle mass etc. will depend upon the ratio of the protein source to that of other energy sources. Thus even though the protein level of a ration may be adequate if the energy level of the ration is low, the protein sources will be used for energy requiring functions and thus not be available for nitrogen requiring functions. These factors must be taken into account when assessing the protein requirements of a given species. Considerable work has been done in an attempt to determine the protein requirement of the cat. With regard to the adult cat, it is now accepted that the protein requirement for maintaining nitrogen balance is probably some where in the neighborhood of 25 to 35% depending upon the source of the protein utilized. When high quality protein such as liver and fish is used this level is probably closer to 25% (Table 2) while if vegetables source proteins are present in significant amounts, the requirement is probably in the 30 to 35% range. As will be discussed later, most commerical cat food products lie within this range. It is interesting to note that the protein

requirement for the cat is somewhat higher than that for the dog. Thus while the adult dog can be maintained on a protein level in the ration between 20 and 25%, the cat requires greater levels of protein than this. With the increasing expensiveness of animal source proteins over the last few years and the subsequent change to greater use of vegetable source proteins, particularly textured soy protein, in the manufacturer of dog products, we can expect that this trend will also occur in commerical cat food formulations. This may require a reevaluation of the normally accepted protein levels in feline rations.

The cat obtains necessary energy requirements from fat, carbohydrates, and protein. Protein and carbohydrate sources supply approximately 4 calories per gram of digestible energy while fat supplies approximately 9 calories per gram. Most experts in feline nutrition have observed that cats appear to maintain themselves better on high fat rations than on rations that are lower in fat and higher in carbohydrates. Under natural conditions, when consuming captured prey, the cat obtains approximately 60% of its calories from fat. Laboratory studies have also indicated that cats grow well on rations containing relatively high levels of fat. In fact, there has been no evidence to show that cats requirement carbohydrate source in the ration. However, if a ration is adequate in protein and fat content additional calories can be supplied in the form of carbohydrate. In this regard it has been demonstrated that glycogen and dextrin are readily digested by the cat but that starch must be pre-cooked or fine ground in order for it to be digestible. Also while new born and young kittens are able to digest large quantities of lactose, this ability decreases with increasing age and some adult

cats may be lactose intolerant. Therefore, the practice of feeding some adult cats large quanities of milk may not be indicated. In practice, most commerical cat foods are somewhat higher in fat content than are commercial dog foods. The total caloric requirement of the cat is probably somewhat higher than it is for the dog. It is normally accepted that the average size dog requires approximately 30 calories per pound per day while the requirement for the average size adult cat is probably in the neighborhood of 35 to 40 calories per pound per day.

The mineral requirements of cats have not been estabished with any degree of reliability. In general mineral mixes used for other species of domestic animals will suffice to meet the mineral requirements of the cat. It has been well established that rations deficient in certain mineral elements for example calcium, will result in the same pathologic changes in the cat as have been noted in other species such as the dog and pig. There has also been some conjecture that high mineral levels in cat rations may be deleterious and lead to increased incidences of such problems as urolithiasis. However, there is very little evidence to indicate that mineral levles in the range of those recommended for other species of domestic animals will cause such problems in the cat.

The vitamin requirements for the cat are probably very similar, at least qualitatively, to those of other domestic animal species. There is no evidence to indicate that the cat has a requirement for any vitamin that is not also needed by other species nor can the cat be maintained with the lack of any vitamin that is known to be an essential nutrient in other species.

There are however some peculiarities in vitamin metabolism in the cat as compared to other species which may alter the nutritional requirements for vitamins or vitamin precursers in this species. For example the evidence available seems to indicate that the cat is unable to convert carotene into vitamin A and therefore requires a dietary source of vitamin A itself whereas most other domestic animals can use carotene as a source of vitamin A. Also, while many species can obtain at least part of their niacin requirement by conversion of tryptophane to the vitamin, the cat evidently lacks this ability and therefore has an absolute dietary requirement for its total niacin needs. While dietary deficiencies of Vitamin E and thiamine have been reported for the cat, these have probably been due to increased destruction of the vitamin in the food stuffs utilized. There is little evidence to indicate that the cat has an increased requirement for these vitamins as compared to other animals.

The water requirements of felines also cannot be overlooked. Fulfilling the fluid requirements of the cat has become of some interest because of its possible relationship to the development or management of urolithiasis in this species. It has generally been accepted that cats drink very little water in the free form and that most of their water intake comes from preformed water in the food or metabolic water derived from the metabolism of fat. Because of this theory the use of dry cat food rations has been discouraged since it was felt that consumption of dry cat food rations might in fact lead to a decreased total water intake and therefore might result in an increased concentration of the

urine and an increased incidence of urolithiasis. Some recent studies have indicated that in fact the total water intake of cats fed a dry cat food was greater than that consumed when fed a canned ration (Table 3). Therefore, the previous hypothesis that cats will have a decreased water intake on dry cat food may not be supportable in fact. With regard to total water intake the requirements are probably similar to those of dogs, being in the neighborhood of 25 to 30 ml per pound per day.

When discussing the nutritional requirements of animals one must also consider the fact that these requirements change depending upon the physiological state of the animal. Therefore, the nutritional requirements of the growing kitten are somewhat different from those of the normal adult and the requirements of the adult cat may vary depending upon other facts such as the amount of activity of the animal for example whether it is maintained in an apartment or allowed to roam free outdoors. There also are varying nutritional requirements druing gestation and lactation.

The protein and energy requirements of the growing kitten are certainly greater than those of the adult and as mentioned previously are greater than those of the dog for either situation (Table 4). The protein content of queen milk is approximately 1/3 greater than that of the dog (Table 5). It has been estimated that the protein requirements of the growing cat are approximately 2 grams per pound of body weight per day while that for the adult cat are less than 1.5 grams per pound per day. Also, the new born kitten requires about 160 calories per pound for maintenance and growth while the adult requires approximately 35 to 40 per pound as mentioned previously. The mineral requirements for the growing cat are also greater than those of the adult although

detailed studies of these requirements have not been performed. The protein and energy requirements of the cat during early lactation are probably similar to those for maintenance but these requirements will increase during the last three to four weeks of gestation so that at queening the requirements are probably about 150% of the maintenance. Requirements for lactation will depend upon the number of kittens in the litter. While detailed levels for the cat have not been determined, studies on dogs have indicated that with a litter of eight puppies the beagle will require approximately 300% of her maintenance requirement. This would also probably be a pretty good estimate for the cat. Of course, this level of feeding should be reduced when the kittens approach weaning and begin consuming solid food. The care of orphaned kittens is probably very similar to that of puppies. These animals can be fed a milk substitute which is similar in content to that of queen's milk and a commercial preparation, Borden's KMR, is available for this purpose (Table 5).

The availability or unavailability of specific information relating to the nutritional requirements of cats is certainly of significance to the cat owner, but in the long run the owner or breeder must make his or her own decisions relative to the nutritional management of animals they own and care for. The cat owner is therefore faced with the first decision of deciding whether to prepare a home formulated ration or to use a commercially available product. If the owner decides to use commercial products then he must make a decision as to which of the multitude of products available on the market is best for his situation.

Since many of the major cat food producing companies have done considerable research and have access to the research results available from other sources, they are probably in the best position to formulate rations that will meet the nutritional requirements of cats. However, the technical information available to them must be tempered with market and consumer data relating to the popularity of various rations with the consuming public. We all certainly hope that the nutritional requirements of the animal are of primary importance and that marketing considerations take a secondary role.

The cat foods available on the market are generally of three types: dry, soft-moist and canned. Most of the dry and soft-moist products are complete and balanced rations and are nutritionally adequate for both growth and maintenance. Canned cat food products are of at least two varieties, one being a complete and balanced ration and the other being specialty or gourmet products. The gourmet or specialty products may not be balanced and therefore may not be adequate as the only food source.

There are advantages and disadvantages to each of the three types of foods mentioned and the final decision must rest with the owner. Advantages of dry type cat foods are that they are generally less expensive than soft-moist, or canned products, have a long shelf life and can be fed ad libitum with few problems. Disadvantages of these products are that the packaging may make them difficult for storage and these rations tend to be less palatable than other types. Advantages of soft-moist cat foods include long shelf life in unopened packages, a somewhat lesser expense than canned cat food products, and individual serving packages, thus reducing the amount of waste. Disadvantages

would include a somewhat greater expense than dry cat food products and a somewhat reduced shelf life once a package is opened. Advantages of canned cat food products are long shelf life and increased palatability while disadvantages would be the rapidity of spoilage after opening the package, and the relative expense of these products compared to the others mentioned.

The label on cat food products can also be of some value in assessing its adequacy. For example it is now required that if a product is marketed to be a complete ration for maintenance, growth, lactation, etc. that the manufacturer must have performed the research to show that the product does indeed meet these requirements. Threfore, if a product is marketed with no such statement as to nutritional adequacy, on the label, one cannot automatically assume that it is a balanced ration. Also, the ingredients are listed in order of decreasing amount of product. Therefore the ingredient listed first is present in the ration in greatest amount and so forth. The cat owner, then, should be advised to purchase a cat food product that does have a statement of nutritional adequacy on the label and one whose ingredients list indicates significant levels of protein from meat and meat by-products.

As mentioned previously, palatability has a great deal to do with the acceptance of any ration by the cat and this may be more important in this species than in some others. Therefore the owner should be advised to choose a cat food product that not only meets the nutritional requirements of the animals under his or her care but also one which is readily eaten by the animal.

Supplementation of a balanced ration with added amounts of vitamins and/or minerals is certainly unnecessary. While this practice is probably

more common in dog feeding and management situations than in the cat, nonetheless it is as unnecessary in the cat as it is in the dog. If the ration is balanced there is absolutely no reason to add addtional amounts of vitamins and/or minerals. Doing so would be of no value in the least and can be very deliterious at the most as will be discussed subsequently.

The formulation of rations in the home using human food ingredients is probably practiced to a greater extent by cat owners than by dog owners. There is certainly nothing wrong with this practice and it can be done with success. However, it is just as important to provide a balanced ration when using home formulated diets as it is when choosing commercial diets. It is therefore very important to consider mineral requirements in addition to protein and energy requirements in these situations. Feeding high levels of animal source protein such as meat or fish is acceptable as long as added sources of vitamins and minerals are made available. As will be discussed later, failing to do so can result in significant nutritional abnormalities particularly relating to the skeletal system.

Long term exposure to abnormal nutritional situations will generally result in clinical manifestations of abnormalities in the cat. These can be related either to problems of over nutrition or under nutrition. As is the case with the dog, general over nutrition resulting in obesity is a significant problem. This is in effect a problem of energy over nutrition resulting from an excessive energy intake in relation to the level of energy expenditure. Studies in other species have indicated that an over weight condition may result in other problems such as cardiac disease, musculo-skeletal abnormalities and decreased life span.

The handling of this condition is frequently an educational problem, i.e. to convince the owner that the animal is overweight and that this condition is deliterious to the continued health of the animal. Once the educational problem is surmounted, the handling of the situation is relatively easy. A primary treatment for this condition is to decrease food intake, initially to the point that the animal metabolizes body fat to meet its maintenance caloric requirement and, after this has been accomplished, to feed sufficiently to maintain normal weight. The general recommendation is to estimate the ideal weight for the animal and then feed approximately 2/3 of the amount that would ordinarily be required to maintain this weight. This will result in a gradual weight loss. When ideal weight has been attained, increase food intake to the level required to maintain that weight.

On the opposite side of the scale is the nutritional management of the cat with anorexia. Cats suffering from many disease conditions will become anorectic and the malnutrition resulting from this anorexia can become life threatening if it is prolonged. When such conditions occur it is generally necessary to provide supportive alimentation either by the oral, or intravenous route. This should be done only under the advice and guidance of a veterinarian. It should be emphasized, however, that when the situation warrants it, the use of supportive alimentation may indeed save the life of an animal which would otherwise succumb.

Mineral deficiencies, particularly of calcium and phosphorous, are relatively common in both the dog and the cat, particularly when home formulated rations or gourmet commercial products are used. This generally

occurs when an all meat or fish diet is fed without sufficient attention to mineral requirements. Meat is very low in calcium and relatively high in phosphorous and a diet composed exclusively of meat will induce the disease condition known as nutritional secondary hyper-parathyroidism (NSHP) in animals. It is particularly prevalent in the young growing animal maintained on such diets. The usual presenting signs are a growing kitten that has been alert and active and suddenly shows signs of pain and unwillingness to move. The characteristic finding fractures of long bones or compression fractures of bones in the vertebral column. Radiographically, the bones are very thin and poorly mineralized. Years ago this condition was thought to be hereditary and called "osteogenesis inperfecta." However, recent investigations have shown that this is indeed a nutritional problem caused by feeding an all meat diet. If irreversible damage, such as damage to the spinal cord, has not occurred, reducing the fractures and placing the animal on a diet that is normal in calcium content will result in a complete cure. Meat is also deficient in iodine and signs of hypothyroidism might also occur in cats on all meat rations. Another disease condition related to calcium metabolism that has been rarely reported in cats is "eclampsia" which is a hypocalcemia or low blood calcium syndrome that is seen in animals that have recently queened. The actual cause of this condition is unknown but in other species such as cattle it seems to be related to an excessively high intake of calcium in the diet before parturition. This condition can most readily be treated by giving intravenous calcium and by removing the kittens from the dam for a one to two day period. Again, a veterinarian should be consulted when signs of this disease such as tetany or convulsions

occur.

Clinical problems related to abnormal nutrition of at least three vitamins have been reported in the cat, these being vitamins E, A, and B_1 or thiamine. In the early 1950's a disease known as yellow fat disease or steatitis was recognized in kittens fed from weaning on diets largely composed of fish particularly red tuna. The clinical signs were those of a cat that was depressed and with a history of extreme pain or hyper sensitivity when touched. When cats died of this disease the fat was found to be very yellow in color and dark placques containing the pigment known as ceroid were found scattered throughout the fat depots.

Since a similar condition had been reported previously in rats and shown to be due to a deficiency of vitamin E, this deficiency suspected in these cases. Addition of vitamin E to similar diets in experimental situations completely prevented the occurrence of the disease. Therefore, it was felt that a vitamin E deficiency was the cause of the problem. As a result of this problem most cat food manufacturers now supplement fish type rations with vitamin E so that at the present time there is a very low incidence of the disease. However, it is not impossible that isolated instances of this disease could occur particularly in situations where owners are preparing home formulated rations with high levels of fish products, particularly those containing significant quantities of fish oil. The condition is generally treated by giving oral doses of 50 international units of vitamin E daily for two to four weeks. The diet should be altered and it may be necessary to resort to supportive alimentation in these cases. It is felt that oxidative rancidity of the poly unsaturated fats present in the fish oil results in the destruction

of any vitamin E that may be present in the ration thus resulting in a vitamin E deficiency.

With regard to vitamin A the clinical syndrome of hypervitaminosis A or over nutrition with vitamin A is more common in the cat than under nutrition. This condition has resulted from feeding cats rations very high in liver and reproduced experimentally when rations with high levels of vitamin A were fed. The disease is characterized by the development of exostoses or abnormal bone growth in various parts of the skeleton particularly the cervical vertebrae, forelimbs and thoracic cage. The resultant postural changes and musculo-skeletal deformities resulted in a very characterisitc clinical syndrome in affected animals. It generally occurs in adult cats and there is no history of previous traumatic injury or other musculo-skeletal problems. The disease process is basically irreversible but treatment with analgesic drugs has been reported to be of paliative value. Since the disease is most likely due to high levels of vitamin A in the liver fed to these animals, a change in ration is definitely indicated. This will prevent further development of the disease process but will be probably of little value in resolving the damage that has already occurred. While the recommended levels of vitamin A for the cat are listed as approximately 1,000 international unit per kg of body weight per day, the cats experimentally affected by feeding liver or vitamin A received levels of approximtely 50 to 100,000 international units per kg per day.

Thiamine deficiency has been reported in cats as a clinical entity in the United States, Canada as well as in other countries. The clinical syndrome occurrs under at least two feeding situations, one in which diets of raw fish particularly carp and harring are fed to cats and

another in which cats are fed a canned ration. Cases of thiamine deficiency in cats being fed canned rations have occurred with rations containing fish or other meat type products. In the case of raw fish diets, it is felt that a thiaminace or thiamine destroying factor is present in the fish and in the case of canned rations it is felt that the vitamin may be destoryed during the processing of the product particularly by overheating.

The first sign of deficiency appears to be anorexia and weight loss which is followed after a period of one to three weeks by incoordination, staggering, and weakness culminating in convulsions and death if treatment is not instituted. A characteristic finding in cats with advanced thiamine deficiency is a ventro-flexion of the head and severe mydriasis or dilation of the pupils with the pupils being unresponsive to light. Treatment of these animals with small amounts of thiamine (100-500 mg) is curative but if kept on the same thiamine deficient rations, the animals will relapse after a variable period of time. If thiamine deficiency is suspected, a veterinarian should be consulted and if treatment with thiamine is curative, a presumptive diagnosis of thiamine deficiency may be made. As a preventive measure, it should be recommended that raw fish be not used as an exclusive diet for cats and that if canned rations are fed, that food from the same batch number not be fed for an extended period of time.

Considerable research work has been done over the last few years relating to the cause and development of urolithiasis in cats. Many factors have been implicated in the development of this disease including nutritional factors, and infectious organisms such as bacteria and

viruses. Since another speaker at this symposium will discuss the possible role of viruses in this disease it will not be discussed further here. Bacterial infection has not been shown to have a significant causal relationship to the development to urolithiasis in the cat. There is considerable controversy in the literature as to the possible role of nutritional factors in the development of this disease.

Feline urolithiasis syndrome (FUS) is a disease that affects both intact and altered male cats but is rarely seen in the female. The incidence has been variably reported as from less than 1% of the population to 10% or more of the population. It is generally seen in adult cats in the 2 to 5 year age group but does occur in younger and older animals. Affected cats show marked signs of discomfort characterized by frequent straining to urinate (which may be misinterpreted as constipation by the owner), and frequent licking of the penis. The penis will often be noted to be protruding from the prepuce and the end of the penis will frequently be of a reddish purple color rather than the normal pink. Occasionally, crystals may be seen at the end of the penis. The syndrome is the result of formation of a crystalloid protein precipitate in the bladder with subsequent obstruction of the urethra by material traveling down it from the bladder. The material found in the bladder contains varying amounts of crystalline material and a muco-proteinaceous ground substance. The mineral is generally of the nature of "struvite" or calcium magnesium ammonium phosphate. The relative amounts of crystalline and proteinaceous material in any given cat is variable, some animals demonstrating almost pure crystalline substances while others showing small amounts of crystalline material and large amounts of proteinaceous

substances.

In the early 1950's it was recommended that a low ash diet be used in an attempt to prevent the occurrence of this disease. Since that time many studies have been done in an attempt to clarify the possible role of the diet in the development of this problem but few definitive results have been obtained. In one study a diet containing up to 30% ash on a dry matter basis was fed to growing kittens with no incidence of obstruction occurring. However, the animals used in this study were young growing kittens as opposed to adult cats in which the disease usually occurs. Also, the highest ash level used, approximating 30% of the diet, contained no additional magnesium. In a more recent study it was shown that if cats with a previous history of urolithiasis were fed a minced beef heart diet, the probabilty of relapse was increased. This diet contained high levels of magnesium, approaching 1% on a dry matter basis. Subsequently, other workers showed that by raising the magnesium and phosphorous level of a canned ration (.75% Mg, 1.6% P) urolithiasis in normal cats could be induced. However, chemical analysis of the crystals found in this study indicated that no ammonium ion was present and therefore the crystalline material could not be identified as struvite. Furthermore, the magnesium level, though not necessarily the P level, needed in these rations to induce urolithiasis was far higher than the level found in any of the commercially available cat foods. Therefore, the results of this study do not confirm a relationship between the feeding of any of the commercially available cat foods with the incidence of urolithiasis.

We have recently performed a study similar to the one just discussed in which a diet high in either magnesium or magnesium and phorphorus was

fed to normal cats. As in the previous study we were able to induce urolithiasis in intact adult male cats in a period of three to six week by using this diet. Also, x-ray crystallographic examination of the crystalline material has confirmed the presence of struvite in some of these cats. Again, the level of magnesium used was far higher than that found in commercial cat food products. Other factors were also noted in the study. For example, the feed intake of these animals dropped dramatically when they were changed from the normal ration to the same ration with added levels of magnesium or magnesium and phosphorus. It is possible that the significant decrease in food intake may have been related to the elaboration of the disease. Also, we have obtained some evidence that these conventional cats may also have been infected with some of the viral agents which will be reported on subsequently in this symposium. This study is now being repeated in SPF cats in an attempt to determine if there may be some inter relationship between a high magnesium intake and a possible viral infection in the causation of the disease.

In summary, although urolithiasis can evidentally be induced by adding high levels of magnesium or magnesium and phosphorus to the ration of the cat, the levels that must be used are far in excess of any of the levels found in commercial cat food products. When comparing the various commercial products available, one notes that the total mineral content on a dry matter basis is frequently higher in canned or soft moist rations than it is in dry rations (Table 6, 7). When this information is added to the information that cats consuming a dry diet often consume more water than those on a soft moist or canned ration, it is difficult

to support the argument that feeding dry cat food rations should be discouraged. It is certainly important, however. that when any change in the ration of any animal is made that it be accomplished gradually and in such a way that nutritional balance is maintained during and after the change. It is also very important that adequate amounts of water be made available to cats at all times. It is probable that the feline urolithiasis syndrome is a multi-factorial problem, with management factors possibly being very important. The possibility of an infectious etiology, though probably not proven at this point, certainly is of great interest and the cat owning public as well as the veterinary professor will anxiously be awaiting the results of further studies.

Table 1

Recommended Nutrient Allowances for Dogs and Cats
(amount per pound body weight per day per an average size adult)

	Dog*	Cat**
Energy (Cal)	30	35-40
Protein (gm)	2.1	2.5-3.0
Fat (gm)	1.1	2.0?
Carbohydrate	--	--
Minerals		
Calcium (mg)	110.00	121.00
Phosphorus (mg)	90.00	106.00
Iron (mg)	0.60	1.52
Copper (mg)	0.07	0.06
Cobalt (gm)	0.06	0.05
Salt (mg)	110.00	166.00
Potassium (mg)	60.00	22.00
Magnesium (mg)	4.00	3.03
Manganese (mg)	0.05	0.06
Zinc (mg)	0.50	0.09
Iodine (mg)	0.02	0.01
Vitamins		
Vitamin A (IU)	50.00	600.00
Vitamin D (IU)	5.00	30.00
Vitamin E (IU)	0.50	1.10
Thiamin (µg)	10.00	120.00
Riboflavin(µg)	22.00	60.00
Pantothernic Acid (µg)	100.00	300.00
Niacin (µg)	113.00	1210.00
Pyridoxine (µg)	10.00	---
Folic Acid (µg)	1.80	0.61
Biotin (µg)	1.00	30.00
Vitamin B_{12} (µg)	0.23	--
Choline (mg)	12.00	30.30

*Modified from NRC (1974)
**Modified from NRC (1972) and Scott (1975)

Table 2

Caloric Intake and Nitrogen Balance of Adult Cats on Mixed Diets of Decreasing Protein Level*

Protein Content (DM) of diet (%)	BV %	Caloric Intake (Cal/lb)	N balance (gms/day)
46	30	36	+ .20
39	35	32	+ .04
32	36	35	- .04
26	53	44	+ .17
19	50	47	- .04
13	53	40	- .40

* Fish and liver as protein source
Greaves and Scott (1960)

Table 3

Water Consumption by
Cats Consuming Dry or Canned Ration

	Dry Cat Food	Low ash Dietary Food
Dry matter Intake (gm/cat/day)	85	52
Water eaten (gm/cat/day)	9	119
Water drunk (gm/cat/day)	181	35
Total H_2O intake	190	154

Diff. - Dry 23% more than Canned

Table 4

Protein and Energy Requirements of Growing Cats

	Requirement	
	Cat	
Age (weeks)	Protein gm/lb/day	Energy Cal/lb/day
0-1	9.05	136
1-2	8.14	127
2-3	10.23	120
3-4	---	113
Weaning	10.23	102
half-grown	2.7	77
adult	1.7	40

Table 5

Composition of the Milk of the Bitch and Queen
Compared to Substitute Products

Nutrient	Bitch Milk	Esbilac	Queen Milk	KMR
Protein (%)	7.3	7.6	9.5	7.6
Fat (%)	8.3	8.2	6.8	4.6
Lactose (%)	3.5	2.9	10.0	4.8
Calories 100 gms	120	130	142	90
Ca (mg/100 cc)	230	168	35	200
P (mg/100 cc)	160	141	70	165
Soldis (%)	22.6	21.0	19	18.2

Table 6

Average Mineral Content of Cat Foods*
(% on a dry matter basis)

Type	Ca	P	Mg
Canned	1.86	1.28	0.15
Soft-Moist	1.82	1.41	0.16
Dry	1.57	1.10	0.16

*Modified from Chow and Hamar

Table 7

Ash Content of Cat Foods

	As is (%)	DM (%)
Dry	6.0	6.7
Soft-Moist	4.0	6.1
Canned (complete)	4.0	16.0
Canned Gourmet	3.0	13.6
Therapeutic Diet	1.5	5.4

FELINE UROLITHIASIS

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A complex urinary tract disease of cats is variously referred to as:

- the feline urological (or urinary) syndrome
- Urethral obstruction
- Urolithiasis

The disease is marked by the formation of stones (calculi), or the tendency towards their formation along the urinary tract. Urolithiasis appears to be a more descriptive term -- and is derived from two Greek words:

ourin = urine
\+ lithos = stone.

Many animal species including humans are afflicted with urolithiasis. The incidence of the disease in male cats has been reported as high as 10%. The overall incidence may be higher if female cats are considered. Female cats are seldom obstructed because they have a shorter wider urethra. The most common clinical sign in the female is cystitis (inflammation of the bladder). The disease may remain undetected in the female unless the cystitis is accompanied by appreciable blood in the urine (hematuria). Identifying the primary cause(s) of urolithiasis has been difficult. Some of the factors which have been implicated, may not be the initial cause, but they may aggravate the disease. Causative factors which have been implicated include nutritional, metabolic, and bacterial infection.

If the blockage is not removed, the cat may die from the accumulation of toxic waste products in the blood which cannot be eliminated in urine. This is known as uremic poisoning. Cats that recover from the disease may

have recurrent episodes of blockage. Feline urolithiasis has been described in many areas of the U.S. and Europe: Cases may occur at any time of the year -- however, more cases occur during the colder months. Cats have developed the disease under a variety of nutritional regimes. In the cat, the stones generally occur as sandy particles or gravel. Small stones may also be found in the bladder and in the urethra. The most common crystalline accumulations in the cat have been identified as struvite (triple ammonium phosphates). Obstruction results when the sand or gravel (frequently mixed with mucus, dead cells, and blood clots) lodge in the urethra to block the free passage of urine.

Our theory, which is supported by experimental evidence, is that feline urolithiasis is caused by the interraction of (two) viruses. The Manx calcivirus (previously classified as a picornavirus) appears to reactivate a latent (dormant) herpesvirus in the urinary tract. This herpesvirus is different from the rhinotracheitis herpesvirus. The reactivated herpesvirus produces cellular changes which result in the development of the disease.

The cellular changes induced in infected cell cultures by the second herpesvirus suggest the possible origin of urinary stones and/or obstructing plugs. These changes are:

-The induction of intracellular and extracellular chemical crystals.

-The formation of "tissue culture calculi" closely resembling the obstructing plugs found in cat urethras.

The reactivation of latent viruses is not an unusual occurrence. For example, the human "cold sore" or "fever blister" results from the reactivation of the Herpes simplex virus. A large percentage of individuals carry

this virus as a latent infection without clinical signs of disease. During periods of stress, or fever, the virus may be reactivated to produce the sore or blisters. A more serious complication caused by the reactivation of this virus is keratitis - (involvement of the eye cornea). A second example is the reactivation in adults of the childhood acquired chicken pox herpesvirus (Herpes zoster). In adults, the reactivated Herpes zoster produces the clinical disease shingles. The exact factors of reactivation are not known. However, stress is considered to play a role.

A third feline virus has been isolated from spontaneous and experimentally induced cases of urolithiasis -- the feline syncytium forming virus. This virus may produce secondary complications -- or may have no effect. The third virus is widely distributed in cat populations and belongs to a subgroup of viruses known as the myxoviruses. The experimentally obstructed cats from which the virus was isolated were not reared in isolation and were probably carrying the virus. This virus produces large multinucleated cells (syncytia) in infected cell cultures.

Experiments are underway in cats reared in isolation and by all available test methods are free of the three viruses in question. These cats are specific pathogen free (SPF) cats. The cats come from a colony which has been in existence for about 8 years.. During these years, there has not been a single case of spontaneous urolithiasis.

In these experimental cats, we hope to establish the role of the three viruses in feline urolithiasis. The ultimate goal of the studies is to develop possible vaccine(s) or treatment to control the disease in cats. This development, depends upon establishing the exact roles of the viruses in the pathogenesis of the disease.

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FELINE LEUKEMIA AND RELATED VIRUSES

by John E. Post, D.V.M., Ph.D.

The role of viruses in the cause of some tumors (neoplasms) is now well established. Certain viruses of both ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) types have been identified as causative agents for several kinds of tumors in a variety of animal species including chickens, mice, cats, and monkeys. Some induce only benign growths such as papillomas or warts. Others cause malignant tumors (i.e. cancer) such as mammary carcinomas and leukemias. As a group they are often called oncogenic (tumor forming) viruses, but evidence is accumulating that some also cause nontumorous forms of disease.

So far, only RNA oncogenic viruses have been isolated from cats. These closely resemble the RNA viruses of other species that cause "leukemias" (tumors of blood forming cells) and sarcomas (tumors of other mesodermal tissue). On the basis of their structural and replication

patterns, virologists have referred to them as C-type viruses in contrast to the somewhat similar A and B morphological types that cause mammary tumors in mice. A and B virus types have not been observed in cats. Collectively all RNA tumor viruses are now commonly called oncornaviruses (oncogenic RNA viruses).

Feline Oncornavirus Types and Characteristics

1. *Feline Leukemia Virus (FeLV).*

"Leukemia" or the "leukemia complex" are terms commonly used to include all the neoplastic diseases of hematopoietic or blood forming cells originating from either bone marrow or lymphoid tissue. Within this group there are many different tumor forms, but basically they all consist of an uncontrolled proliferation of either white or red blood cells (leukocytes or erythrocytes). Oncornaviruses causing these kinds of malignant tumors are known as "leukemia viruses".

In 1964, the first FeLV was demonstrated by Dr. W. F. H. Jarrett and his associates in Scotland while studying a cluster of leukemia cases in cats. Since that time this virus has also been found in many countries including the United States. Experimental and epidemiological studies have shown that FeLV is contagious and causes leukemias and other diseases in cats. Different serotypes and strains of FeLV have been recognized, and there is some evidence

that these may differ in their disease producing potential. Publicity about the transmissibility of this virus among cats and the possible susceptibility of humans to infection has caused considerable concern.

Like other leukemia viruses, FeLV does not ordinarily destroy the cells that it infects. Instead, it either stimulates them to proliferate in a neoplastic manner, or it has no observable pathogenic effects. Infected cells produce new virus at their cell membranes by a budding process that forms particles with a central RNA core surrounded by protein and a modified cell membrane envelope. Virus particles can be observed by electron microscopy, one method sometimes used for diagnosing infection. See Figures 1 and 2. In addition to these formed virus particles, FeLV structural proteins and glycoproteins appear in the cytoplasm and on the surface of infected cells. Their presence can be observed by immunofluorescent techniques, and this forms the basis for currently used diagnostic tests employed to detect virus infection and immunity.

A unique characteristic of all oncornaviruses is the presence of a DNA polymerase enzyme, sometimes called reverse transriptase. When the virus infects a cell, this enzyme is capable of transcribing the genetic information of the viral RNA into the chromosomal DNA of the cell that it infects. Thus, virogenes and oncogenes carried by a virus may become permanently established as part of the genetic

make up of the infected cell. This means, then, that in order to eliminate a FeLV infection, it is necessary to destroy all virus-infected cells.

2. *Feline Sarcoma Virus (FeSV).*

Shortly after FeLV was discovered, Snyder and Thielen in California found a fibrosarcoma inducing virus in a cat with multiple fibrosarcomas (malignant fibroblastic cell tumor) and Post and Rickard at Cornell University found, in a leukemic cat, a virus that induced liposarcomas (malignant fat cell tumors). Since then other FeSV's have been observed in additional cases of clinical fibrosarcoma.

The physical, chemical, and antigenic properties of these sarcoma viruses are identical to those of FeLV, but their biological behavior is different. Unlike FeLV they cause connective tissue type sarcomas rather than leukemias, and in laboratory cultured cells they cause a visible transformation effect that is not induced by FeLV.

Experimental transmission studies have shown that some strains of FeSV are highly pathogenic for young susceptible cats causing nearly a 100% incidence of tumors following a short incubation period. In natural cat populations, however, sarcomas are not common and FeSV appears to be an insignificant pathogen compared to FeLV.

3. *Feline Endogenous Virus.*

When fetuses and placentas of cats are examined by electron microscopy a very small number of C-type virus particles may be

found that closely resemble FeLV and FeSV in appearance. In cat cells, where they originate, these viruses grow very poorly, but they thrive in the cells of some other species, including man. Virus isolation is facilitated by chemically treating cultured cat cells with iododeoxyuridine or bromodeoxyuridine and then co-cultivating these cells with those of another species. In one interesting experiment, human tumor cells were transplanted to a fetal cat, where growing in association with cat cells, they became infected with the feline endogenous virus. For some time, this virus isolate, designated RD114, was suspected of being a human tumor virus. A similar virus was isolated from a permanent cat kidney, tissue culture cell line that has been extensively used for laboratory studies and vaccine production. It is suspected that all cats carry this virus in a latent or hidden form.

Feline endogenous virus is inherited genetically and is not infectious or pathogenic for cats. Since it can be infectious for the cells of other species, however, studies are being made to determine whether the endogenous virus of one species can become the pathogenic virus of another. So far, inoculation of this feline virus into other species has not caused any disease.

Diseases Associated with FeLV and FeSV

FeSV has only been associated with either fibrosarcomas or liposarcomas. These tumors are rare in cats and so this virus seems to have minor clinical significance. FeLV, on the other hand, has been

shown to cause a variety of hematopoietic neoplasms, some anemias, and some immune deficiency conditions that predispose cats to other diseases. The various diseases associated with FeLV infection are briefly described below:

1. *Lymphosarcoma* - these tumors make up the majority of malignancies caused by FeLV. They consist of solid masses of proliferating lymphocytes. On the basis of organ involvement they are separated into the following forms but combinations of these may occur:
   a. *Thymic* - this type typically occurs in young cats 1 to 2 years of age. Though this tumor may extend to other tissues, it primarily involves the thymus, which expands to form a large mass in the thorax. Its hidden location can make diagnosis difficult. When the tumor mass reaches a large size, lung compression by the tumor and accumulated fluid causes obvious respiratory embarrassment. The clinical diagnosis may be confirmed by finding tumor cells in aspirated pleural fluid.
   b. *Generalized or Multicentric* - this form is most likely to occur in middle-aged cats but is seen in a wide range of ages. Lymphoid tissue throughout the body is often involved. Lymph nodes, spleen, and liver may become markedly enlarged. These can be palpated making this form of lymphosarcoma more easily recognized. However, a surgical biopsy may be needed to distinguish this from other diseases that cause lymph node enlargement.

c. *Alimentary* - this form often occurs in older cats. The major tumor masses arise from lymphoid tissue commonly present in the wall of the gastrointestinal tract. The associated mesenteric lymph node may also be involved. These tumors can cause partial intestinal obstruction resulting in clinical signs such as vomiting, diarrhea, or inappetance.

d. *Renal* - this form also usually affects older cats and may be present in cases having the alimentary form as well. Nodular or diffuse infiltration of the kidney with neoplastic lymphoid cells causes gross enlargement that may be evident on palpation. Interference with normal renal function may cause clinical signs of renal insufficiency.

e. *Miscellaneous Forms* - lymphoid tumors involving only the skin, the eye, or some areas of the nervous system are seen in cats but occur infrequently. Of these, the ocular form has been induced experimentally by the inoculation of FeLV.

2. *Lymphocytic Leukemia* - this refers to a true leukemia where there is an abnormal proliferation of neoplastic lymphocytes in the circulating blood and blood spaces such as spleen and bone marrow. This condition may exist by itself or be associated with a lymphosarcoma form of disease. Examination of peripheral blood establishes the diagnosis.

3. *Myeloproliferative Diseases*-myeloid cells are those that form the bone marrow, and these consist mainly of developing red cells and

white cells. Neoplastic proliferations of any of the variety of cells in this group are referred to as myeloproliferative diseases. Clinically these appear as true leukemias like lymphocytic leukemia and involve the circulating blood and blood spaces. Diagnosis is made by examining peripheral blood and bone marrow.

4. *Anemia* - two forms of anemia have been associated with cats naturally or experimentally infected with FeLV. One is a hypoplastic or bone marrow depression anemia and leukopenia where a failure in its generation of both red cells and white cells results in low peripheral blood cell counts.

The other kind of anemia induced by FeLV is a hemolytic form where red cell depletion is associated with a destruction of mature blood cells. It is suspected that both of these kinds of anemia are caused by an immune mechanism initiated by an alteration of blood cell membranes when these cells are infected by FeLV.

5. *Immune Suppression* - many kittens inoculated with FeLV develop thymic atrophy and become unusually susceptible to a variety of infections. Likewise, many adult cats persistently infected with FeLV have chronic or recurrent disease problems. Skin grafting and phytomitogen lymphocyte stimulation tests have shown a deficiency in cell mediated immunity in these infected cats. A similar deficiency in humoral immunity has not yet been evaluated but is suspected since many cats persistently infected with FeLV do not develop antibodies to this infecting virus. The immunosuppressive effects of leukemia viruses have also been observed in mice, but the mechanism for this is not yet understood.

6. *Other Diseases* - cats affected with a large variety of disease conditions have a high incidence of FeLV infection. Especially noteworthy among these are: feline infectious peritonitis, feline infectious anemia, toxoplasmosis, stomatitis, and respiratory diseases. There is no evidence that FeLV is the direct cause for any of these, but there are good suggestive indications that FeLV, by its immunosuppressive effect, lowers an infected cat's resistance to these conditions so that they become more serious disease problems. This may also explain why some sick cats respond poorly to treatment and some remain chronically ill or have repeated episodes of illness.

A kind of kidney disease called glomerulonephritis has been observed in a number of FeLV infected cats, both in those with no tumors and those with leukemia. It is suspected that this disease is caused by the formation of FeLV antigen—antibody complexes that accumulate in kidney glomeruli.

Recently, FeLV has been found in many cats with fetal resorption and abortion problems. FeLV is suspected of having a causative role in these conditions but this has not been proven.

FeLV has been demonstrated in the tissues of a number of feline mammary tumors. Here also, it is uncertain whether it has anything to do with causing them. When experimentally inoculated into susceptible kittens, viruses isolated from these tumors have so far caused leukemia but no mammary tumors.

Epidemiology of FeLV Infections

1. *Incidence.*

Less than 0.1% of all domestic cats develop leukemia each year. FeLV can be found in 60 to 90% of these and is the obvious major cause for this kind of neoplasia, but all leukemic cats are not virus positive. The incidence rates of FeLV-related diseases are not known, but they appear to be higher than the incidence of leukemia. Some clinically normal cats, also, are persistently infected with FeLV. The number of virus infected cats at any given time, however, is estimated to be only about 2% of the total cat population, though this figure is much higher in certain confined populations.

2. *Transmission.*

FeLV is contagious and is transmitted from cat to cat by contact. Where contact between cats is high, as in cities, and breeding colonies, the spread of infection is high. Infected cats, whether they are sick or healthy virus carriers, can shed infectious virus in saliva and urine and probably also in milk, feces, and exhaled air. FeLV survives only a short time (a few hours to a few days) in the environment, but during this time it can infect other cats. Genetic transmission from parent to offspring is also suspected since the virus is commonly present in the testes and ovaries of infected cats, and the offspring of such animals are often infected. Transmission by blood sucking insects seems possible, as well, but this has not been proven.

3. *Immunity.*

All cats exposed to FeLV do not develop disease or become persistent virus carriers. Many apparently develop some degree of immunity by means of a humoral immune response that suppresses virus infection. Two kinds of antibody are produced: (1) virus neutralizing antibodies, and (2) antibodies directed against antigens on the surface of virus infected cells (feline oncornavirus associated cell membrane antigens, FOCMA). The former afford protection against virus infection and the latter protect against tumor formation. These kinds of protection can be passively transferred in colostrum from immune queens to their newborn kittens.

Laboratory tests have been developed for measuring the levels (titers) of these antibodies. What level constitutes a protective neutralizing titer has not been established, but it has been shown that very low anti-FOCMA titers do not protect against tumor growth.

The distribution of nonimmune, immune, and infected cats varies in different populations. Some surveys have shown that anti-FOCMA antibodies are present in 50% of unconfined urban cats (Boston, Detroit, Glasgow) but present in only 6% of rural cats (Scotland). In the urban group, only 6% of weaned kittens have evidence of immunity, but the percentage increases with age, presumably because opportunities for virus contact increase

with age. In contrast, the number of cats in these populations that develop leukemia and other FeLV-related diseases and show little or no immune response is very low.

The pattern of disease and immunity among confined groups of cats in breeding colonies or multicat households can be very different, however. If FeLV is present, the incidence of leukemia may be 25% or more and the number of immune cats is low. If FeLV is absent, neither leukemia nor immunity develop.

Cats exposed to FeLV, then, respond in different ways. They may, (1) not become infected at all, (2) become temporarily infected, but develop immunity and overcome the infection, (3) become infected and continue to carry and shed virus indefinitely while remaining clinically normal, or (4) become infected and develop leukemia or one of the other FeLV related diseases. Which of these that is destined to occur in any particular cat is basically related to the ability of that cat to respond immunologically on the one hand, versus the immunosuppressive effects of the virus, on the other. Age and probably genetic factors in the exposed cat plus the strain and dosage of the infecting virus influence these immune mechanisms.

How these factors balance out to cause either disease or immunity is not fully understood, but it is obvious that both immature age and group confinement of cat favors disease rather than immunity. It is speculated that immune responses are less successful in multicat groups because exposure dosages are higher than in free-roaming cats.

Control and Management of FeLV Infections

1. *Diagnosis - FeLV Tests.*

Numerous techniques have been developed for detecting FeLV or some of its components, but the one that has become most practical for diagnostic purposes is an indirect immunofluorescence technique developed by Dr. W. D. Hardy and now offered commercially by a number of laboratories. The test is performed on either blood or bone marrow smears and detects FeLV group specific antigen present in infected blood leukocytes. The validity of this test depends on the use of antiserum specific only for the antigens associated with FeLV. If other activity is present, false positive results may be reported. At present there is no official control over the preparation of these test serums or the performance of the tests, and controversies have arisen because different laboratories have reported different results on samples from the same cat.

A more accurate but less practical method for demonstrating infection is by virus isolation in tissue culture. This method is not offered, so far, by diagnostic laboratories, but some investigators have used this on a selected group of cases to substantiate the results of their immunofluorescent tests. Virus isolation is made from plasma, blood leukocytes, or bone marrow.

When choosing a laboratory to perform FeLV tests it is wise to seek some assurance of their credibility. Some official certification of reliable laboratories may be forthcoming in the future.

It should be emphasized that FeLV tests do not detect leukemia itself but rather reveal the virus infection that causes leukemia. Clinically normal virus carriers will give a positive test. Also, some clinically leukemia cats are virus negative and would appear negative on these tests.

2. *Treatment.*

As in humans, corticosteroids and other anticancer drugs such as cyclophosphamide and vincristine have been beneficial in producing remission of variable duration in cats with leukemia. Corticosteroids have also been helpful in treating FeLV induced anemias. Generally, however, such treatments are only temporarily effective and do not eliminate the FeLV infection if it is present.

Treatment methods to eliminate FeLV infections have not been developed, but immunotherapy and antiviral drug therapy are being studied and show some promise. So far, this research is in the early investigational stages.

3. *Eradication of Infection.*

One proven but sometimes harsh method of controlling disease is to identify the carriers of the causative agent and eradicate them. This method is being applied against FeLV on a voluntary basis and is giving quite favorable results, especially in those catteries where infection was causing many cases of leukemia and anemia.

In a procedure recommended by Dr. W. D. Hardy, all cats testing positive for FeLV are eliminated or isolated. Remaining virus negative cats are tested at 3 month intervals and if any new positives appear, they are eliminated. After 2 negative tests, the cattery may be free of infection.

Experience has shown that most cats having positive evidence of FeLV in their leukocytes remain positive indefinitely and have a high risk of eventually developing leukemia or anemia. However, a few such positive cats have subsequently developed immunity and thrown off their infections. If the latter were to happen it would most likely occur within 3 months, and therefore there is some rational for not immediately destroying positive cats, but instead, hold them in isolation for 3 months to see if they might revert to a negative state.

Along with the eradication of infected animals, it is also important to rid the premises of infection. FeLV is destroyed by most common detergents and disinfectants.

4. *Vaccination.*

Considerable effort is being directed toward developing vaccines effective in preventing FeLV infection and tumor growth. Experimentally, these look very favorable, but time is needed to prove their efficacy and safety before they can be offered for common usage.

The Human Hazard of FeLV

Considerable concern was aroused when it was shown that FeLV could infect and replicate in laboratory-cultured human cells. Also, it was experimentally possible to induce leukemia or sarcoma in dogs and monkeys by inoculating them before or on the day of birth with FeLV or FeSV. So far, these cross-species infections have occurred only in situations where immune mechanisms were not functional, and so it is currently believed that normal humans would not become infected if naturally exposed to FeLV.

This belief is further substantiated by the failure to find FeLV in large numbers of humans, including many with leukemia and many who have a great deal of contact with cats. It must not be overlooked, however, that some humans may be susceptible because they are not immunocompetent. These include fetal and newborn infants, individuals under immunosuppressive therapy, and those with genetic immunological defects.

Some human serums have shown virus neutralizing and other antibody activities against FeLV or FeLV-infected cells. This activity has not been fully evaluated. It could represent some previous exposure to FeLV resulting in a specific immune response, or it could just represent the presence of antibodies that coincidentally cross react with FeLV antigens.

Summary of Important Points

1. There are 3 recognized feline oncornaviruses (FeLV, FeSV, and feline endogenous virus). Only FeLV appears to be very clinically significant.
2. FeLV causes leukemia, anemias, and immunosuppression that predisposes cats to other diseases.
3. The outcome of FeLV infection is determined by multiple factors that cause either an effective immune response, or conversely, immunosuppression in the infected host. Age of the host and the strain and dosage of infecting virus are most important among these factors.
4. Most adult pet cats naturally exposed to FeLV develop some evidence of immunity rather than disease, but similarly exposed young cats and groups of confined cats of various ages have a high incidence of disease and poor immune responses.
5. Virus carriers tend to remain so indefinitely and have a high risk of eventually developing fatal leukemia or anemia.
6. FeLV can be detected in blood smears and this can serve as the basis for a test and eradication system to control the spread of this infection.
7. When available, vaccines will probably be the ultimate way to control FeLV infection.
8. FeLV is probably only a health risk to immunoincompetent humans, if to any humans.

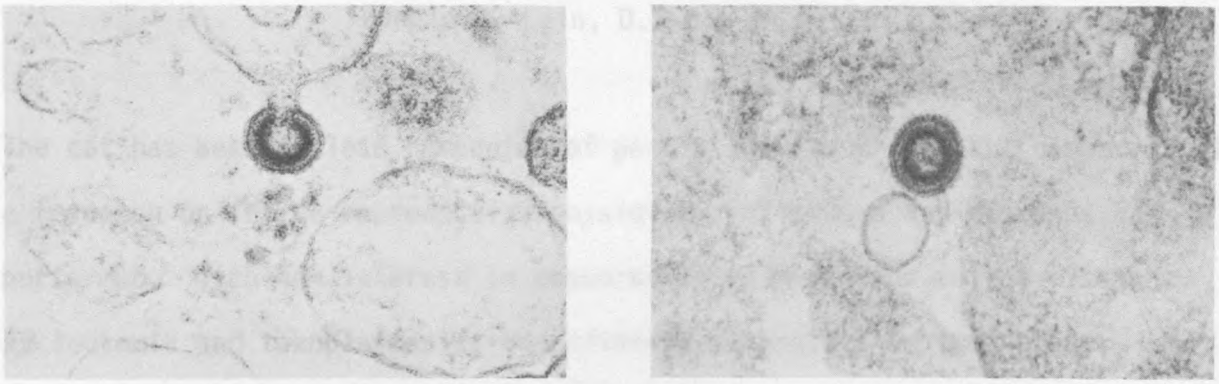

Figure 1. Electronmicrographs of FeLV particles. LEFT - budding particle being formed and released at cell membrane. RIGHT - free extracellular virus particle. Magnification - 100,000 X.

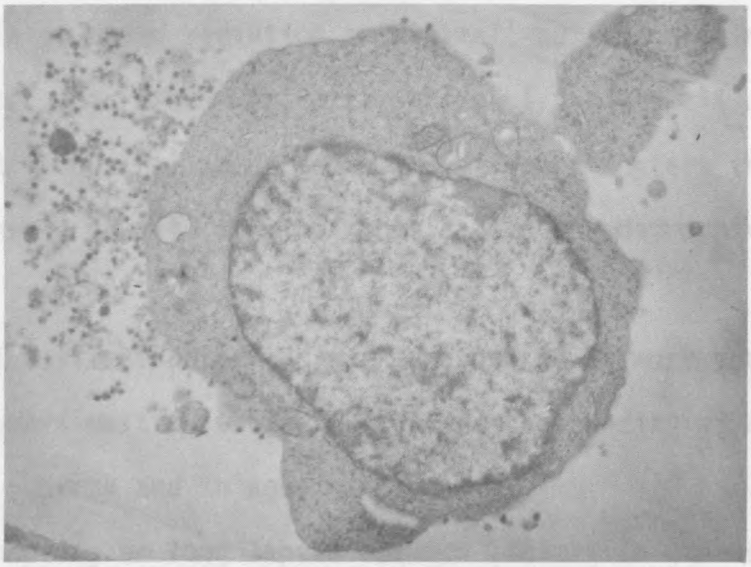

Figure 2. Electronmicrograph of a feline lymphosarcoma tumor cell growing in tissue culture and producing many virus particles. Magnification - 8,000 X.

Feline Reproduction

Donald H. Lein, D.V.M., Ph.D.

The cat has been a close companion of people for centuries, but comparatively little research on feline reproductive physiology, disorders and diseases has been performed. With new interest in comparative medicine and feline diseases, such as leukemia and toxoplasmosis, and advanced technology in immunology, microbiology, endocrinology and other related fields, a renewed interest in feline reproduction, obstetrics, gynecology, and andrology, now known totally as feline theriogenology, is emerging.

Normal Feline Reproductive Physiology

Puberty in the cat depends on the growth rate and season of birth. Queens reach sexual maturity from 4 to 12 months of age, while toms are usually fertile at 6 months. Strain or breed variation is minimal, but adequate nutrition, freedom from disease, late winter or early spring births are all necessary for early puberty which is controlled by the stimulation of centers in the brain to release adequate levels of pituitary hormones called gonadotrophins that activate the gonads.

The reproductive life span of the cat is about 14 or more years, with a period of 8 to 10 years most suitable for continuous breeding of a queen. Litter size is reduced at puberty and in aged cats.

Occassional breeding or long lapses between litters in queens are more likely to lead to reproductive problems or infertility then is continuous breeding. This is especially true when sham breeding or induced ovulation by use of a sterile rod stimulating the cervix or hormone injections are given to stop the behavioral signs of heat or estrus results in the pseudopregant state and proliferation of the uterine lining (endometrium).

The hormones of reproduction are controlled by the hypothalamic centers in

the brain which when stimulated secrete specific releasing factors from their nerve endings that are carried to the anterior pituitary gland in the base of the skull via a portal circulatory system and stimulate the release of the gonadotrophic hormones, luteinizing hormone (L.H.) and follicle stimulating hormones (F.S.H.). These hormones are carried to the gonads via the circulatory system.

The hypothalamic centers are also under the control of higher central nervous system centers and are influenced by the stresses of emotion, disease, nutritional deficiences and environmental influences, especially the length of daylight in the cat.

Follicle stimulating hormone (F.S.H.) is believed to cause the maturation of follicles in the ovary that secrete estrogens and are responsible for estrus or heat in the queen. In the tom, F.S.H. is believed to initiate the early stages of spermatogenesis (formation of sperm). Luteinizing hormone (L.H.) in the queen is believed to be released by direct nerve stimulation during copulation causing ovulation and the formation of corpora lutea from the ruptured ovarian follicles. The corpora lutea secrete progesterone, the hormone of pregnancy. Whether L.H. alone, or L.H. and/or prolactin, another hormone secreted from the anterior pituitary gland, are the hormones that support the maintance of the corpora lutea in the queen is unknown at this time. In the tom, L.H., or sometimes called I.C.S.H. (interstitial cell stimulating hormone) in the male, is believed to stimulate the interstitial cells or more specifically, Leydig cells of the testes, to produce testosterone which is needed to complete formation of sperm (spermatogenesis), maturation of sperm (spermiogenesis) and maintain the secondary male sexual characteristics and libidio.

The gonadal hormones, estrogen, progesterone and testosterone are called steriod hormones. They also can be produced, but usually at very low levels,

from the cortex of the adrenal gland. When adequate levels of these steroid hormones are reached, they control the release of the gonadotrophin hormones from the pituitary gland by decreasing the secretion of gonadotrophic releasing hormones from the hypothalamus. This is called a negative feedback mechanism and is a control mechanism that insures the constant recycling of the queen.

It must be remembered that other hormones are needed for proper reproductive activity although their effect is more through maintance of body homeostasis than activity as specific reproductive hormones. These include thyroid stimulating hormone (T.S.H.) and thyroxine, growth hormone (S.T.H.) or somatotrophin, corticotrophin (ACTH) and the adrenalcorticoids. Abnormalities in the total body endocrine picture can create impaired reproduction or total cessation of reproduction.

Reproductive disorders caused by hormone dysfunction are frequently diagnosed empirically, but little is known about the normal hormone levels in the cat so that definite diagnosis and knowledgeable therapy are impossible. Use of hormones indiscriminately can lead to permanent sterility, and supportive hormonal therapy may lead to genetical perpetuation of hormone dysfunction in future offspring since the production, secretion, and actions of hormones at target organs are probably genetically controlled.

The use of competitive protein-binding radioassay, radioimmune assay, and chromatography methods for hormone analysis in several species has lead to increased knowledge of normal levels so that hormonal disorders can be diagnosed and treated within physiological ranges. Little research has been done in the cat. Considerable work on several cats of different breeds and stages of the estrus cycle and pregnancy must be studied to establish basic values for all the hormones involved in reproduction.

The queen is normally a <u>seasonal polyestrous</u> animal with the active breeding

season starting in mid Janaury and continuing to September and October in the Northern hemisphere. She is called a "long day" breeder because the brain centers controlling reproduction are influenced by the length of daylight. Continuous indoor lighting, 12 or more hours, will usually cause cycling throughout the year in the queen. Less then 12 hours may lead to constant anestrus.

The tom also has a depressed sexual activity during the Fall months. Companionship of another cycling female or a tom maybe needed to stimulate a queen to cycle normally.

The estrous cycle in the queen is usually about 14 days long if mating does not take place and consist of three stages: proestrus, the period of rapid follicular growth in the ovary, lasting 1 to 2 days, estrus, or the period of sexual receptivity of the tom, lasting 3 to 6 days, and metestrus, lasting about 7 days. If ovulation does not occur, the ovarian follicles and ova (eggs) undergo degeneration during metestrus and the queen recycles again with a new set of follicles.

The queen is an induced ovulator. Pseudocopulation, sterile mating or the use of exogenous luteinizing hormone (L.H.) therapy causes ovulation of the mature follicles to take place and the formation of corpora lutea from the ruptured follicles which produces progesterone and mimicks the pregnant state (pseudopregnancy) with endometrial proliferation and possible mammary gland development. The corpora lutea remain for 20 to 44 days and ovarian activity usually begins within 7 to 10 days following pseudopregnancy, so the average cycle then becomes about 6 weeks long.

The gestation period following a fertile mating is 65 days plus or minus 4 days in the queen. A lactational anestrus is common in queens until the kittens are weaned. A few queens will show estrus, 7 to 10 days after giving birth and may conceive.

Vaginal cytology of the queen is similar to that in the bitch in that estrogen

induces cornification of the epithelial cells and leukocytes are absent during estrus. There is no bleeding present in the queen during proestrus.

The sexual behavior of the queen through her reproductive life consists of no sexual receptivity to the tom during metestrus, anestrus, or pregnancy. During proestrus, vaginal secretions under the influence of estrogens from the developing ovarian follicles, attract toms. These odorous substances are called phermones. The queen will not accept the tom during proestrus. During estrus, the queen is sexually receptive to the tom, showing a changed attitude, the typical characteristic meow, purrs, rubs her head against the tom, crouches on her forelimbs, elevates the perineal region and tips her pelvis forward in the so called "mating crouch", deflects the tail to one side and treads with her hindlimbs. She immediately accepts the tom during this period.

Copulation consist of rapid intromission and ejaculation after the tom mounts and grasp the neck skin of the queen with his teeth. Intromission and ejaculation of the tom results in a shriek from the queen and a rapid twist sideways to free herself. The queen will roll over and over and lick her external genitalia. After 20-60 minutes the queen again will accept the tom, or another tom. This pattern continues for about 2 days (range 1-4 days).

Ovulation, rupture of the mature ovarian follicles and release of the ripe ova (eggs) occurs from 24 to 50 hours following copulation (most around 25 to 27 hours) although investigators give a range of 1 to 5 days. Sperm require about 2 to 24 hours in the uterus before fertilization may occur. This process is called capacitation. Fertilization takes place in the oviduct or fallopian tube of the queen and may occur up to 49 hours after ovulation.

Fertilized ova remain in the oviduct for about 4 days before entering the uterus, undergoing multiple cellular division and growth. Implantation occurs in the uterine cavity about 13 to 14 days postcoital and a rapidly growing zonary

placenta is formed.

Pregnancy can usually be detected in the relaxed queen by abdominal palpation at 20-30 days when individual conceptuses can be palpated. After 30 days, conceptuses become ovid and difficult to discern since the uterus is then distended becoming a uniform tubular structure. In late pregnancy, the queen increases in weight proportion to litter size and movements or palpation of kittens can be determined. Radiographs from about day 40 of pregnancy to term can be used to determine pregnancy and the size of the litter, although repeated use of this procedure on the queen and fetuses can lead to radiation damage. Ultrasound using a Doppler instrument for diagnosis, from about the fourth week of pregnancy to term, can be used to detect fetal and placental circulation and movements. Hormonal assays when developed and studied in the queen for hormones of pregnancy, may become useful in detecting early pregnancy and ensueing fetal loss.

Parturition or the act of giving birth initially starts with a drop in rectal temperature in the first stage of labor. Healthy queens seldom have difficulty in labor. The first litter with only one or two large kittens may cause difficult birth (dystocia). Queens that are highly inbred, have nutritional deficiencies or the stress of a disease, many have uterine inertia. Pelvic deformities may cause difficult delivery.

Normal fetal presentation in the queen may be either anterior or posterior. Thirty to sixty minute intervals may be seen between delivery of 1 or 2 kittens. There may be a 12 to 24 hour delay also following the delivery of 2 or 3 kittens before the rest are born.

Cannibalism of newborn kittens is seen more likely in the first parturition of a queen. These queens should probably not be rebred. Stillborn kittens and placentas are usually eaten.

Reproductive Diseases and Disorders in the Queen

A thorough understanding of the normal reproductive physiology of both the queen and tom are needed before a meaningful diagnosis, possible therapy and/or prevention can be carried out in solving feline reproductive problems. A thorough history including date of birth, age at puberty, health history, vaccination schedules, preventative therapies, possible use of the animal (pet, breeding, showing, combinations), other pet companions, litter mate problems, pedigree, estrus dates, abnormal estrous cycles, previous pregnancies, sexual behavior, abnormal vaginal discharges and other pertinent information concerning the animal should be given.

Examination of the individual should include not only the urogenital tract, but also the general health of the animal. The animal may have to be examined throughout a cyclic period or followed through a pregnancy to effectively study the problem. Routine hemograms, blood profiles, test for infectious diseases that have been developed, vaginal cytology, urinalysis, vaginal and urine cultures, hormone analysis when eventually available, exploratory abdominal surgery to view the urogenital tract , uterine biopsies, genetic consuling and cytogenetics and other test may be needed to possibly establish a definite diagnosis.

A reproductive disorder or disease can be caused by poor husbandry, nutritional problems, stress of other diseases or enviromental stress, physiologic problems, genetic or acquired deformities of the urogenital tract, hormonal imbalance or dysfunctions, inflammatory and/or infectious diseases and other pathologic states thay may affect the urogenital tract or combinations of the above.

Precociousness has been seen in well grown kittens, although this usually is within the 4 month age range and can be quite acceptible. The influence

of good nutrition, late winter or early spring litters, adequate light and contact with older cycling queens are effective stimuli for early cycling. Some cyclic queens are still nursing their previous litter and I wonder if the milk during estrus may contain enough natural estrogens to "mimick" estrus in these kittens.

Precocious mammary gland development has occasionally been seen in supposedly prepuberal queens. Some of these conditions have been misdiagnosed clinically as extensive neoplasms of the complete mammary chain. The enlarged mammary glands are usually firm and may or may not be secreting. Histopathologic examination reveals a fibroadenomatous hyperplasia of the gland. Examination of the genital tract of these affected queens has revealed undiagnosed pregnancy or early involution of the uterus following an undetected parturition or abortion. A hormonal cause involving combinations of estrogen and/or progesterone following a sterile mating, possible spontaneous ovulation, or prolonged nursing of a cycling queen with transfer of steroid hormones via the milk to the prepuberal offspring are other possible causes if ovarian activity is not found. Regression to normal will take place in time. Hormonal studies when available and vaginal cytology would be very diagnostic during this time.

Prolonged anestrus may be caused by several factors: debility, nutritional problems, endocrine imbalances, genetic causes, anomalies of the reproductive tract, and diseases. An adequate history, thorough examination, hormonal analysis when available and vaginal cytology over a period of time are needed to determine the cause. Housed cats with improper illumination (less then 12 hours per day), lack of exposure to other cats and undiagnosed pregnancy can be simple problems causing anestrus.

Nymphomania has been encountered in females with apparent cystic follicular degeneration. These are usually older queens that have not had litters, or

only a few litters and have cystic endometrial hyperplasia and/or endometritis-pyometra complex. Ovariohysterectomy is recommended. Nymphomania has also been seen following ovariohysterectomy where a ovary or a portion of ovary has been left intact, or a possible accessory ovary is present. Possible adrenal cortical source or a psyche state may be involved in this behavioral problem. Blood hormone levels would be very valuable in these individuals. Progestrin therapy maybe beneficial in these conditions.

Pseudocyesis or pseudopregnancy may be induced by pseudocopulation, a sterile mating, L.H. therapy and possibly by spontaneous ovulation. Spontaneous ovulation has been reported in isolated caged cats and is thought to be caused by stroking, handling, excitement or simple examination of an individual cat while in estrus. Estrogens, androgens, and progestrins have been used to suppress any clinical manifestations.

Cystic hyperplasia - endometritis - pyometra complex is a condition seen in queens ranging from 3 to 14 years of age, especially queens that have borne few litters. Free roaming queens that have consecutive pregnancies appear to have little problem. Researchers in England show that this syndrome is quite similar to that in the bitch. Cystic hyperplasia induced by estrogens and progesterone of consecutive periods of pseudocyesis is eventually followed by acute subacute and chronic endometritis and pyometra. Escherichia coli is most frequently isolated, but staphylococci and streptococci have also been found. Urinary tract involvement may also be found and some cases maybe bacteriologically negative. Other agents should be sought in these cases.

The affected queen may appear normal to various degrees of clinical manifestation resulting in a possible fulminating septic acute endometritis with a bloody discharge, depression, toxic bone marrow depression and anemia and septicemia resulting in rapid deaths. Pyometras may be closed or open with drainage and

discharge. The uterus is frequently paper thin in the closed condition and rupture with entensive peritonitis and rapid death is possible. An enlarged uterus though must be differentiated from possible unknown pregnancy. The total white blood cell count may be high normal to 75,000 or may appear depressed with toxic bone marrow depression. Antibiotic sensitivities and therapy, supportive therapy and ovariohysterectomy are indicated. It is difficult to impossible to treat these conditions and return the queen to a useful reproductive life. Further research into the pathogenesis and possible therapy of this condition is needed. It is important to start to breed cats after sexual maturity and have continuous litters without long periods between pregnancies because of the endometrial hyperplasia-endometritis-pyometra complex. Queens used for show or pets and then reverted to breeders or occassional breeders after 4 or 5 years of age may have poor reproductive performance because of this syndrome. Indiscriminate hormone therapy to suppress estrus or delay estrus over a long period of time can also lead to this syndrome.

Abortion, mummified fetuses, stillborns, anomalies, early embryonic death and fetal resorption are increasing problems that especially plaque the large cat breeders and their veterinarians. Frequently these cats appear clinically normal. Some may have evidence of a vaginal discharge. Within the last few years, several infectious diseases have been incriminated in these syndromes:

1. Feline viral rhinotracheitis: abortion, stillborns, mummification, neonatal deaths and vaginitis.
2. Panleukopenia (infectious feline enteritis): abortion, stillborns, mummification, neonatal deaths and teratogenic effects (cerebellar hypoplasia, retinal degeneration).
3. Feline leukemia virus has been associated with infertility, fetal resorption and abortion. This problem seems to remain constant throughout the queens reproductive performance once the infection becomes established.

4. Toxoplasmosis can cause abortion, stillborns, resorption, mummification and neonatal death.
5. Mumps virus may possibly be incriminated in fetal waste.

Inutero transmission or transplacental infection with viral agents appears to be an insidious cause of the above syndrome. Live viral vaccines should not be given during pregnancy since they may cause this problem. Diagnosis is usually difficult since the viral agent has usually disappeared before the condition is recognized. A detailed history, signs of prior illness in the queen or other feline members should be described, serological or other immunological evidence of the possible infectious agents should be carried out and histopathological and microbiologic study of the aborted or stillborn fetuses and placentas may be helpful.

Toxic substances during the pregnancy may cause the above syndrome of fetal wastage. Griseofulvin, an antibiotic used for treating skin infections in cats, has been incriminated in multiple teratogenic effects in kittens and should not be used during pregnancy. A good rule of thumb is to not use medications, additives, or long term preventative therapy through the gestation period. Any known substance contacted by or given to the queen during pregnancy should be mentioned in the history.

Habitual or chronic abortion has been thought to be due to progesterone insufficiency. Other causes, especially feline leukemia virus, should be eliminated before a diagnois of progesterone insufficiency is made. Endogenous progerterone blood levels of these chronic aborters should be studied so that a definite diagnosis can be made and supplemental treatment given. Since this condition maybe inherited, these queens should not be used as breeding stock.

Uterine torsion of one whole gravid horn or more likely one fetus within a horn does occur and may result in dystocia (difficult birth), uterine hemorrhage,

acute abdominal pain, rupture, peritonitis, death, or in many cases, no clinical signs are observed and the twisted portion tears and may seperate completely, allowing one or more fetuses with their placentas to drop into the peritoneal cavity. Secondary extrauterine pregnancy may occur. The fetus may disintegrate into small pieces becoming embedded in the omentum or the entire fetus may mummify and become attached to the omentum or abdominal organs. The mummified fetuses can be palpated per abdomen as hard masses. The affected uterine horn may straighten after rupture if not seperated and heal with a scar. Primary extrauterine pregnancy in the queen is rare.

Chronic cervicitis and vaginitis has been diagnosed in the queen. A discharge may be difficult to detect since the cat frequently cleans the genitalia. Trauma or infection following a difficult birth may cause these conditions. Stenosis may follow with closure of the vagina at the vestibule or fibiosis and stenosis with complete closure may be found at the cervix. A differential diagnosis of a complete persistent hymen must be made in the virgin queen. Diagnosis under sedation with a sterile otoscope cone maybe possible. The birth canal should be cultured for possible microorganisms if active inflammation is present and antibiotic sensitivity of the isolated agent is required before treatment.

Reproductive Physiology and Infertility in the Tom

The male is born with descended testes. Cryptorchid or ectopic testis should not be corrected but removed when the tom has reached appropriate age, size, and maturity, since this condition maybe inherited.

Spermatozoa are present in the seminiferous tubules of well grown toms by 30 to 36 weeks of age. Semen can be collected with an artificial vagina but a considerable training period prior to successful collection must be carried out. A female in estrus or an ovariectomized female injected with estrogen

must be used as a teaser and mount. The average volume of an ejaculate is about 0.035 ml. and contains about 12 to 15 X 10^8 sperm/ml.

A tom will defend and mark a territory. The territory will be marked by spraying a mixture of urine and a secretion containing valeric acid from anal glands that produces the characteristic penetrating "catty" urine odor.

Infertility in the tom is infrequently seen or reported, although purebred or inbred toms should be examined closely for any signs of abnormal genital development before use. Shy toms with poor libido should not be used for breeding since this sexual behavior maybe inherited.

The tortoiseshell male cat is reportedly sterile and has a syndrome homologous to the Klinefelter's syndrome in man. These males will have a cell karotype of XXY or XX/XY/XXY mosaicism and contain a Barr body at the nuclear membrane in smears made from buccal cells or drumstick polymorphonuclear leucocytes from blood (expression of extra X chromosome in cells, similar to the female). These male cats have small testicles, lack libido, and are sterile.

A few tortoiseshell males are fertile and have XX/XY mosaic karyotype or possibly a normal XY component with somatic mutation occuring in the X cells so that some express the orange while others express black color.

The male, as well as the female, should always be examined and considered when investigating an infertility problem. A history including his breeding record, health, vaccination schedule and any preventive medication or dietary additives should be examined. A complete physical exam of the scrotal contents, penis and the cat in general should be conducted. Semen for examination may be obtained by flushing the vaginal cavity of the queen immediately following coitus. A semen sample collected by artifical vagina is more complete but difficult to obtain without considerable time and training.

FELINE SKIN DISEASES

by
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I. Bacterial Disease

A. Abscessation

1. very common; usually secondary to fighting and cat bites.
2. most frequent locations are limbs, face, base of tail, and back.
3. signs vary to some extent depending on site, size, and amount and tension of subcutaneous tissues; other signs may include fever, loss of appetite, depression, and lethargy.
4. treatment is usually surgical.
5. prophylaxis: consider castration of males.
6. with recurrent or non-healing abscesses. consider FeLV infection.

II. Fungal Disease

A. Dermatophytosis (Ringworm)

1. common; more in tropical climates.
2. many fungi involved (from soil and carrier animals); transmission by direct and indirect contact.
3. signs extremely variable, from typical bald, scaly-crusty patches, to broken or discolored hairs, to normal!; mostly young cats.
4. diagnosis requires fungal culture.
5. treatment must include:
   (a) animal (oral and topical)
   (b) in-contact animals
   (c) environment
6. quite contagious to people, cats, and dogs.
7. don't use griseofulvin (Fulvicin$^{(R)}$) in pregnant queens.

III. Parasitic Disease

A. Flea Allergy Dermatitis

1. most common skin problem; more of a problem in summer.
2. due to allergy to flea saliva.
3. affects cat, dog, and man.
4. signs include scratching, chewing, licking, hair loss, redness, open sores, and scabs over rump and spreading up the back and down the hindlegs.
5. treatment must include:
   (a) animal (systemic and topical)
   (b) in-contact animals
   (c) environment

B. Otodectic Mange (Ear Mites)

1. very common; any age; any time of year; most common cause of ear disease in the cat.
2. affects cat, dog, and man.
3. diagnosis requires otoscopic and/or microscopic exam.
4. treatment must include:
   (a) animal (whole body!!)
   (b) in-contact animals

IV. Endocrine Disease

A. Feline Endocrine Alopecia

1. no breed or age predilection; 90% of cases in males.
2. cause not definitely known; associated with early spaying or castration (sex hormone deficiency or imbalance?).
3. signs include partial baldness without itching, redness, etc., over rump, belly, and inner thighs.
4. no diagnostic test available.
5. treatment is with sex hormones.

V. Unsure

A. Eosinophilic Granuloma Complex

1. 3 disease syndromes:
   (a) eosinophilic ulcer
   (b) eosinophilic plaque
   (c) linear granuloma
2. cause unknown; not contagious.

3. diagnosis often requires biopsy.
4. treatment:
   (a) cortisone-like drugs
   (b) megestrol (Ovaban(R))

B. Miliary Eczema Syndrome
1. a disease complex (not a single disease).
2. no age, sex, breed predilections; not affected by spaying or castration.
3. recognized causes include:
   (a) flea allergy dermatitis
   (b) food allergy
   (c) lice
   (d) cheyletiellosis
   (e) intestinal parasitism
   (f) dermatophytosis
   (g) fatty acid deficiency
   (h) biotic deficiency
   (i) drug eruption
   (j) idiopathic (cause unknown)
4. signs include variable degrees of hair loss, itching, redness, scabs, and open sores over back, then rest of body.
5. diagnosis must include tests to rule out above causes.
6. treatment varies with cause.

FELINE RESPIRATORY DISEASES

Fredric W. Scott, D.V.M., Ph.D.

All feline respiratory diseases were originally thought to be "pneumonitis" caused by the psittacoid agent, *Miyagawanella felis* now identified as *Chlamydia psittaci*. Extensive research in several countries now indicates that pneumonitis is not the main cause of respiratory disease of cats. There are, in fact, numerous agents that produce clinical disease which may be indistinguishable. The two most important diseases are feline viral rhinotracheitis and feline calicivirus infection. These two diseases are approximately equal in incidence and account for the majority of feline respriatory diseases. It is important to realize that multiple infection can occur in the same animal. Thus, an agent which normally does not produce clinical disease will exacerbate an infection with another respiratory agent.

CAUSE

1. *Feline viral rhinotracheitis (FVR,"Rhino").*

Feline viral rhinotracheitis is an acute respiratory disease of cats caused by a herpesvirus. This is a DNA virus which is is quite labile, being sensitive to acid, heat, and lipid solvents such as ether. FVR virus will survive for only 18 to 24 hours at room temperature. All isolates of FVR virus that have been studied belong to a single serotype, i.e., there is only one FVR virus.

2. *Feline calicivirus (picornavirus) infection (FCI).*

Feline calicivirus infection is an acute respiratory infection of cats due to one of a number of strains of calicivirus. This virus is an RNA virus which is similar to the human cold viruses. The calicivirus is more resistant than the herpesvirus, surviving for one to two weeks at room temperature.

3. *Feline pneumonitis (FPN).*

This acute respiratory disease is caused by the psittacoid agent, *Chlamydia psittaci (Miyagawanella felis, Bedsonia felis)*. This agent is not a true virus in that it contains both DNA and RNA. It is labile, being sensitive to heat, ether, acids, and broad spectrum antibiotics. There may be two or more serotypes of this agent, although this point is not entirely clear.

4. *Reovirus infection.*

Reovirus infection is caused by feline reovirus which is similar to reoviruses of many other species. "Reo" stands for "respiratory enteric orphan" virus indicating that this virus replicates in the respiratory and enteric tracts of various animals, often without producing disease. The virus is a resistant RNA virus and more than one serotype may exist.

5. *Parainfluenza.*

Experimentally, cats have been infected with a canine parainfluenza virus, designated SV_5-like virus, which is a flu-like virus. This virus is very prevalent in dogs and is often involved, along with other agents, in the respiratory disease of dogs commonly called "kennel cough." The significance of this virus in feline respiratory disease is not known.

6. *Mycoplasma infection.*

Mycoplasma can frequently be isolated from cats with respiratory disease. However, clinical disease cannot be produced by experimental inoculation of Mycoplasma unless the animals are stressed prior to inoculation. The importance of Mycoplasma are probably as secondary invaders. These are labile organisms and may be susceptible to antibiotics.

7. *Bacteria.*

Numerous bacteria may be involved as secondary invaders in respiratory diseases. The extent of the role of bacteria in feline respiratory disease has not been determined. Bordetella appears to cause severe bronchopneumonia as a concurrent infection with some of the above viruses. It is not known whether or not this bacterium, or any of the numerous other bacteria that are common secondary invaders, can produce respiratory disease without the aid of a virus.

SPREAD OF DISEASE

The route of infection in natural cases of viral infection is either oral or intranasal. Following infection there develops the acute disease after an incubation period of from one to several days depending upon the dose of the virus involved. The clinical disease lasts from one to several days (even lingering for weeks in some cases) again depending upon the severity of the infection and the virus involved.

Infected animals will discharge virus or other agents in the saliva, nasal and ocular discharges, in the feces of feline calicivirus and feline reovirus infections, and in the urine of feline calicivirus infections. Infection of susceptible cats occurs by direct contact, by contact with fomites (cages, food or water dishes, litter pans) that have been contaminated with virus or other agents, and by aerosol exposure due to sneezing and coughing of infected cats. These viruses may be transmitted several feet by aerosol droplets. Hands, clothing, or shoes of persons handling and caring for infected cats frequently become contaminated and can serve as a vehicle for transmitting these respiratory disease producing agents to susceptible cats.

An important aspect of the spread of the respiratory diseases of cats is the presence of a carrier state. Following recovery from FVR cats will continue to shed herpesvirus intermittently from the oropharynx for many months. Calicivirus infected cats have been shown to shed virus continuously from the throat and occasionally in the feces for long periods of time. Mother cats which had the FVR or FCI as kittens may pass the virus to their young. Severe stress or another viral or bacterial infection may cause those animals that are carrying virus to become infectious to other cats.

METHOD OF DISEASE PRODUCTION

Oral, ocular, or intranasal infection results in a local infection of the epithelium of these regions which then spreads to involve the remainder of upper respiratory epithelial cells, and may even spread

to involve the lungs. The infection generally remains as a superficial infection but may spread through the blood (viremia) to produce a generalized infection. Feline viral rhinotracheitis generally does not produce a viremia but in certain instances viremia may occur and infection of the osteoblasts (bone-forming cells) may result. Viremia also may cause infection of the fetuses and abortion of pregnant cats.

Although the clinical disease in feline calicivirus infections often is milder than FVR, the spread of virus is generally greater. Infection occurs not only in the respiratory mucosa, but may also occur in the intestine and the urinary tract. Severe pneumonia may occur in calicivirus infections. Ulcerations of the tongue and of the hard palate may occur following FCI.

Studies have shown that FVR infection may produce severe disease in germ free cats. Thus, secondary bacterial infections are not necessary to produce the disease. However, in any respiratory infection the disease may be complicated by secondary bacterial or other viral infections.

DIAGNOSIS

Feline respiratory disease is easily diagnosed but the exact cause is extremely difficult to determine clinically. The diagnosis is made on the basis of clinical signs and can be confirmed by special laboratory tests.

1. *Clinical signs.*

Although there are certain generalities concerning the severity of disease produced by the different agents that may help in making a clinical diagnosis, all of the agents involved

in the feline respiratory disease complex can produce signs which are essentially identical in any given case. This makes it extremely difficult to determine exactly which agent(s) is the cause of the specific infection and for the most part this can be determined only with the aid of laboratory tests. Sneezing and coughing are the first clinical signs observed, especially in FVR, followed shortly by a sensitivity of the eyes to light (squinting), red and swollen eyes, and a watery discharge from the eyes. Frequently only one eye is involved at first with involvement of the second eye occurring in a few hours. The eye discharge usually becomes thicker and contains pus. Infection of the nose frequently causes a runny nose followed in one or two days by a thick nasal discharge which may dry and form crusts. These crusts block the nostrils and force the cat to breathe through its mouth. Excess salivation may occur, especially if tongue ulcers are developing. The animal is usually depressed and may stop eating. There may be a fever, especially early in the infection.

There are some generalities which may help in determining which agent is involved. FVR usually is a severe infection, especially in young kittens. Ulcers of the eye may develop, followed by a severe infection of the entire eye and total blindness.

Calicivirus infections generally are milder than FVR. If pneumonia develops, however, the mortality may be high, especially in young kittens in colonies or catteries.

Reovirus infection is mild, with signs usually restricted to a mild eye infection.

2. *Laboratory tests.*

Diagnosis can be confirmed by viral isolation in the laboratory. Pharyngeal, ocular, or nasal swabs may be taken and submitted to a laboratory where the swabs are placed in cell cultures or embryonated eggs for viral isolation. In most cases the pharyngeal swab produces the best chance of viral isolation. Unfortunately few diagnostic laboratories are equipped to run these viral isolation tests.

TREATMENT

Treatment for feline respiratory disease is for the most part symptomatic. Broad spectrum antibiotics are indicated to prevent secondary bacterial infections. In pneumonitis broad spectrum antibiotics are specifically indicated since this agent is susceptible to antibiotics. Eye ointments containing antibiotics are indicated for relief of the conjunctivitis. However, the routine use of ointments containing corticosteroids is contraindicated unless there is specific need. In human herpes infection there is definite evidence that corticosteroids may lead to the development of ulcerative keratitis. There is some indication that a similar condition may exist in FVR.

Fluids are indicated in severe infections to overcome dehydration. Oxygen therapy is also indicated if the animal is severely distressed from lack of respiratory function. Systemic vitamin injections may be indicated since many diseased cats have a low vitamin

level, especially vitamins A and B. Some clinicans have indicated that vitamin C is valuable while others dispute the value of vitamin C in treatment of respiratory disease.

Good nursing care is extremely important in treating respiratory diseases of the cat. It is important to clean the dry, crusted material from the nose in order to allow drainage of the nasal passages. A cat that cannot smell does not eat. Vaporization may be helpful in decreasing the swelling in the membranes and removing the nasal discharges. Baby foods are beneficial as cats tend to eat baby foods before they will eat regular cat foods.

There are some specific products that may be beneficial in treatment of herpes infection in the cat. Idoxuridine or IDU (a specific antiviral compound) is beneficial in treatment of ocular herpesvirus infection. There are other specific antiviral agents which may in time prove beneficial.

PREVENTION

Prevention of feline respiratory disease depends upon: 1) identifying and restricting the source of virus (infected cats); 2) reducing the concentration of virus in the environment; and 3) immunizing cats through vaccination.

Since the major source of infection is via direct contact of susceptible and infected cats, any means of reducing or preventing direct contact of these cats will greatly reduce the chance of infection. The use of isolation or quarantine areas is well recognized to house new cats, cats that are on the show circuit, or cats that have been sent away for mating.

These cats should be isolated for a period of at least two weeks and observed for signs of illness. Even with this precaution these animals may be chronic carriers of infection and may introduce infection when they enter the colony.

As these agents are also transmitted by aerosol, it is very important to have proper conditions concerning the air flow within catteries. The humidity should be kept at a reasonably low level and the ventilattion should be good with ten air changes per hour within the room. Infected cats or cats that are starting to sneeze or cough should be immediately isolated in a distant corner of the ward or preferably in a distinct isolation ward.

Since many queens are carriers of virus and they will transfer this virus to the kittens, it may be beneficial to wean kittens at a relatively early age when the kittens still may have some protection from passive maternal antibodies. These kittens can be removed and raised separate from the adults.

One should be constantly aware of the methods to prevent indirect spread of infectious agents. Dishes and other utensils that cats may come in contact with should be disinfected between uses. It is preferable to use disposable dishes. Persons handling or caring for such cats should wash their hands between cats. If rubber gloves are worn, these can be disinfected and washed between cats. The weak link in any control measure is usually the people involved.

The most effective way of preventing infection is by immunization with vaccines. Extensive research in recent years has resulted in several vaccines being developed and marketed to protect cats against FVR and FCI.

These, in addition to the pneumonitis vaccine, provide considerable protection against the most important respiratory diseases.

These vaccines are safe when given as directed and prove reasonably good protection against severe infection. Vaccinated cats may still become infected but usually do not show any signs of illness. Virus may replicate in small amounts in the superficial cells of the upper respiratory tract which are protected from the antibodies or immunity of the blood stream. An occasional vaccinated cat (approximately 10%) may have a "watery eye" for one or two days after exposure to FVR virus, or some cats may sneeze a few times. These adverse reactions are mild compared to the severe disease normally seen with "rhino".

Kittens should be vaccinated against FVR and FCI (and possibly FPN if it is a problem in that area) at eight to ten weeks of age and again three to four weeks later. These vaccinations can be given at the same time as those for panleukopenia (enteritis). If problems with infection in younger kittens are encountered in a cattery, kittens should receive their first FVR-FCI vaccine at five weeks of age and the second vaccine at eight to nine weeks of age.

There is as yet no need for the development of a vaccine to the remaining agents in the respiratory disease complex. The reovirus and SV_5-like agents have not been shown to be a significant cause of disease in the cat. The mycoplasma and bacteria are secondary invaders and as such do not warrant the development of vaccines with the amount of information that is available at present.

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