THE ROLE OF CERTAIN FEED SUPPLEMENTS IN THE RATIONS OF RANCH-RAISED MINK

by

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A THESIS

submitted to

OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1955

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Date thesis is presented August 15, 1949

Typed by Lenora Bond

ACKNOWLEDGMENT

This opportunity is taken to express my sincere appreciation to the many persons who have helped in the preparation of this thesis.

Special thanks are due Mrs. Phyllis Watt Wustenberg for her guidance in planning the experimental project and for her extremely competent assistance in analyzing the experimental data.

Grateful acknowledgment is expressed to Professor Roland E. Dimick for critically reading the manuscript and offering helpful suggestions for its successful completion.

Appreciation is conveyed to Mr. John Adair for his invaluable assistance in collecting the experimental data.

The author is greatly indebted to Dr. J. R. Haag and Dr. Jim Oldfield for their guidance in the literature studies on this problem.

Thanks are due Benjamin Essman and Samuel McCorkle for devoting many hours in the grading of the experimental pelts in the facilities of the Seattle Fur Exchange which were generously offered by Michael Dederer.

Much credit is due Floyd Sisson, Charles Mayer, Erland Juntunen, Otto Florschutz, and the many other students who assisted in feeding and pelting the experimental animals, and for their never-ending humor which made the long hours of work pass swiftly.

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THE ROLE OF CERTAIN FEED SUPPLEMENTS IN THE RATIONS OF RANCH-RAISED MINK

INTRODUCTION

This report presents the results of selected diet trials conducted with ranch-raised mink, Mustela vison Schreber, at the Oregon State College Experimental Fur Farm during the period of May 1953 through January 1954. The feeding experiments were designed primarily to ascertain the extent to which readily available marine fishes and certain feed supplements might replace "red-meat" products commonly used in mink rations. The test diets were evaluated on standards of growth response in the mink and on color and quality of fur produced.

At the suggestion of the research committee of the Oregon State Fur Producers Association, the major studies conducted at the Experimental Fur Farm since 1951 have been directed toward finding economical and readily available replacements for such "red-meat" products, as horsemeat, condemned beef liver and beef tripe, in the diets of ranch-raised mink. Fur farmers of the State consider that the general scarcity of "red meat" with associated high prices is one of the most important limiting factors in mink farming.

These investigations were conducted under the supervision of the Department of Fish and Game Management, Oregon Agricultural Experiment Station, under the

direction of Professor R. E. Dimick, Department Head. Miss Phyllis R. Watt, formerly Research Assistant and Project Leader of fur farm research, advised on experimental procedure, directed the management of the experimental animals and assisted in evaluation of the results obtained from these studies. The Research Committee of the Oregon State Fur Producers Association served as an advisory council and submitted problems of particular importance to the mink ranchers of the State. The association has actively encouraged the improvement and expansion of the experimental fur farm, and in January 1953 donated for experimental purposes, 17 female and 5 male Aleutian mink, a color phase mutation, generally regarded by the fur industry as the ranch-raised mink most susceptible to nutritional disorders and diseases.

A cumulation of circumstances brought about the decline of "red-meat" products available for fur animal feeding. For many years, the fur industry depended primarily upon horsemeat and slaughter house by-products, as the basis for its main feed supply, except in areas immediately adjacent to the coast where supplies of fresh marine fish products were available. Decline of the horse population as the Nations' farms turned to power machinery, and the increased demand for horsemeat to be used both for

human consumption and as pet food made it soon evident that the fur industry must turn to other animal protein sources. Concurrently, beef products suitable for mink feed became increasingly scarce. Improved conditions for raising beef led to fewer rejections of slaughtered animals, while higher prices and increased meat consumption during the war and postwar years encouraged utilization of products formerly destined to become animal feed. Increasingly marine fish became the basic feed for the fur industry, while "red-meat" products were reluctantly decreased in mink rations. The question was ultimately posed: Can "red-meat" products be entirely or partially replaced in a satisfactory manner with less costly and more readily available feedstuffs?

METHODS AND MATERIALS

The Problem

Studies conducted at the Oregon State College Experimental Fur Farm in 1951 and 1952 (15, 16) demonstrated that rations containing large percentages of certain marine fish and devoid of all other fresh "red-meat" products except beef liver, produced mink which were smaller and of lesser pelt value than those given similar rations in which horsemeat and beef tripe

were constituents. It was further shown that when beef liver was also omitted from the ration, growth and pelt value were even more markedly reduced.

Experimental diets designed to test the quality of certain feed supplements as replacements for fresh "red-meat" products, were therefore divided into two subcategories: (1) those in which horsemeat and beef tripe were absent, and (2) those in which liver, horse-meat and tripe were lacking. The addition to these diets of certain feed supplements permitted the evaluation of these supplements as materials capable of eliminating deficiencies caused by the removal of "red-meat" products from the diet, as measured by the response of ranch-raised mink in growth and pelt value.

The Supplements

Since the deficiencies created by lack of "red-meat" products in the rations of mink were characterized by diminished growth, decreased fur production and lack of desired darkness of fur, it was believed that the particular feed supplements selected for testing might supply a factor or factors for remedying one or more of these undesirable conditions.

The Antibiotics

The discovery of the animal protein factor during the protein-lean years of World War II, and the subsequent discovery that this factor when concentrated from culture residues of antibiotic producing molds promoted growth in many domestic animals beyond that obtained by vitamin B_{12} alone, led to the widespread use of antibiotic supplements as witnessed in animal nutrition today. Probably the most significant nutritional gains by antibiotic feed supplements have been registered in chickens, turkeys and swine, where exceptional weight gains have occurred, with fewer intestinal disturbances, earlier marketing dates, and increased feed efficiency adding merit to the use of these "wonder drugs" in animal nutrition. (8, p.481)

Many theories have been advanced pertaining to the mode of action of antibiotics in increasing the growth of some domestic animals. Although the hypotheses of vitamin sparing action, enhanced utilization of proteins, and increased nutrient absorption are accompanied by experimental supporting data, the bulk of evidence favors the advocacy of the view that the growth promotion action of antibiotics is a result of controlling the bacterial flora in the intestinal tract, either by suppression of those forms which produce toxins and/or compete with the host for available nutrients, or by favoring those forms which

synthesize nutritional factors required by the host for optimum growth (8, p.482). In support of the latter view there are data from many research centers which indicate that animals raised in sterile environments do not respond with increased growth from being fed antibiotics. Similarly, no growth increase is observed when the antibiotic is injected (1, p.334).

The antibiotic supplements tested in these investigations were feedgrade aureomycin with guaranteed vitamin B_{12} analysis and feedgrade terramycin plus vitamin B_{12}. Both antibiotic supplements were fed at the rate of 4.5 grams of antibiotic per ton of prepared feed, with vitamin B_{12} levels of 4.5 milligrams per ton of prepared feed.

Aureomycin was added in the form of $2\frac{1}{4}$ pounds per ton of mixed feed, of Aurofac (Lederle), which contains 1.8 grams of aureomycin per pound and 1.8 milligrams of vitamin B_{12} per pound of supplement. The terramycin was given as 14 ounces of Animal Mix TM-5 (Pfizer) containing 5 grams of terramycin hydrochloride per pound while the vitamin B_{12} was included in Bicon 6/ (Pfizer) at 12 ounces per ton of mixed feed.

Methionine

Methionine is a sulfur containing amino acid which

has been proven to be essential for man and some other animals and to be indispensible for adequate nutrition, but cannot be synthesized in sufficient quantity to meet the demands of normal growth, and therefore must be supplied in the diet.

Methionine appears to have three broad functions. It is an essential building stone for proteins necessary for growth and maintenance of body tissues. Secondly, methionine can furnish "labile methyl" groups in the body for certain necessary chemical reactions which occur in living organisms; and last but by no means of less importance, it can give rise to another important sulfur-containing amino acid, cystine, in an irreversible reaction occurring in the liver. Due to the many demands made on methionine certain diets may be deficient in this amino acid (9).

The proteins of hair are extremely high in cystine, which probably accounts for the high methionine-cystine requirements of animals whose bodies are covered with fur or hair. Experiments with rats, chickens, and sheep indicate that during periods of protein deficiency hair, feather and wool growth proceed at the normal rate dominant to the demands of the protoplasmic proteins, resulting in a negative nitrogen balance (11). When the diets of white laboratory rats were supplemented with

methionine and cystine by Mahadevan (10) methionine produced a hairy growth and increased the cystine content of the coat. Cystine and methionine proved interchangeable for growth, regeneration, and composition of the coat.

In those diets to which methionine was added, diets III and XII, a level of 0.05 per cent of the dry matter was included. It was shown in 1951 by Watt (15, p.3) that 0.05 per cent was superior to 0.1 per cent supplementation. This finding is supported by evidence from other workers of deleterious effects induced by imbalance through over addition of this amino acid in the diets of laboratory rats (5, p.198 and 17, p.357).

Arsanilic Acid

Arsanilic acid (para-aminophenylarsenic acid), another of the supplements tested, has been shown to be growth stimulating factor in chickens and swine, probably in the same manner as the antibiotics; that is, by alteration of the intestinal bacterial flora, since it too fails to elicit response in animals raised aseptically. In addition to the bacteriostatic properties of arsanilic acid, there are indications that this compound is responsible for increased feather growth and for greater disposition of fat and pigment in the skin of

chickens through its physiological action of dilating the peripheral blood capillaries (3, p.61).

Arsanilic acid was added to diet IV at the rate of 0.00375 per cent of the dry matter.

Vitamin Supplement

That liver is a food of great nutritional and therapeutic value is a generally accepted fact, providing liberal amounts of many of the known vitamins and perhaps some as yet unrecognized growth factors. In removing liver from the diets of mink, it was acknowledged that perhaps one of the greatest losses might be that of the water soluble vitamins of the B-complex. An attempt was made to reconstitute the vitamin level of the liver-free diets by supplementation of diet group X, with concentrates of B-vitamin materials, in the form of Fortafeed 2-49C manufactured by Lederle Laboratories. This vitamin supplement is compounded with a base of dried fermentation solubles and press cakes from the microbiological manufacture of riboflavin, aureomycin and vitamin B_{12}, together with extracted animal liver meal and soybean oil meal plus substantial quantities of synthetic folic acid. The guaranteed vitamin content of this supplement is as follows:

Riboflavin	2,000	milligrams	per	pound
Pantothenic acid	2,000	"	"	"
Niacin	2,000	"	"	"
Choline chloride	10,000	"	"	"
Folic acid	60	"	"	"

This vitamin supplement was added to the diets at the rate of one pound for every three hundred pounds of dry matter in the ration.

Live Yeast Compound

A viable yeast and bacterial leavening agent used by some of the Oregon fur farmers was included in two of the diets in an attempt to supplement the B-vitamin and amino acid content of the ration, as well as make more readily available the nutrients inherent in the feed. The product used in these studies, Lacto-Leav'n, Red Tag manufactured by the Speciality Foods and Feeds Exchange of Monroe, Wisconsin, is essentially a mixture of viable lactic acid producing bacteria and an acid resistant yeast in a concentrated dried cultured medium designed to supply the necessary nutrients for their growth. The ingredients of this supplement are listed as: viable resting yeast organisms and lactic acid bacteria cultured in media of condensed buttermilk, Lactobacillus bulgaricus culture, barley malt, ground oats, ground wheat, ground rye, corn meal, dextrose, levulose syrup, selected hops and pure yeast. This mixture is then fermented to a certain stage

and then dried at a low temperature.

Reports from many sources indicate that live yeast partially removes nutrients from the diet at the expense of the animal to which it is being fed. However, reports from some Oregon mink ranches indicated some growth advantages in including this compound in the rations of mink.

The antibiotics, arsanilic acid, methionine, vitamin supplement, and live yeast compound were pre-mixed with the cereal contents of the ration in order to insure even distribution of the supplement throughout the ration.

The Experimental Diets

The diets discussed in this paper are those selected from the nutritional studies of 1953 relating to the replacement of fresh "red-meat" products in mink rations. To avoid confusion, the diet numbering system presented in this thesis is identical with that used in Progress Report #4 (7). In order to maintain continuity of numbered diets, the entire list of diets tested during the 1953 nutritional studies and their composition is listed in table I, with those diet test groups not discussed in this paper in the shaded columns.

Table 1. Constituents of Diets, 1953

Constituents	DIET GROUPS																			
	I	II	III[1]	IV[2]	V	VI[3]	VII[4]	VIII[7]	IX	X[6]	XI	XII[8]	XIII[7]	XIV	XV	XVI	XVII	XVIII[9]	XIX[9]	XX[9]	XXI[9]
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Meat																					
Horsemeat	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	$7\frac{1}{2}$	....	....	....
Liver	4	3	3	3	3	3	3	3[5]	....	....	....	....	....	3	3	3	3	$3\frac{1}{2}$	$3\frac{1}{2}$	3	3
Tripe	14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	$13\frac{1}{2}$	$13\frac{1}{2}$	....	....
Whale meat	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	$7\frac{1}{2}$	....	....
Fish																					
Mixed Sole	42	42	42	42	42	42	42	42-45	39	39	39	39	....	42	42	22	22	$42\frac{1}{2}$	$42\frac{1}{2}$	44	22
Rockfish	25	25	25	25	25	25	25	25	25	25	25	25	25	....	25	15	15	25	25	25	15
Rosefish	....	....	....	....	....	....	....	....	....	....	....	....	....	25	....	....	....	....	....	....	....
Turbot	....	20	20	20	20	20	20	20	20	20	20	20	....	....	....	....	....	....	....	....	....
Skate without liver	....	....	....	....	....	....	....	....	....	....	....	....	59	20	20	....	....	....	....	18	....
Skate liver	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	46	50	....	....	....	....
Dogfish shark	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	....	....	....	....	....
Cereal													....	....	....	....	....	....	....	....	50
Wheatgerm	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	4	4
Cerl-meal	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Alfalfa Meal	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$
Brewer's Yeast	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	1	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	1	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$
Bone Meal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Live Yeast	....	....	....	....	$\frac{1}{2}$	....	....	....	....	....	$\frac{1}{2}$	....	....	....	....	....	....	....	....	....	....
Protein Concentrate																					
Powdered Milk	....	....	....	....	....	....	....	....	2	2	2	2	2	....	....	....	....	....	....	....	....
Meat Meal	....	....	....	....	....	....	....	....	2	2	2	2	2	....	....	....	....	....	....	....	....
Blood Meal	....	....	....	....	....	....	....	....	2	2	2	2	2	....	....	....	....	....	....	....	....

[1] 0.05% Methionine (dry matter) was added.
[2] 0.00375% Arsonilic Acid (dry matter) was added.
[3] $2\frac{1}{2}$ lbs. Aureofac + vit. B_{12} per ton of wet feed added.
[4] 14 ozs. TM5 and 12 ozs. Bicon 6 per ton of wet feed was added.
[5] Once a week.
[6] 1 lb. Fortafeed 2-49C (Lederle) per 300 lbs. dry matter was added.
[7] Changed to diet IX on Sept.1.
[8] 0.05% Methionine (dry matter), 14 ozs. TM5 and 12 ozs. Bicon 6 (ton of wet feed) added.
[9] Fed beginning Sept. 1, to adult mink groups.

Marine Fish Products

In order to simulate the diets used by a majority of Oregon mink ranchers, the diet formulated to evaluate feed supplements in a "red-meat-free" ration included large percentages of many varieties of marine fishes, which for simplicity were reduced to three categories, as follows:

(1) Mixed sole

This group of marine fish contains a number of species of the bottom flatfish of the flounder group, frequently called sole in this area. Those forms which were fed include: English sole, Paraphrys vetulus Girard; petrale sole, Eopsetta jordani Lockington; mottled sand dab, Citharichthys sordidus Girard; rex sole, Glyptocephalus zachirus Lockington; sand sole, Psethichthys melanostictus Girard; Dover sole (slime sole), Microstomus pacificus Lockington; Bellingham sole, Isopsetta isolepsis Lockington; and infrequently the curl-fin sole, Pleuronichthys decurrens Jordan and Gilbert (2).

Dover sole, petrale sole and English sole make up almost the entire sole filleting industry in Oregon and are widely used by the mink ranchers. Sole comprised 42 per cent of the wet diet by weight in those rations in which beef liver was present and was included at 39 per cent of the feed in liver-free diets.

(2) Rockfishes

The fishes in this category belong to the genus Sebastodes in the family Scorpaenidae, and are of several species, namely: red rockfish, Sebastodes ruberrimus Cramer; black rockfish, Sebastodes melanops Girard; grey rockfish, Sebastodes mystinus Jordan and Gilbert; bacaccio, Sebastodes paucispinis Ayres; green-striped rockfish, Sebastodes elongatus Ayres; and the yellow-tailed rockfish, Sebastodes flavidus Ayres (2). Of the six species listed only the red rockfish is extensively used by the filleting industry. Rockfishes were fed at 25 per cent of the wet weight of the diets.

(3) Arrowtoothed halibut

Although arrowtoothed halibut, Atheresthes stomias Jordan and Gilbert, commonly called turbot, is classified in the family Pleuronectidae, the flounder family, and might be included in the category of mixed sole, the fast growth elicited by this fish separates it into a nutritional classification of its own. This fish was included in the diets at 20 per cent of the wet weight, except for omission in the diet of the control group, group I, which contained horsemeat, liver and tripe.

All marine fish used in these experiments were caught off the Oregon coast, transported to the experimental fur

farm by truck, quick frozen at -10° F. and stored at 15° F. until used.

Cereal Products

Two cereal mixes were used in the diet tests; one in the control diet, diet I, which contained the "red meats"; and, the other in the remaining rations which were primarily marine fish. The cereal portion of the control diet, diet I, which comprised 8 per cent of the total diet by wet weight contained the following ingredients:

Per Cent	Constituents
2	wheatgerm meal
2	Cerl-meal (a Crown Mills product)
1½	alfalfa meal
1½	brewers' yeast
1	bone meal

In the diets containing no "red meats", the quantity of wheatgerm meal was increased to 4 per cent giving a total cereal content of 10 per cent to the ration, by mixed feed weight. The brewers' yeast in diets V and XI was reduced by 0.5 per cent and replaced with an equal part of live yeast compound.

Protein Concentrates

Three animal protein concentrates were added to the diets lacking liver, horsemeat and tripe, in an attempt to replace the high quality protein and other growth factors

associated with these meats. Blood meal, meat meal and dried skim milk were the protein supplements which were added, each at two per cent levels to diets IX, X, XI, and XII.

(1) Blood Meal

Blood meal, a packing house by-product, consists of blood which is heated until it is coagulated and then dried and pulverized. Blood meal has been used very successfully for protein supplementation in swine and poultry rations for many years. The proximate analysis of blood meal according to Carroll and Krider (6, p.296) is as follows:

Per Cent	Constituents
91.8	dry matter
84.5	protein
1.1	fat
1.0	fiber
0.33	calcium
0.25	phosphorus

Although the protein content of blood meal is extremely high, its quality is poor and the digestibility low. The calcium and phosphorus levels are also low (13, p.601).

(2) Meat Meal

The quality of meat meal concentrate, unlike blood meal and dried skim milk, varies greatly, depending upon

its constituents and the nature of the processing which it receives. Meat meal is described by Morrison (13, p.595) as the dried ground residue remaining after removal of fat by steam or dry heat, from animal tissue, exclusive of hair, hoofs, and horns and without admixture of gastrointestinal tract contents. This would indicate that materials such as trimmings from the killing floor, inedible organs and tissues, cleaned entrails, residues from fat rendering, foeti from pregnant female animals which are slaughtered, and condemned carcasses are the packing house products utilized in this preparation.

Standards have been set by the Federal Government for certain qualities in meat meal, such as the 60 per cent minimum crude protein, unless otherwise designated, and the 4.375 per cent maximum phosphorus content. Despite these controls, the product is subject to extreme variation in quality. Proteins of low quality and digestibility, such as blood, bone and connective tissue, while not lowering the protein content do tend to reduce the quality of protein present. The availability of proteins in meat meals are subject to variation, depending upon the heat maintained in the drying process. The biological value of proteins are reduced and many vitamins destroyed, when the product is dried at a high temperature. Meat meal is a good source of calcium, phosphorus,

manganese, iron, copper, niacin, and choline. It is, however, low in vitamins A and D, riboflavin, and pantothenic acid (13, p.596).

(3) Dried Skim Milk

Dried skim milk, also known as non-fat dry milk solids, is a dairy product attaining widespread use in both animal and human nutrition. The value of milk in nutrition has been demonstrated beyond doubt, and with the controlled processes for drying little of its nutritive value is lost in the preparation. Dried skim milk is highly palatable and an excellent source of water soluble vitamins. The low fat content necessarily limits the amounts of the fat soluble vitamins which are available. The proximate percentage analysis of dried skim milk is listed by Morse, Davis and Jack (12, p.201) as follows:

Per Cent	Constituents
3.23	moisture
36.90	protein
50.75	lactose
0.88	fat
8.15	ash
1.31	calcium
1.02	phosphorus

Red-Meat Products

Liver included in diets I through VII was rejected

beef livers deemed unfit for human consumption by Federal inspection standards. This product was obtained fresh at local slaughter houses and quick frozen for later use. Horsemeat was obtained through the Oregon State Fur Producers Cooperative Association in frozen fifty pound blocks which were denatured with charcoal. Tripe was obtained fresh from local slaughter houses and frozen until used.

Preparation

The fish and tripe were placed in a large container of water and allowed to thaw at room temperature overnight. The horsemeat and liver were thawed in air at room temperature to avoid excessive loss of juices. The fish used in the feed were cleaned by removing the digestive tract, but with care being taken not to remove the livers. The alimentary tract of the fish was removed to eliminate materials of variable nutritional quality which may have been ingested by the fishes. The diet ingredients were ground, weighed to diet specifications, and mixed just prior to feeding of the experimental animals each afternoon. Sufficient feed was given each mink once daily from June 29, at the start of the diet trials, until pelting time, to ensure ad libitum feeding of the experimental animals. Prior to being placed in individual

cages on June 27, the young mink were fed twice daily, with the morning feed being saturated with fresh whole milk obtained through the Oregon State College Dairy Products Laboratory.

The diets tested can be grouped into three natural divisions, depending on the amount of fresh "red meats" included. Diet I is a basic control ration, proven to be adequate in maintaining health, satisfactory growth and in producing good pelt quality in mink. This diet is similar to rations fed by many successful ranchers throughout the State and has been included at the Oregon State College Experimental Fur Farm in nutritional studies for diet comparisons during the past three experimental feeding seasons. This ration includes horsemeat, beef liver, and beef tripe, and the following constituents as listed by per cent of the total wet weight of the diet:

Per Cent	Constituents	Per Cent	Constituents
7	horsemeat	2	wheatgerm meal
4	liver	2	Cerl-meal
14	tripe	1½	alfalfa meal
42	mixed sole	1½	brewers' yeast
25	rockfish	1	bone meal

Diets II, III, IV, V, VI, and VII are lacking horsemeat and tripe but contain liver. Rations fed to groups III through VII contained the following supplements selected to replace the missing horsemeat and tripe: diet III, methionine; diet IV, arsanilic acid; diet V, live yeast; diet VI, aureomycin; diet VII, terramycin.

Diet II is a control diet for this category, in that it is unsupplemented. The basic diet for this group contains:

Per Cent	Constituents	Per Cent	Constituents
3	liver	4	wheatgerm meal
42	mixed sole	2	Cerl-meal
25	rockfish	1½	alfalfa meal
20	turbot	1½	brewers' yeast
		1	bone meal

Rations given to diet groups IX, X, XI, and XII, are devoid of all three fresh "red-meat" products present in Diet I, namely: liver, horsemeat and tripe. Diet group IX serves as a control group for diets X, XI, and XII, which are supplemented with vitamin supplement, live yeast, and methionine plus terramycin, in that order. All diets in this division including the control contain three protein concentrates, blood meal, meat meal and dried skim milk. The contents of the basic diet are as follows:

Per Cent	Constituents	Per Cent	Constituents
39	mixed sole	4	wheatgerm meal
25	rockfish	2	Cerl-meal
20	turbot	1½	alfalfa meal
2	blood meal	1½	brewers' yeast
2	meat meal	1	bone meal
2	dried skim milk		

Experimental animals in each of these first seven diet test groups numbered 32, including 16 male and 16 female dark mink. The remainder of the diet groups contained only 16 animals, 8 males and 8 females, because

of the preliminary nature of the liver-free ration studies.

Proximate Analysis

That correlation often exists between the proximate analysis of a feedstuff and the nutritional response of the animals to which it is given is generally recognized by nutritionists; therefore, the proximate analysis of each of the diets discussed is presented in table II and the analysis of some of the diet constituents appears in appendix I.

The analytical determinations were made by Miss Arlene Stone, Research Assistant, Department of Agricultural Chemistry, under the direction of Dr. J. R. Haag.

The Experimental Animals

The Oregon State College Experimental Fur Farm has continuously kept a herd of dark ranch mink since its reestablishment in 1950, when 50 dark mink were donated by the Oregon State Fur Producers Association for nutritional research. In March 1953 the breeding stock for the experimental colony contained 99 females and 23 males. Mating began on March 6 of that year and continued until March 28. Ninety-eight of the females were successfully mated and gave birth to 434 young or

TABLE II

PROXIMATE ANALYSIS OF EXPERIMENTAL DIETS
(Wet basis)

	Ration (in per cent)							
	Moisture	Crude Protein	Ash	Crude Fat	Crude Fiber	Nitrogen-Free Extract	Calcium	Phosphorus
Group I	75.38	13.52	2.97	4.57	0.59	2.97	0.72	0.47
Group II	72.54	14.28	4.10	4.91	0.57	3.60	1.19	0.70
Group III	73.51	13.71	3.87	4.62	0.59	4.06	1.10	0.66
Group IV	73.30	14.38	3.85	4.68	0.66	3.13	1.08	0.66
Group V	73.64	14.29	3.61	4.55	0.64	3.27	1.02	0.62
Group VI	73.84	14.26	3.85	4.58	0.63	2.84	1.11	0.65
Group VII	72.25	15.34	4.41	5.05	0.62	2.33	1.09	0.67
Group IX	71.24	16.21	4.11	4.88	0.63	2.93	1.23	0.71
Group X	72.00	15.49	4.23	4.34	0.59	3.35	1.37	0.79
Group XI	73.18	14.23	3.43	4.10	0.61	4.45	0.89	0.54
Group XII	72.34	14.55	4.23	4.04	0.71	4.14	1.04	0.62

an average of 4.7 young kits for each female mated or an average of 4.4 kits per female on the ranch was obtained. These young were placed in individual pens June 28 in preparation for diet testing which began on July 1, 1953.

In selecting experimental animals to be placed within a diet test grouping, three factors were considered which might affect the ultimate results of the tests, namely: (1) genetic relationship; (2) individual animal weights; and (3) origin as to litter size. It was decided that where practical, animals which were litter mates (having the same parents) would not be included in the same diet group. Also, it was decided that the mean weight of the mink within any one diet group would not vary significantly from the mean weights of the other groups at the inauguration of the studies. The mean weight of the experimental animals within diet test groups showed a maximum variation of three ounces on June 28, 1953.

To minimize further any factors which might affect the experimental results, consideration was given to the litter size from which the animals were selected. The sizes of the litters produced in 1953 were arbitrarily divided into three groups, large litters, medium litters, and small litters, so that one-fourth of the kits were born in large litters, one-fourth were found in small

litters, and the remaining one-half of the young occurred in medium sized litters. This resulted in the following breakdown as to litter sizes: Small litters, of one to four kits; medium litters, of five, six and seven young; and large litters, of eight or more kittens. Animals for experimental diet groups were then selected from these three classifications in a ratio of 1 : 2 : 1, thus insuring more even distribution of the test mink originating from litters of various sizes.

Procedure for Collecting Growth Data

The growth resulting from the various diets was measured by two methods. A weight increase record of the mink was established from biweekly weighings of the experimental animals, beginning with the weight on June 28, two days prior to the initiation of the test diet feeding, and continuing until November 4. The animals were trapped from their pens at two week intervals, weighed on a hanging scale, and their weights recorded to the nearest ounce.

A further indication of growth and perhaps one of greater economic importance is the size of the finished pelt. A measurement was taken from the tip of the snout to the base of the tail on the finished pelt and recorded in inches. This measurement is considered expressive of

the area of fur in the pelt, and is partially indicative of its monetary value.

Procedure for Collecting Pelt Data

Careful inspection of the fur of the mink in the experimental diet groups began November 15, 1953, in order to ascertain when the pelts of the animals were prime and should be taken. At the proper time the mink were pelted and the pelts tagged with the serial number of the animal from which it was taken. Records were kept on the date of pelting for each mink and the diet which it had received. After preliminary finishing of the pelts, measurement of the length was taken.

On January 5, 1954, the pelts were taken to Seattle, Washington, where they were graded for color and fur quality values by Mr. Benjamin Essman and Mr. Samuel McCorkle, experienced fur judges, in the facilities generously provided by the Seattle Fur Exchange. The pelts were first separated or lotted into six classes according to the desirability of their color, based primarily on the darkness of the guard hair and underfur, and the degree to which they complemented one another. The pelts within these six classifications were then assigned a relative numerical value for fur color, one through six, with pelts of more desirable color being

represented with a higher pelt color value than those of poorer color. Class one pelts contained only pelts which were damaged to the extent that their value was severely reduced and the so-called "cotton pelts" or those in which the underfur is devoid or nearly devoid of pigment. Pelts of this category were highly undesirable. The above evaluation of color gives the association of a high color value with a desirable pelt.

Within each color classification the pelts were assigned relative value for fur quality with only two divisions, good or poor. Those pelts termed poor, generally lacked luster, contained insufficient guard hair to cover the underfur, or did not provide adequate quantities of underfur to render plushiness to the pelt. The pelts of good fur quality possessed sheen and presented a balance of guard hair and underfur, with a sufficiency of both. A numerical value of five was assigned pelts of good quality and a value of four given those of poor quality. It was believed that these numerical values would approximate the price differential which would be made on these two qualities of fur when the pelts were marketed.

Mink from the experimental diets saved for breeding purposes were selected primarily because of their large size and good pelt value, consequently a fur color value

of six and a fur quality value of five was assigned them. The pelt size was not recorded for these animals retained for breeding purposes. An exception is made in diet group IV, where six female mink were retained for breeding purposes, with the intention of establishing if the arsanilic acid might alter the normal reproductive behavior of the mink. Since these selections were based on heredity rather than size or fur qualities, these animals were omitted in calculating the mean values for this diet group.

OBSERVATIONS

Growth Studies

Weight Gain

As a measure of the quality of a ration, the weight of a mink is only of secondary importance to the mink rancher. It is important only, with few exceptions, as a measure directly proportional to the size of the pelt taken from the animal. With this limitation established, the following section will compare the value of the diets in promoting growth as measured by weight of the animals at biweekly intervals from June 28 to November 4.

A summary of the mean weight of the experimental

diet group animals as obtained in weighings is listed in table III. A more complete review of the weight studies may be obtained from the listing of weights of the individual mink within the diet test groups appearing in appendix II.

Male mink being almost twice as large as the females possess greater growth requirements; consequently, when a ration fails to meet adequately the needs of the mink, the males are affected most notably. The greater variation occurring in the mean weight gains of the larger male mink lends considerably greater value to their weight gains as an indicator of the capacity of a ration to elicit growth, than to the weight gains of the females which occur in relatively close grouping.

The greatest weight gain of the male mink is exhibited by those in group VII, where an increase of 2 pounds and 8 ounces was observed over the period from June 28 at which time these animals weighed an average 1 pound and 2 ounces through November 4, when they reached 3 pounds and 10 ounces. The capacity of this diet to promote growth is further substantiated by the increase shown by the females from the initial weighing of 1 pound 2 ounces to 2 pounds 4 ounces for a gain of 1 pound 2 ounces. This gain is identical with the female mink given the aureomycin supplemented ration, diet VI,

TABLE III

AVERAGE BIWEEKLY WEIGHTS OF MINK IN EXPERIMENTAL DIET GROUPS
(in pounds and ounces)

Group No.	Number in Group	June 29	July 15	July 29	August 12	August 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	November 4
FEMALES											
I	16	1-1	1-7	1-11	1-12	1-15	2-0	2-1	2-5	2-4	2-4
II	16	1-0	1-6	1-9	1-11	1-11	1-13	1-13	2-1	2-2	2-0
III	16	1-0	1-5	1-8	1-9	1-11	1-13	1-14	2-1	2-1	2-0
IV	16	1-0	1-5	1-8	1-10	1-11	1-12	1-13	1-14	2-0	1-15
V	16	1-0	1-6	1-9	1-10	1-10	1-12	1-13	1-15	2-0	2-1
VI	16	1-1	1-7	1-9	1-12	1-13	1-14	1-15	2-1	2-2	2-3
VII	16	1-2	1-6	1-9	1-11	1-11	1-14	2-0	2-1	2-2	2-4
IX	8	1-0	1-5	1-8	1-9	1-10	1-12	1-13	1-14	1-15	2-0
X	8	1-0	1-5	1-8	1-9	1-10	1-12	1-13	1-14	1-14	2-0
XI	8	1-1	1-6	1-11	1-11	1-12	1-13	1-13	2-0	2-0	2-1
XII	8	1-0	1-8	1-9	1-12	1-13	2-0	1-15	2-1	2-1	2-3
MALES											
I	16	1-5	2-0	2-7	2-11	3-1	3-4	3-8	3-11	3-14	3-12
II	16	1-4	1-12	2-2	2-6	2-10	2-13	2-15	3-2	3-4	3-3
III	16	1-4	1-12	2-2	2-7	2-12	3-0	3-2	3-4	3-6	3-6
IV	16	1-4	1-12	2-2	2-7	2-12	3-0	3-2	3-2	3-5	3-4
V	16	1-3	1-12	2-1	2-5	2-9	2-12	2-14	3-0	3-3	3-3
VI	16	1-5	1-12	2-3	2-7	2-10	2-14	3-0	3-1	3-3	3-4
VII	16	1-2	1-12	2-5	2-10	2-12	3-1	3-4	3-5	3-6	3-10
IX	8	1-4	1-9	1-14	2-2	2-4	2-14	2-8	2-10	2-11	2-15
X	8	1-4	1-11	2-1	2-5	2-8	2-9	2-10	2-11	2-9	2-13
XI	8	1-2	1-13	2-3	2-8	2-12	2-13	2-14	3-2	3-3	3-6
XII	8	1-2	1-11	2-2	2-5	2-10	2-14	2-15	3-2	3-3	3-5

and is the third best weight increase shown by female mink.

A diet producing male mink of greater ultimate weight with only a slightly less weight gain over the period of biweekly weighings, was diet group I, the basic control diet group. The males in group I registered a weight gain of 2 pounds 7 ounces from their initial weight of 1 pound five ounces on June 28 to a final weight on November 4 of 3 pounds 12 ounces. The excellence of this basic ration is further presented in the growth gains of the females of this group, which were unsurpassed in mean weight gain. The females of group I began the test period with a mean weight of 1 pound 1 ounce, increasing to 2 pounds 4 ounces to establish a gain of 1 pound 3 ounces.

The unsupplemented control groups, groups II and IX, produced animals with markedly less growth than the ration which contained the "red-meat" products, diet I. Males given ration II gained 1 pound 15 ounces in growing from 1 pound 4 ounces to 3 pounds 3 ounces during the test period; while the females, weighing 1 pound at the beginning of the trials, finished with a mean weight of 2 pounds, for an even 1 pound gain. An identical pattern was followed by the females in group IX with the males in this group showing less tendency to gain weight than those of group II. The males in group IX registered only an

increase of 1 pound 11 ounces in growing from 1 pound 4 ounces to a final weight of 2 pounds 15 ounces.

Males in group III receiving the amino acid methionine gained 3 ounces more than the unsupplemented control group, group II. A 2 pound 4 ounce gain was recorded for the live yeast supplemented liver-free diet, showing a 9 ounce advantage over the liver-free control diet, diet IX.

Females in diet groups V, live yeast supplemented, and VI, aureomycin supplemented, gained at a slightly greater rate than the female mink of the control group for these diets, diet group II.

No weight advantage was made by the male mink when the control diet, diet II, was supplemented with arsanilic acid, aureomycin or live yeast. Similarly the vitamin supplement added to the liver-free control diet gave no indication of increased growth.

Pelt Length

The present fur market is one of strong demand for long pelts which will not require piecing and matching when they are made into fur garments. This present buying trend gives considerable merit to the pelt length measurement as a means of partially indicating the monetary value of the pelt. Pelt length measurements present in many

cases the same picture of growth as that shown by the weight studies; however, in many cases where weight gains are identical, especially common in the mean weight gains of the female mink, there is variation in the mean pelt length measurements thus indirectly permitting evaluation of the diet for growth production. A tabulation of the mean pelt length for the mink within the diet groups is found in table IV.

The male mink in group I obtained a mean pelt length of 24.28 inches, which is larger than that produced by any other diet, while the females of this group responded equally as well in producing a mean pelt length of 20.56 inches.

The unsupplemented high fish control diet, diet group II, produced a mean pelt length of 23.23 inches in the males and 19.88 inches for the females. These averages are 1.05 and 0.68 inches less than the male and female measurements, respectively, of diet group I, which were given the ration containing horsemeat and tripe.

The males in diet group VII, terramycin supplemented, produced a pelt averaging 24.16 inches in length. This is only .12 inch less than the basic control diet group, group I, and is .93 inch longer than that produced by the unsupplemented high fish control, group II. The females of group VII showed similar ranking in pelt length with

TABLE IV

SIZE, COLOR, AND QUALITY RATINGS FOR MINK PELTS, BY DIET GROUPS
(Explanation of rating scales presented on pages 36-40)

Diet Group	Females			Males		
	Color Rating	Size Inches	Quality Rating	Color Rating	Size Inches	Quality Rating
Group I	4.47	20.56	4.69	4.19	24.28	4.50
Group II	4.00	19.88	4.64	3.87	23.23	4.64
Group III	4.25	19.71	4.58	3.62	23.50	4.57
Group IV	3.67	19.28	4.78	3.33	23.81	4.60
Group V	3.69	19.93	4.57	3.94	23.26	4.81
Group VI	5.12	20.02	4.80	4.12	23.20	4.60
Group VII	4.50	20.45	4.40	3.80	24.16	4.71
Group IX	4.00	19.54	5.00	3.88	21.65	4.88
Group X	4.12	19.34	4.88	3.50	21.62	4.86
Group XI	4.25	19.53	4.22	4.00	23.53	4.71
Group XII	4.57	20.57	4.71	4.12	23.21	4.38

a mean 20.45 inches, .57 inch longer than the control females in group II.

The male mink in the methionine supplemented group seemed to receive more advantage as measured by pelt length than did the females of the group. This reflects findings from 1951 and 1952, which indicated that males on methionine supplemented rations gain more than the females (15, p.6 and 16, p.4).

The males in group IV receiving arsanilic acid developed a surprisingly long pelt length in relationship to their mean weight gain. This condition seems to indicate thinness of these animals, which is consistent with their nervous temperament as discussed later in the paper.

The live yeast supplementation appeared to result in an increased advantage in pelt length, especially noticeable in the males of the liver-free diet group, group XI, where a mean length of 23.53 inches was obtained as compared to 21.65 inches of the unsupplemented control, group IX. The females did not show this improvement, being essentially equal to the control group.

The methionine, terramycin supplemented liver-free diet, group XII, produced considerable length gains over the liver-free control. The pelts of the male animals in group XII averaged 23.21 inches as compared to a mean

21.65 inches for the control diet, group IX. Similarly, the pelts of the female mink of group XII were 20.57 inches in length, while the female animals in group IX produced a pelt of 19.54, giving an advantage of 1.03 inches to the terramycin, methionine supplemented group.

Aureomycin did not appear to increase the pelt length over the unsupplemented control diet, nor did the vitamin supplement aid the pelt length measurement of the liver-free control diet group.

Pelt Value Studies

Fur Color

The standard dark mink is colored primarily by two color pigments; namely, black pigment and red-brown pigment. An abundance of black pigment, melanin, imparts to the fur an extremely dark ebony coloring, highly prized by the fur buyers of the present market, while furs colored predominately by the red-brown pigment present a reddish-brown appearance and are less desirable. The color classifications which are dealt with in this study are based upon the darkness of the color in the guard hair and the underfur, and upon the degree to which they contrast. Dark furs of low contrast between the guard hair and underfur are desirable. The intensity of darkness in the six arbitrary color divisions defies description except

as these classes are relative to one another. A color value of six was alloted to pelts of extremely dark color, while a rating of one was given "cotton pelts" and to those of very red color. As the color rating decreases, the less dark is the fur color and consequently the lower the monetary value of the pelt. Mean color ratings values for the mink within the diet groups are listed in table IV. Although the color ratings are treated separately by sex, unlike size ratings, there is no indication that either the male or female pelts have definite advantage over the other in this category.

The adequacy of the basic control diet, diet I, in producing peltage of dark color has been well demonstrated by the mink farming industry for many years, and by previous dietary experimental work of Watt in 1950, 1951, and 1952 (14, 15, 16). In this year's studies, the color was again exceptionally good on this diet, with color values of 4.47 and 4.19 for the female and male pelts respectively. In contrast to results of the research in 1952, in which Watt (16, p.5) found poorer color in mink on aureomycin, the mink in diet group IV fed aureomycin containing feed, produced a pelt of extremely fine coloration for one containing large quantities of marine fish. This is reflected in the color values of 5.12 and 4.12 for the female and male pelts respectively of this

group.

The mediocre pelt color value recorded by the high marine fish control diet, diet II, of 4.00 for the female pelts, and 3.87 for the male pelts, seems not to have been improved to any extent by the addition of the live yeast culture, Lacto-leav'n, as evidenced in the values of 3.94 and 3.69 for the males and female pelts respectively of group V.

There is indication in the color value of 4.25 exhibited by the pelts from the female mink in group III that methionine may improve the color over that of the unsupplemented control; however, this color improvement was not shared by the male mink in the same diet group. Similarly, terramycin gave indication of improving the color of those females on a high fish diet, without apparently affecting the color of the male mink pelts.

Arsanilic acid, which was included in the diet primarily in an attempt to facilitate pigmentation of the fur, failed in this respect. The pelts of this group acquired the lowest color rating of any test group, with mean color values of 3.67 and 3.33 for the male and female pelts respectively.

In the liver-free diets, the control diet, group IX, closely approached the high fish diet control group in mean color values, with a value of 4.00 for the female

mink and a value of 3.88 for the males. Although no improvement could be observed in the addition of the vitamin supplement to this base ration, encouraging results were seen in the addition of live yeast and methionine plus terramycin, as in diets XI and XII respectively.

Fur Quality

Mean fur quality ratings for the diet test group animals are presented in table IV. Greater consideration was given to the fur color as a means of selecting proper time of pelting than was given to fur quality. The proper time of selection for pelting based upon fur color did not, in all cases, coincide with the time of optimum pelt quality, the result being reflected in pelt value qualities which seem inconsistent with the merit of a diet relative to growth promotion and fur color.

Although an evaluation of the ultimate optimum fur quality of a pelt cannot be made from these data, certain interpretations may be drawn. The value of pelt quality when studied relative to fur color value permits the notation of the proximity of the time of optimum pelt quality to that of optimum pelt color. The coincidence of these times is highly desirable and is perhaps a function of the diet. It appears to be associated in

many cases with those diets which seem inadequate in growth promotion and desirable fur color production.

The liver-free control diet, diet IX, while exhibiting qualities of low growth promotion and poor color, shows the highest fur quality of any of the test diets for both the male and female mink, with values of 4.88 and 5.00 respectively. Second high in pelt quality values for both sexes was diet test group X, which received a liver-free diet supplemented with vitamins. Similarly, this diet appeared undesirable on the basis of growth and pelt color values.

Diets which were evaluated as proficient in producing large animals of good color such as diets I, VII, and XII, seemed to be of less than average value in producing pellage of good quality, at the time of optimum color.

Appearance and General Condition

Certain animals within the diet groups, generally those of relatively low weight at the beginning of the study, became weak, exhibited loss of appetite with subsequent improper nutrition, followed in many cases by extreme weakness and death. It was believed that in all such cases that the primary cause of death could not be directly attributed to the diet. No one diet contained

an unusually large number of such cases.

Experimental animals in group IV, given a diet containing arsanilic acid, were observed to be of unusually nervous temperament, and extremely quick of movement when excited, as particularly noted during the biweekly weighings. This perhaps partially explains the thinness of the animals in this diet group, as expressed by their long pelt measurement and low weight gain. The mink in all other diet test groups appeared normal in all respects, except for conditions of growth and pellage which are otherwise expressed in this thesis.

Dates of Pelting

There have been indications in previous studies by Watt (14, p.32) that in general, the time of priming of the pelt may be influenced by the diet. From the compiled dates of pelting listed in table V, no clearcut conclusions may be drawn; however, it appears that terramycin may delay priming to some extent.

DISCUSSION AND CONCLUSIONS

The role of the dietary supplements considered in this report are discussed on the basis of data obtained in feeding trials conducted in 1953, and from previous studies at this station in 1951 and 1952 by Watt (15, 16).

TABLE V

NUMBERS OF EXPERIMENTAL MINK PELTED ON VARIOUS DATES IN RELATION TO THE DIET GROUPS

Group	November							December			
	23	24	25	27	28	29	30	2	5	8	11
MALES											
I		1			1		2	2	8		
II			1		1	2	1	1	5	4	
III					4	1		1	5	1	1
IV		2	1	2	3	3	2		2		
V	1	2		4	1	2		2	2		2
VI				4	1	1	2	2	4	2	
VII						1		1	7	5	1
IX					1	3		2	1		1
X			1	1	3				2		1
XI					1	1	1			2	2
XII							2	2	4		

FEMALES	November									December			
	20	23	24	25	26	27	28	29	30	2	5	8	11
I		5		3		1	3	2			1		
II		3	1	3		3	1				2		
III	1	5		1		1	3	3					
IV		3	1			2		1	1		1		
V	2	7				1	1			1			
VI		4	2		2	2	1	1	1		2		
VII		2	1	4	3	1	1		2		1		
IX			2		1	2		2					
X			3				3	1			1		
XI			3		1	1	2			1			
XII		1	1				1		1	2	1		

Interpretations and any conclusions which may have been drawn from these observations are presented in this section.

Antibiotics

Aureomycin

Aureomycin has been included in diet testing for three years of nutritional studies beginning in 1951. Results from the three years' tests indicate little ultimate size is gained by the use of this supplement at the level of 4.5 grams per ton of mixed feed. The excellent color value assigned to pelts of the animals given aureomycin in 1953 is in direct contradiction with the results of diet trials of 1952; however partial substantiation is revealed in results of 1951 studies, which note some color improvement in animals given a high fish-containing ration supplemented with 1 per cent aureomycin, on a dry weight basis. There appears to be no decisive change in fur quality dur to the addition of this supplement. The role of antibiotic supplements in disease prevention and treatment are beyond the scope of this paper.

Terramycin

Terramycin in an overall evaluation seems to be superior to aureomycin as a high fish-containing mink ration supplement, when fed at an equivalent level of 4.5 grams of antibiotic per ton of mixed feed. Terramycin came under study at this experiment station during 1952

and 1953. In studies conducted in 1952, terramycin supplemented diets evidenced their capacity to promote growth both above the unsupplemented high fish control and above the aureomycin supplemented rations. These results were again repeated in 1953, with the use of terramycin in high fish rations, and in combination with another supplement, methionine, in a liver-free diet. In the results of both years' investigations, the size of the experimental mink given terramycin in addition to the high fish ration closely approached that attained by the animals on the basic "red-meat"-containing diet. No conclusive results were obtained pertaining to the effect of terramycin on pelt color and pelt quality, although there was no indication of a deleterious effect to these qualities. On the basis of these studies, it appears that terramycin added to mink feed at the level of 4.5 grams per ton of mixed high fish ration, provides advantages over the unsupplemented diet, and is superior to an equal level of aureomycin.

Methionine

The use of the amino acid methionine in mink rations was first investigated in the nutritional studies of 1951. Methionine was originally incorporated into the rations of mink in conjunction with the use of soybean

oil meal as a protein supplement, as soybean proteins are notoriously deficient in this amino acid. The unpalatibility of soybean oil meal was soon evident and its use discontinued; however, the value of methionine in a high fish ration was recognized at this time. Primarily, the improvement incited by methionine is one of growth, particularly evident in the male experimental mink. The diet trials of 1952 first showed that a greater growth benefit was occurring in the male animals than in the females given the same ration. From this years' data it may be seen that the males given methionine were larger by criteria of both weight gain and pelt length than the gains recorded by the control diet, while the females appeared unaffected in either measurement in this comparison. Work by Hale and Oldfield[1] showed that a similar situation existed in rats, which when placed on a methionine low ration the females consistently outgained the males.

Color seems not to be ostensibly affected by the addition of methionine to the diet, and although there were indications of increased guard hair growth in these animals there was no appreciable increase in the overall pelt quality.

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1 Dr. James E. Oldfield, Associate Professor, Oregon State College, in personal interview with the author.

In comparison of two levels of methionine supplementation in 1951, 0.05 per cent of the dry weight added to a high fish diet proved to be considerably more effective in eliciting growth than did addition of 0.1 per cent of the dry weight. It is interesting to note, however, that a seemingly significant increase in the guard hair production of the latter group occurred. The combination of methionine and the antibiotic terramycin gave particularly favorable indication of satisfactorily replacing fresh beef liver when fed in conjunction with protein concentrates of blood meal, meat meal, and dried skim milk.

With the present market trend to demand for pelts of large size, there seems to be sufficient evidence of increased growth advantage produced by 0.05 per cent of the dry diet weight methionine supplementation to recommend the use of this amino acid in the rations of ranch mink.

Arsanilic Acid

The initial trial use of arsanilic acid in mink feeds at Oregon State College was in 1953 diet trials. Absolutely no advantage was gained in growth or pellage values through the use of this supplement in these investigations. The nervous reaction by the

experimental animals receiving this supplement was considered detrimental to their well-being, and it was therefore concluded that arsanilic is of negative value as a supplement for high fish mink rations.

Vitamin Supplement

The water soluble vitamins contained in the vitamin supplement investigated in this study proved ineffective in stimulating growth, in enhancing fur color and in pelt quality values of mink on liver-free feed. The vitamins which were unquestionably lost through the omission of liver from the diets of mink were not sufficiently replaced by the vitamin supplement used in this study.

Live Yeast Compound

Studies investigating the use of Lacto-Leav'n, live yeast compound, in high fish mink diets were begun by Watt in 1952. Results of two years' studies, 1951 and 1952, reveal a slight growth gain, exhibited as weight gain rather than pelt size, for animals given rations containing this supplement.

Marked growth gain was recorded in 1953 for the male animals given live yeast in addition to a liver-free ration. Fur color and quality values were unaffected by the addition of live yeast, except for slight improvement

in pelt color obtained through its use with the liver-free ration.

SUMMARY

A study was undertaken at the Oregon State College Experimental Fur Farm, during the period of May 1953 through January 1954, in an effort to resolve one of the Northwest mink ranching industry's most pressing problems, that of replacing "red-meat" products in the rations of mink. Certain feed supplements thought to have merit in replacing beef liver, beef tripe and horsemeat, in the usual mink rations, were evaluated in diet trials on the basis of growth promotion, fur color and pelt quality, as expressed in dark ranch mink.

The literature pertaining to the nutritional aspects of the dietary constituents was reviewed, with specific reference to the supplements being tested.

Diets were formulated in such manner as to be: (1) devoid of horsemeat and beef tripe, but containing three per cent beef liver, and (2) lacking horsemeat, beef tripe, and beef liver, but with the inclusion of two per cent each of blood meal, meat meal, and dried skim milk. To these base diets one of the following supplements was added: aureomycin, terramycin, methionine,

arsanilic acid, vitamin supplement, and a live yeast compound. One of the experimental diets was supplemented with both terramycin and methionine.

Growth promotion was evaluated by two methods: (1) weight gain ascertained from biweekly weighings, and (2) length of pelt measured from the prepared furs. Fur color and fur quality values were assigned the pelts of the experimental animals by experienced fur judges of the Seattle Fur Exchange. These data were compiled by diet groups and sex, and analyzed utilizing the mean values of these classifications.

The following evaluations were made from the data collected in this study, with consideration of the results of Watt (15, 16) in similar nutritional studies conducted at the Oregon State College Fur Farm in 1951 and 1952:

1. Increased growth of mink was evident in experimental animals fed terramycin when compared to those on unsupplemented high fish rations, and when compared to those raised on aureomycin supplemented rations.

2. The amino acid methionine at the level of 0.05 per cent of the dry feed weight gave increased growth in the male mink but not in the females.

3. Terramycin and methionine in combination showed favorable indication of replacing fresh beef liver in certain liver-free rations.

4. Arsanilic acid appears to be detrimental to mink in all three qualities measured, growth, fur color, and pelt quality, when fed at 0.00375 per cent of the dry weight of the ration.

5. Slight growth improvement was evident in high fish rations supplemented with one-half per cent of live yeast compound, with marked growth improvement recorded in liver-free diets containing this supplement.

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APPENDICES

APPENDIX I

ANALYSIS OF SOME EXPERIMENTAL DIET CONSTITUENTS

Material Analyzed	Proximate Analysis (Wet Basis)					
	Moisture	Ash	Crude Protein	Fat	Calcium	Phos-phorus
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Black Rockfish (whole)	73.7	3.03	18.28	5.69	1.99	1.02
Turbot (whole)	75.6	2.13	14.39	11.48	0.41	0.32
Green Rockfish (whole)	71.0	4.86	18.65	6.92	0.78	0.52
Slime sole (carcass)	79.1	3.12	11.42	5.92	0.73	0.42
Red Rockfish (carcass)	77.8	3.89	15.45	2.55	1.14	0.65
Rex Sole (whole)	80.8	3.20	14.70	1.26	--	--
Petrale Sole (whole)	77.1	3.60	16.50	2.61	--	--
English Sole (whole)	76.7	3.90	15.20	3.41	--	--
Sand Sole (whole)	78.9	3.60	15.10	1.95	--	--
Beef liver	84.6	2.75	12.60	1.46	--	--
Beef tripe	69.1	2.22	19.80	10.50	--	--
Horse meat	72.5	2.88	18.60	3.50		

APPENDIX II

A COMPARISON OF INDIVIDUAL BIWEEKLY WEIGHTS OF MALE AND FEMALE MINK INCLUDED IN EXPERIMENTAL DIET GROUPS-1953

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	Nov. 4
GROUP I (Basic) - Diet started July 1											
1000	F	0-15	1-7	1-10	1-11	1-15	2-1	2-1	2-4	2-4	2-3
1001	F	1-5	1-11	2-0	2-0	2-3	2-4	2-5	2-9	2-8	2-5
1002	F	1-2	1-9	1-11	1-14	1-15	2-0	2-3	2-8	2-4	2-4
1003	F	1-5	1-9	1-10	1-11	1-12	1-13	1-15	2-1	2-1	2-1
1004	F	1-0	Died July 7								
1005	F	1-1	1-9	1-12	1-13	2-1	2-3	2-5	2-8	2-9	2-8
1006	F	1-2	1-10	1-15	2-2	2-4	2-5	2-7	2-11	2-12	2-12
1007	F	0-13	1-3	1-8	1-10	1-11	1-13	1-14	2-0	2-0	2-1
1008	F	1-1	1-8	1-12	1-14	2-0	2-1	2-2	2-3	2-4	2-2
1009	F	0-14	1-6	1-9	1-13	2-0	2-1	2-3	2-14	2-12	2-12
1010	F	1-2	1-9	1-13	1-12	2-0	2-1	2-0	2-5	2-5	2-4
1011	F	1-0	1-7	1-10	1-11	1-11	1-12	1-12	1-15	1-13	1-14
1012	F	0-12	1-6	1-12	1-14	2-1	2-2	2-4	2-8	2-8	2-8
1013	F	0-15	1-7	1-11	1-15	2-1	2-3	2-4	2-8	2-7	2-5
1014	F	1-1	1-7	1-9	1-10	1-10	1-11	1-12	2-0	2-1	2-2
1015	F	1-0	1-3	1-5	1-5	1-6	1-6	1-6	1-9	1-9	1-10
1016	M	1-14	2-10	3-3	3-6	3-14	4-3	4-8	4-12	4-14	4-11
1017	M	1-10	2-2	2-7	2-11	3-0	3-4	3-6	3-9	3-11	3-10
1018	M	1-6	2-2	2-9	2-11	3-4	3-6	3-12	3-14	3-15	3-14
1019	M	1-9	2-3	2-11	2-14	3-7	3-11	4-1	4-5	4-7	4-6
1020	M	1-4	1-14	2-3	2-6	2-9	2-14	3-1	3-3	3-7	3-4
1021	M	1-4	1-15	2-6	2-10	2-14	3-1	3-2	3-4	3-6	3-5
1022	M	1-3	2-1	2-9	2-15	3-5	3-9	3-11	4-0	4-2	4-1
1023	M	1-4	2-1	2-8	2-14	3-6	3-6	3-11	4-0	4-1	4-1

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	Nov. 4
1024	M	1-6	2-1	2-8	2-12	3-2	3-7	3-13	3-14	4-2	4-2
1025	M	1-5	1-14	2-4	2-9	2-13	3-3	3-4	3-5	3-5	3-5
1026	M	1-3	1-14	2-4	2-10	2-14	3-3	3-6	3-12	4-0	4-2
1027	M	1-4	1-14	2-5	2-7	2-11	2-13	3-0	3-1	3-5	3-3
1028	M	1-3	1-12	2-3	2-6	2-10	2-11	2-14	3-1	3-4	3-4
1029	M	1-8	2-3	2-9	2-14	3-5	3-8	3-13	4-0	4-3	4-4
1030	M	1-6	2-2	2-8	2-13	3-3	3-4	3-5	3-6	3-9	3-5
1031	M	0-14	1-9	2-0	2-4	2-9	2-12	2-15	3-0	3-4	3-5
GROUP II - Diet started July 1.											
1032	F	1-7	1-10	1-14	2-1	2-3	2-4	2-4	2-8	2-9	2-8
1033	F	1-1	1-6	1-8	1-8	1-9	1-10	1-10	2-0	2-1	2-1
1034	F	1-6	1-10	1-13	1-14	1-12	1-13	1-13	2-1	2-3	2-5
1035	F	1-2	1-6	1-10	1-12	1-13	1-15	2-1	2-3	2-2	2-2
1036	F	0-15	1-5	1-7	1-7	1-7	1-8	1-6	1-8	1-7	1-3
1037	F	1-5	1-7	1-10	1-12	1-13	1-14	2-0	2-3	2-4	2-5
1038	F	1-0	1-6	1-8	1-10	1-11	1-11	1-11	1-15	2-2	2-0
1039	F	0-15	1-4	1-6	1-9	1-9	1-12	1-12	2-2	2-3	2-2
1040	F	0-15	1-4	1-8	1-8	1-10	1-15	2-0	2-1	2-3	2-2
1041	F	0-15	1-2	1-5	1-7	1-7	1-9	1-9	1-12	1-14	1-15
1042	F	1-3	1-10	1-14	1-15	2-2	2-3	2-3	2-5	2-6	2-5
1043	F	0-13	1-4	1-7	1-9	1-10	1-12	1-13	2-2	2-2	2-0
1044	F	0-10	1-0	1-6	1-9	1-10	1-14	2-1	2-4	2-7	2-7
1045	F	0-15	1-6	1-8	1-9	1-10	1-10	1-8	1-13	1-13	1-12
1046	F	1-0	1-7	1-8	1-15	1-12	1-15	1-15	2-1	2-1	1-14
1047	F	0-14	1-3	1-5	1-8	1-9	1-10	1-10	1-12	1-15	1-14
1048	M	1-3	1-11	2-0	2-1	2-2	2-4	2-5	2-6	2-7	2-7
1049	M	1-7	2-0	2-6	2-10	3-0	3-3	3-5	3-8	3-12	3-12

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	Nov. 4
1050	M	1-0	Died July 8.								
1051	M	1-13	2-8	3-0	3-6	3-11	3-13	4-0	3-15	4-2	4-1
1052	M	1-2	1-6	1-11	1-13	1-15	1-15	2-3	2-8	2-10	2-9
1053	M	1-7	1-14	2-2	2-2	2-6	2-8	2-10	3-0	3-1	3-4
1054	M	1-5	2-0	2-6	2-12	2-15	3-3	3-4	3-5	3-10	3-8
1055	M	1-3	1-10	2-0	2-7	2-13	3-1	3-2	3-4	3-4	3-2
1056	M	1-5	1-12	1-15	2-2	2-4	2-7	2-8	2-13	2-14	2-15
1057	M	1-6	1-9	1-14	2-2	2-5	2-9	2-10	2-13	2-14	2-14
1058	M	1-4	1-13	2-4	2-9	3-0	3-6	3-9	3-15	3-14	3-12
1059	M	1-3	1-12	2-3	2-8	2-12	3-0	3-1	3-6	3-7	3-6
1060	M	1-0	1-8	2-1	2-9	2-15	3-4	3-6	3-12	4-0	4-0
1061	M	1-2	1-8	1-14	2-2	2-6	2-7	2-9	2-11	2-12	2-9
1062	M	1-3	1-9	1-14	2-2	2-5	2-8	2-8	2-12	3-0	3-0
1063	M	1-4	1-8	1-15	2-2	2-7	2-9	2-11	2-14	2-15	3-0
GROUP III - Diet started July 1.											
1064	F	1-0	1-2	1-3	1-7	1-8	1-10	1-11	1-13	1-15	1-15
1065	F	1-0	1-5	1-8	1-10	1-11	1-13	2-0	2-2	2-3	2-2
1066	F	1-2	1-6	1-9	1-11	1-11	1-14	2-1	2-3	2-3	2-3
1067	F	1-4	1-8	1-12	1-14	1-13	2-2	2-4	2-7	2-9	2-8
1068	F	0-11	1-4	1-8	1-10	1-12	1-15	2-0	2-3	2-3	2-3
1069	F	1-4	1-8	1-11	1-13	1-14	2-2	2-1	2-4	2-3	2-4
1070	F	0-15	1-4	1-7	1-9	1-10	1-9	1-9	1-10	1-8	1-7
1071	F	1-3	1-7	1-10	1-10	1-11	1-12	1-12	2-0	2-0	2-1
1072	F	0-12	1-4	1-7	1-10	1-12	1-15	2-0	2-4	2-3	2-1
1073	F	0-13	1-4	1-8	1-12	1-15	2-3	2-4	2-5	2-7	2-6
1074	F	1-0	1-4	1-6	1-8	1-9	1-11	1-10	1-14	1-13	1-12
1075	F	1-3	1-9	1-12	1-12	1-14	2-1	2-0	2-2	2-3	2-3
1076	F	1-0	1-6	1-10	1-11	1-12	1-15	1-15	2-1	2-0	1-14

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	Nov. 4
1077	F	0-15	1-6	1-8	1-12	1-12	1-13	1-12	1-12	1-13	1-14
1078	F	0-11	1-2	1-3	1-3	1-3	1-4	1-6	1-7	1-9	1-7
1079	F	0-12	1-2	1-6	1-11	1-13	2-0	2-0	2-2	2-3	2-2
1080	M	0-15	1-2	1-2	1-4	1-3	Died November 27.				
1081	M	1-4	1-11	2-1	2-4	2-10	3-0	3-5	3-5	3-8	3-12
1082	M	1-10	2-1	2-7	2-12	3-2	3-6	3-6	3-9	3-11	3-13
1083	M	1-8	1-15	2-5	2-11	2-13	3-3	3-3	3-4	3-3	3-4
1084	M	1-6	2-1	2-8	2-14	3-2	3-8	3-11	3-10	3-12	3-13
1085	M	1-6	2-0	2-5	2-11	2-13	3-2	3-3	3-2	3-3	3-2
1086	M	1-6	2-2	2-8	2-14	3-1	3-4	3-7	3-7	3-8	3-10
1087	M	1-4	1-13	2-2	2-5	2-8	2-9	2-11	2-14	3-0	3-1
1088	M	1-4	1-12	2-2	2-8	2-14	3-4	3-7	3-11	4-0	4-0
1089	M	1-1	1-8	1-14	2-4	2-10	2-14	2-14	3-1	3-3	3-3
1090	M	1-6	1-15	2-7	2-13	3-2	3-4	3-6	3-11	3-12	3-11
1091	M	1-4	1-11	2-3	2-6	2-12	2-13	2-12	2-14	3-0	3-0
1092	M	1-5	1-12	2-2	2-6	2-10	2-13	2-12	2-15	3-3	3-3
1093	M	1-2	1-9	2-0	2-5	2-10	2-14	3-1	3-3	3-5	3-4
1094	M	1-0	1-10	2-2	2-6	2-9	2-11	2-12	3-0	3-1	3-1
1095	M	1-3	1-8	1-15	2-2	2-6	2-8	2-10	2-14	3-1	3-2
GROUP IV - Diet started July 1.											
1096	F	1-3	1-9	1-13	1-14	1-15	2-1	2-1	2-3	2-4	2-2
1097	F	0-15	1-3	1-4	1-6	1-8	1-9	1-9	1-9	1-11	1-10
1098	F	0-15	1-7	1-9	1-11	1-13	1-14	1-15	2-2	2-4	2-4
1099	F	0-15	1-4	1-7	1-10	1-11	1-10	1-11	1-15	2-0	1-12
1100	F	0-15	1-4	1-8	1-9	1-11	1-11	1-11	1-14	2-1	2-0
1101	F	1-2	1-8	1-12	2-1	2-0	2-0	2-0	2-1	2-2	2-2

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	Nov. 4
1102	F	1-11	1-8	1-11	1-14	2-1	2-2	2-4	2-5	2-6	2-5
1103	F	1-1	1-6	1-10	1-11	1-12	1-15	2-1	2-4	2-3	2-4
1104	F	0-13	1-3	1-4	1-6	1-8	1-10	1-9	1-10	1-11	1-9
1105	F	0-12	1-2	1-5	1-6	1-7	1-9	1-10	1-12	1-14	2-0
1106	F	1-1	1-8	1-13	1-13	1-14	2-0	2-0	2-3	2-5	2-5
1107	F	0-15	1-6	1-10	1-11	1-12	1-13	1-12	1-15	2-0	1-12
1108	F	0-14	1-6	1-11	1-15	2-1	2-4	2-4	2-6	2-8	2-8
1109	F	0-11	1-0	1-4	1-2	1-3	1-4	1-4	1-6	1-6	1-7
1110	F	0-13	1-2	1-4	1-4	1-4	1-4	1-3	1-2	1-3	1-0
	Died November 11.										
1111	F	1-0	1-3	1-6	1-6	1-8	1-10	1-11	1-12	1-14	2-0
1112	M	1-6	2-0	2-6	2-10	2-12	3-3	3-6	3-7	3-9	3-8
1113	M	1-10	1-15	2-4	2-10	2-14	2-15	2-15	2-14	3-1	3-0
1114	M	1-6	1-14	2-5	2-10	2-13	3-3	3-4	3-11	3-11	3-11
1115	M	1-13	2-8	3-0	3-3	3-8	3-14	4-0	4-2	4-2	4-1
1116	M	1-4	1-13	2-2	2-8	2-14	3-1	3-4	3-8	3-13	3-14
1117	M	1-0	1-9	2-0	2-4	2-8	2-14	2-14	3-0	3-4	3-4
1118	M	1-2	1-8	1-13	2-0	2-3	2-5	2-8	2-8	2-10	2-10
1119	M	1-0	1-8	1-13	2-2	2-4	2-6	2-8	2-11	2-15	3-1
1120	M	1-4	1-14	2-8	2-12	3-3	3-6	3-8	3-6	3-8	3-5
1121	M	1-9	1-15	2-5	2-9	2-13	3-2	3-4	3-4	3-6	3-6
1122	M	1-2	1-9	1-12	2-1	2-3	2-8	2-9	2-12	2-12	2-12
1123	M	1-5	1-15	2-5	2-13	3-2	3-6	3-6	3-6	3-8	3-9
1124	M	1-6	1-12	2-3	2-8	2-10	2-14	3-0	3-1	3-4	3-3
1125	M	0-11	1-3	1-8	Died August 6.						
1126	M	1-2	1-11	2-0	2-3	2-6	2-8	2-9	2-12	3-2	2-13
1127	M	1-2	1-11	2-1	2-5	2-12	2-14	2-14	3-0	3-0	3-2

APPENDIX II--continued

Serial Number GROUP V	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	Nov. 4
1128	F	0-15	1-4	1-5	1-5	1-6	1-7	1-9	1-11	1-12	1-14
1129	F	1-4	1-9	1-12	1-13	1-14	1-15	2-0	2-2	2-3	2-4
1130	F	0-14	1-2	1-3	1-4	1-3	1-4	1-4	1-7	1-8	1-8
1131	F	1-3	1-9	1-11	1-13	1-14	1-14	2-2	2-3	2-3	2-4
1132	F	1-2	1-8	1-11	1-11	1-11	1-14	1-15	2-0	2-1	2-1
1133	F	1-3	1-10	1-15	2-2	2-3	2-5	2-7	2-9	2-12	2-11
1134	F	1-2	1-8	1-11	1-14	1-15	2-1	2-2	2-4	2-5	2-6
1135	F	0-13	1-1	1-3	1-5	1-7	1-9	1-9	1-12	1-14	2-0
1136	F	1-0	1-5	1-6	1-7	1-7	1-10	1-10	1-12	1-14	2-1
1137	F	0-14	1-5	1-8	1-8	1-9	1-10	1-14	2-1	2-3	2-5
1138	F	1-0	1-7	1-9	1-10	1-10	1-11	1-10	1-12	1-14	1-14
1139	F	1-2	1-8	1-13	2-3	2-3	2-6	2-6	2-7	2-7	2-6
1140	F	1-0	1-4	1-6	1-6	1-5	1-6	1-5	1-7	1-8	1-10
1141	F	0-15	1-5	1-7	1-8	1-8	1-10	1-10	1-12	1-11	1-9
1142	F	0-15	1-5	1-7	1-9	1-9	1-12	1-11	1-13	1-13	1-13
1143	F	1-0	1-6	1-9	1-11	1-11	1-14	1-14	2-1	2-3	2-4
1144	M	0-14	1-5	1-10	2-2	2-4	2-7	2-8	2-11	2-13	2-14
1145	M	1-12	2-6	2-14	3-2	3-4	3-8	3-14	3-15	4-1	4-1
1146	M	1-7	2-0	2-5	2-10	2-14	3-3	3-5	3-10	3-13	3-14
1147	M	1-5	1-12	2-0	2-5	2-11	2-13	2-15	3-1	3-3	3-4
1148	M	1-4	1-12	2-1	2-5	2-8	2-8	2-12	2-14	3-1	3-2
1149	M	1-1	1-9	1-14	2-1	2-4	2-5	2-6	2-7	2-9	2-10
1150	M	1-4	1-14	2-5	2-9	2-14	3-2	3-5	3-5	3-9	3-9
1151	M	1-3	1-13	2-1	2-6	2-10	2-14	2-14	3-1	3-4	3-4
1152	M	1-4	1-14	2-4	2-8	2-13	3-1	3-2	3-5	3-5	3-8
1153	M	1-6	2-1	2-8	2-13	3-3	3-7	3-10	3-12	3-13	3-10
1154	M	1-0	1-8	1-13	2-0	2-5	2-8	2-10	2-10	2-11	2-10
1155	M	1-0	1-7	1-9	1-9	1-9	1-10	1-10	1-12	1-13	2-0
1156	M	0-15	1-8	1-13	2-2	2-6	2-9	2-11	2-14	3-0	3-1

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 7	Oct. 21	Nov. 4
1157	M	1-4	1-8	1-13	2-1	2-5	2-8	2-9	2-10	2-13	2-13
1158	M	1-0	1-8	1-11	1-14	2-1	2-2	2-2	2-3	2-6	2-7
1159	M	1-3	2-0	2-6	2-12	3-3	3-5	3-9	3-11	3-14	3-14
GROUP VI. Diet started July 1.											
1160	F	1-3	1-7	1-10	1-11	1-11	1-13	1-10	1-12	2-0	2-0
1161	F	1-1	1-4	1-6	1-9	1-10	1-10	1-12	2-0	2-0	2-0
1162	F	1-3	1-7	1-10	1-11	1-11	1-12	2-0	2-1	2-2	2-4
1163	F	1-4	1-10	1-14	2-2	2-3	2-5	2-5	2-5	2-6	2-7
1164	F	0-11	1-7	1-14	2-3	2-4	2-5	2-7	2-11	2-15	2-15
1165	F	0-15	1-3	1-6	1-7	1-8	1-12	1-14	2-1	2-3	2-4
1166	F	1-2	1-8	1-12	1-15	2-0	2-2	2-3	2-3	2-6	2-5
1167	F	0-15	1-5	1-8	1-11	1-14	2-0	2-0	2-1	2-2	2 -2
1168	F	1-4	1-13	2-1	2-4	2-4	2-5	2-8	2-8	2-9	2-12
1169	F	1-1	1-7	1-10	1-12	1-11	1-15	2-1	2-1	2-2	2-3
1170	F	1-1	1-7	1-10	1-14	1-15	2-1	2-1	2-3	2-3	2-3
1171	F	1-2	1-9	1-12	1-14	1-14	2-0	1-15	1-15	2-0	1-15
1172	F	0-15	1-2	1-4	1-4	1-4	1-5	1-5	1-8	1-8	1-10
1173	F	0-14	1-4	1-6	1-8	1-8	1-9	1-8	1-10	1-11	1-15
1174	F	1-1	1-5	1-7	1-7	1-10	1-10	1-12	1-11	1-12	1-12
1175	F	0-14	1-8	1-11	1-12	1-14	2-0	2-1	2-1	2-2	2-2
1176	M	1-9	2-3	2-10	2-14	3-2	3-5	3-9	3-11	3-12	4-1
1177	M	1-2	1-11	2-2	2-4	2-7	2-10	2-13	2-13	2-15	3-3
1178	M	1-4	1-11	1-15	2-0	2-2	2-4	2-5	2-7	2-7	2-9
1179	M	1-4	1-15	2-7	2-14	3-3	3-8	3-12	3-13	3-12	3-13
1180	M	1-4	1-9	1-15	2-4	2-7	2-8	2-8	2-5	2-8	2-10
1181	M	1-8	2-0	2-7	2-12	3-0	3-7	3-6	3-15	4-1	4-6
1182	M	1-5	1-15	2-6	2-10	2-15	3-1	3-1	3-0	3-2	3-4
1183	M	1-3	1-12	2-6	2-6	2-9	2-12	2-15	3-0	3-3	3-6
1184	M	1-1	1-7	1-13	2-1	2-3	2-6	2-7	2-7	2-11	2-11

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 8	Oct. 21	Nov. 4
1185	M	0-15	1-7	1-11	1-15	2-0	2-3	2-3	2-4	2-5	2-8
1186	M	1-7	2-1	2-10	3-0	3-6	3-10	3-15	3-14	3-15	4-0
1187	M	0-15	1-8	1-15	2-4	2-9	2-12	2-14	3-0	3-2	3-3
1188	M	1-3	1-8	1-15	2-2	2-5	2-9	2-12	2-14	3-1	3-5
1189	M	1-6	1-14	2-5	2-12	3-0	3-6	3-8	3-8	3-13	4-4
1190	M	0-15	1-7	1-12	1-14	2-2	2-6	2-6	2-6	2-9	2-10
1191	M	1-0	1-10	2-3	2-8	2-15	3-7	3-12	3-13	4-0	3-15
GROUP VII - Diet started July 1.											
1192	F	1-2	1-7	1-12	1-14	1-15	2-1	2-2	2-3	2-5	2-7
1193	F	1-2	1-5	1-8	1-10	1-9	1-12	2-1	2-2	2-2	2-4
1194	F	1-3	1-8	1-10	1-12	1-11	1-14	2-0	2-3	2-5	2-7
1195	F	1-7	1-12	1-13	2-0	1-15	2-1	2-1	2-4	2-5	2-5
1196	F	1-2	1-8	1-10	1-14	1-14	2-0	2-0	2-0	1-13	2-1
1197	F	1-2	1-9	1-12	1-14	1-15	2-1	2-2	2-4	2-6	2-8
1198	F	1-3	1-7	1-11	1-10	1-10	1-10	1-10	1-12	1-15	2-0
1199	F	1-0	1-5	1-6	1-8	1-10	1-13	2-0	2-1	2-0	2-1
1200	M	1-2	1-8	1-10	1-11	1-12	1-14	2-9	2-15	3-0	3-4
1201	F	0-13	1-0	1-3	1-4	1-5	1-9	1-9	1-10	1-12	1-14
1202	F	0-14	1-4	1-6	1-8	1-9	1-11	1-12	1-12	1-15	2-3
1203	F	0-14	1-4	1-6	1-8	1-9	1-11	1-10	1-11	1-10	1-11
1204	F	1-1	1-6	1-8	1-10	1-11	1-14	2-0	2-1	2-2	2-5
1205	F	0-13	1-4	1-8	1-11	1-12	1-14	1-14	2-0	2-1	2-0
1206	F	1-2	1-9	1-12	1-13	1-13	2-0	2-1	2-2	2-3	2-5
1207	F	0-15	1-7	1-11	1-14	1-13	2-0	2-1	2-2	2-2	2-4
1208	M	1-10	2-0	2-6	2-9	2-14	3-1	3-4	3-5	3-6	3-11
1209	M	1-7	1-14	2-4	2-10	2-14	3-2	3-6	3-6	3-9	3-12
1210	M	1-10	2-2	2-12	3-3	3-7	3-11	4-0	4-3	4-4	4-6

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 8	Oct. 21	Nov. 4
1211	M	1-4	1-14	2-5	2-10	2-14	3-2	3-2	3-4	3-5	3-10
1212	M	1-8	1-13	2-5	2-10	2-14	3-1	3-2	3-3	3-5	3-7
1213	M	1-5	1-14	2-8	3-1	3-5	3-9	3-13	3-15	4-0	4-0
1214	M	1-6	1-15	2-6	2-11	3-0	3-3	3-7	3-9	3-10	3-14
1215	M	1-5	1-13	2-7	2-11	3-1	3-4	3-8	3-6	3-5	3-6
1216	M	1-7	1-15	2-9	3-1	3-5	3-11	4-0	4-2	4-1	4-5
1217	M	1-5	1-14	2-5	2-9	2-12	2-15	2-15	2-15	3-0	3-2
1218	M	1-3	1-9	2-0	2-5	2-8	2-12	2-12	2-12	2-13	3-3
1219	M	0-10	0-10	0-10	Died Nov. 10						
1220	M	1-4	1-13	2-3	2-7	2-10	2-14	2-15	2-15	2-14	3-3
1221	M	1-6	1-11	2-0	2-2	2-3	2-4	2-5	2-7	2-8	2-11
1222	M	1-4	1-12	2-4	2-9	2-11	2-13	2-14	3-1	3-0	3-4
1223	M	0-11	1-6	2-0	2-6	2-10	2-15	3-4	3-7	3-8	3-7
GROUP IX - Diet started July 1.											
1240	F	1-0	1-5	1-10	1-12	1-13	2-1	2-3	2-4	2-5	2-8
1241	F	1-5	1-8	1-10	Escaped.						
1242	F	1-3	1-6	1-9	1-10	1-12	1-14	2-0	2-1	2-2	2-4
1243	F	1-1	1-6	1-9	1-12	1-13	1-14	1-14	2-0	2-0	2-0
1244	F	0-15	1-3	1-6	1-7	1-8	1-8	1-8	1-10	1-9	1-11
1245	F	0-12	1-2	1-5	1-8	1-8	1-11	1-14	2-1	2-1	2-1
1246	F	1-0	1-2	1-6	1-8	1-8	1-10	1-10	1-10	1-12	1-12
1247	F	0-12	1-4	1-7	1-9	1-8	1-11	1-11	1-12	1-12	1-13
1248	M	1-4	1-6	1-10	1-12	1-14	1-15	2-1	2-2	2-4	2-7
1249	M	1-1	1-9	2-0	2-3	2-6	2-10	2-11	2-15	3-1	3-2
1250	M	1-6	1-12	2-1	2-6	2-10	2-14	2-14	2-13	2-15	3-1
1251	M	1-8	1-13	2-0	2-6	2-6	2-14	2-7	2-9	2-7	2-9
1252	M	1-4	1-5	1-8	1-12	1-14	2-0	2-0	2-3	2-5	2-10

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 8	Oct. 21	Nov. 4
1253	M	1-3	1-5	1-4	1-8	1-10	1-15	2-0	2-2	2-4	2-6
1254	M	1-5	1-12	2-0	2-4	2-5	2-7	2-9	2-11	2-12	3-1
1255	M	1-4	1-12	2-9	2-9	2-12	3-2	3-4	3-5	3-7	4-1
GROUP X - Diet started July 1.											
1256	F	1-4	1-6	1-9	1-11	1-11	1-12	1-13	1-14	2-0	2-2
1257	F	1-4	1-7	1-9	1-10	1-10	1-13	1-15	2-0	2-1	2-2
1258	F	0-15	1-3	1-5	1-6	1-6	1-8	1-7	1-8	1-9	1-10
1259	F	1-1	1-6	1-10	1-11	1-13	1-15	2-0	2-0	2-1	2-3
1260	F	1-0	1-6	1-8	1-11	1-14	1-15	2-1	2-0	2-0	2-1
1261	F	0-15	1-5	1-10	1-11	1-12	1-15	2-1	2-1	2-2	2-4
1262	F	1-0	1-5	1-8	1-11	1-11	1-7	1-9	1-12	1-14	1-14
1263	F	0-11	1-1	1-4	1-3	1-5	1-7	1-7	1-9	1-9	1-11
1264	M	1-5	2-0	2-10	2-13	3-2	3-6	3-8	3-10	3-10	3-14
1265	M	1-5	1-15	2-3	2-6	2-11	2-12	2-11	2-12	2-14	3-1
1266	M	1-3	1-8	1-14	2-2	2-5	2-8	2-0	2-0	2-0	2-0
1267	M	1-3	1-7	1-11	1-14	1-14	1-13	1-9	1-9	1-10	1-9
1268	M	1-3	1-12	2-2	2-6	2-7	2-8	2-8	2-9	2-8	2-9
1269	M	1-4	1-10	2-0	2-5	2-8	2-11	2-11	2-13	2-13	2-15
1270	M	1-1	1-9	1-15	2-4	2-7	2-8	2-7	2-8	2-9	2-12
1271	M	1-4	1-14	2-3	2-6	2-7	2-8	2-7	2-8	2-8	2-10
GROUP XI - Diet started July 1.											
1272	F	1-1	1-5	1-7	1-8	1-9	1-10	1-11	1-13	1-14	1-14
1273	F	1-5	1-9	1-11	1-10	1-10	1-11	1-11	2-0	1-14	2-0
1274	F	1-1	1-7	1-11	1-13	1-15	2-0	2-0	2-2	2-3	2-3
1275	F	0-15	1-4	1-7	1-9	1-11	1-11	1-12	1-14	2-1	2-1
1276	F	1-0	1-6	1-12	1-11	1-10	1-12	1-14	2-0	1-13	2-0
1277	F	0-15	1-6	1-10	1-11	1-11	1-12	1-11	2-0	2-0	2-3

APPENDIX II--continued

Serial Number	Sex	Biweekly Weights in Pounds and Ounces									
		June 29	July 15	July 29	Aug. 12	Aug. 26	Sept. 9	Sept. 23	Oct. 8	Oct. 21	Nov. 4
1278	F	0-14	1-7	1-12	1-14	2-0	2-1	2-1	2-2	2-1	2-1
1279	F	1-1	1-5	1-9	1-10	1-12	1-12	1-12	1-14	1-15	1-15
1280	M	1-5	1-12	2-0	2-2	2-6	2-7	2-7	2-10	2-13	3-0
1281	M	1-10	2-1	2-10	3-0	3-4	3-6	3-5	3-9	3-7	3-11
1282	M	1-5	1-12	2-2	2-8	2-9	2-9	2-11	3-0	3-2	3-4
1283	M	1-4	1-12	2-2	2-5	2-9	2-8	2-10	2-13	2-14	2-14
1284	M	1-4	1-13	2-6	2-9	2-15	3-3	3-4	3-6	3-8	3-13
1285	M	1-2	1-13	2-5	2-12	3-2	3-7	3-9	3-15	4-0	4-2
1286	M	0-14	1-10	2-1	2-4	2-6	2-6	2-7	2-10	2-11	2-15
1287	M	1-1	1-11	Died July 15.							
GROUP XII - Diet started July 1.											
1288	F	1-3	1-7	1-11	1-12	1-13	1-13	1-14	1-15	2-0	2-1
1289	F	1-4	1-9	1-12	1-14	2-0	2-3	2-3	2-4	2-5	2-5
1290	F	0-15	1-4	1-8	1-11	1-11	1-14	1-12	1-12	1-12	1-14
1291	F	1-4	1-10	1-13	1-15	2-0	2-3	2-5	2-5	2-6	2-7
1292	F	0-12	0-15	0-15	Died August 11.						
1293	F	1-2	1-8	1-11	1-12	1-12	1-15	2-0	2-0	2-0	2-2
1294	F	0-12	1-2	1-4	1-6	1-6	1-8	1-7	1-10	1-10	1-11
1295	F	0-14	1-5	1-11	1-15	2-2	2-5	2-3	2-7	2-7	2-10
1296	M	1-0	1-8	2-0	2-4	2-10	2-12	2-15	3-2	3-5	3-7
1297	M	0-14	1-6	1-14	2-2	2-6	2-10	2-12	2-14	3-1	3-2
1298	M	1-6	1-11	2-2	2-7	2-13	2-15	2-15	3-1	3-1	3-6
1299	M	1-5	1-14	2-3	2-4	2-8	2-12	2-12	2-15	3-0	3-3
1300	M	1-2	1-15	2-5	2-9	2-12	3-3	3-4	3-6	3-8	3-14
1301	M	1-5	2-0	2-9	2-14	3-3	3-9	3-11	3-13	4-0	4-0
1302	M	1-1	1-12	2-3	2-5	2-10	2-12	2-12	2-14	2-14	3-0
1303	M	0-15	1-6	1-15	2-1	2-5	2-8	2-10	2-11	2-11	2-14