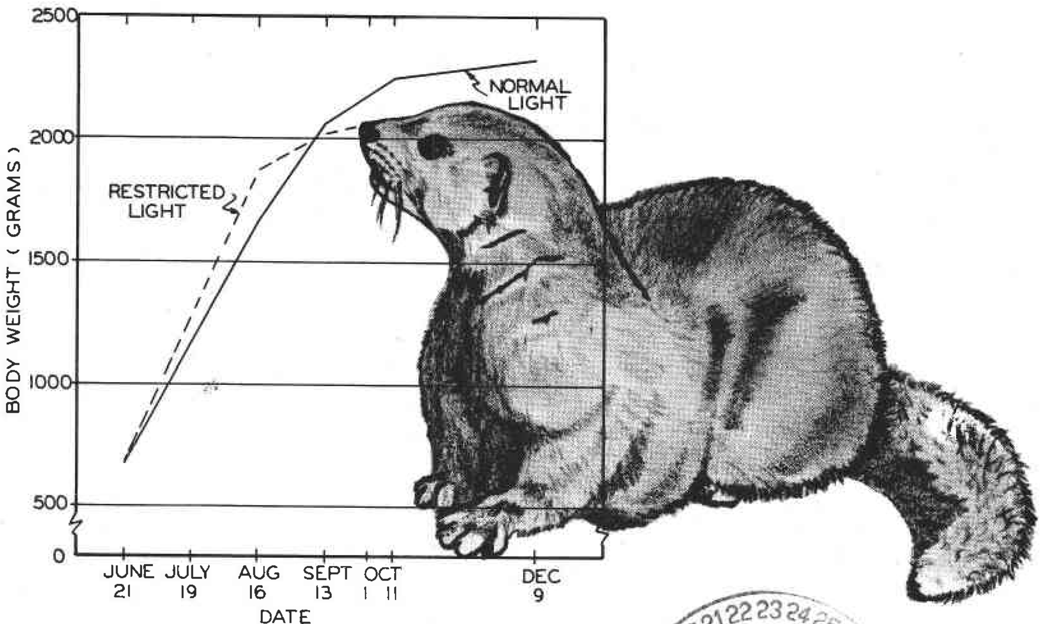
1968-1969 PROGRESS REPORTS

Mink Research: Controlled Light and Furring



AGRICULTURAL EXPERIMENT STATION
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Accelerating Winter Fur Growth in Mink Through Regulation of Light - 1968 Progress Report

Efficient livestock production has been achieved by man's imposing artificial conditions to control the variables of nature. Historically, production techniques have developed in a rather definite progression with the accumulation of pertinent information. This evolutionary procedure first involves some degree of confinement, then control over feeding, breeding, and disease. At first, trial and error are necessarily employed; with innovation and experience animal production assumes the status of an art and finally a science with the systematic accumulation of knowledge. Only at this point does it possibly become predictable.

The ranch-raising of mink is a recent but typical example of the history of animal production. Mink were originally taken from the wild by fur trappers, confined in colonies, supplied with more or less natural types of feed, and allowed to reproduce at random. It was soon found, however, that by individual penning and by providing feed and water that pelt quality and yields were greatly improved. Efforts quickly turned to supplying proper feeds through determination of nutritional requirements and ration formulation, an endeavor which continues today. Close confinement not only permitted full control over nutrition but allowed animal improvement and propagation of mutants by employment of selection programs and breeding systems. Parasite control was an unexpected additional benefit of caging and removal from contact with the soil. Control of major diseases was rapidly established by development of vaccination programs. Management systems were developed with improvements in housing and in feeding and watering methods.

A logical next step in this progression is to extend control to other aspects of the environment such as the creation of an artificial climate. This is especially true when it is known that environmental factors influence an animal as dramatically as light is known to influence the life cycle of the mink—yet heretofore, after almost a century of propagation under artificial conditions, this important aspect has been virtually ignored in practical mink production.

Much of the current research on environmental factors related to mink production has dealt with controlling exposure to light in an attempt to influence the reproductive cycle with the objectives of possibly producing kits out of season and increasing the number of litters per year. In this area there has also been considerable work on control of light to shorten the period of delayed implantation and thereby increase embryo survival. The primary research efforts with mink at the Oregon Agricultural Experiment Station have traditionally been concerned with fur and fur production and not reproduction. Consequently the area of light and its effects on the furring cycle of the mink kit has been pursued here.

EXPERIMENTAL

Body growth of the young mink is extremely rapid and usually completed by early October. Weight gains made after this time are generally attributed to fattening. The winter furring cycle is ended and fur is prime between mid-November and early December at which time the animals are pelted. The interval between achieving body growth and fur priming is from 45 to 60 days. Theoretically it appeared possible by manipulation of the light environment to accelerate the winter fur growth cycle and thereby coordinate development of body and fur growth without detracting significantly from pelt size.

raised under conditions of controlled lighting and three similar groups under natural daylight. Additionally, because the stress of body growth is considerably less for young females and not present for adults, groups of 10 standard-dark, female, mink kits and

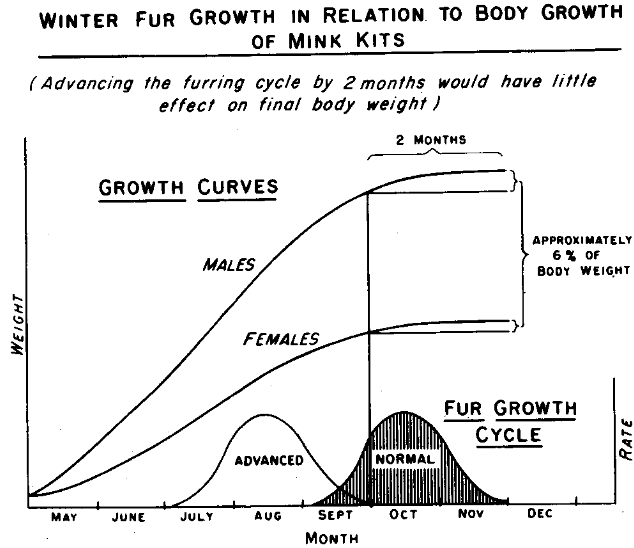

Figure 1.

The possibility remained, however, that superimposing body and fur growth cycles would create sufficient stress on the animal as to be physiologically unfeasible.

Four experiments involving regulation of light exposure patterns in the young, growing mink were conducted from 1965 through 1968 with the primary objective of accelerating the winter fur growth cycle so that fur would develop earlier. Each experiment is presented separately.

EXPERIMENT 1 (1965) (1)

Methods and Materials

In this first experiment both light regulation and hormone treatment were involved, although effects of the latter are not pursued here. Three groups of 10, randomly selected, standard-dark, male, mink kits were 10 adult females were raised under controlled lighting conditions.

Animals subjected to artificial light were housed in an insulated, light-tight room approximately 10 x 17 feet in dimension. An exhaust fan mounted high in an outside wall was used for ventilation and ran continually. The air intake was located low in the door on the opposite wall. A plastic-lined, wooden trough approximately 6 inches deep and filled with water, which was periodically emptied to the outside, was provided for waste disposal. This arrangement was subsequently found to be unsatisfactory as ammonia fumes were present in high concentration and were drawn past the mink as a result of the location of the fan.

The fifty mink were placed individually in pens around the perimeter of the room and over the waste disposal troughs. Pens for males were made of 1″ x 2″ galvanized wire mesh 15″ wide x 18″ high x 24″ long; female pens were somewhat smaller (21″ x 12″ x 20″). No nest box was provided. Tap water was furnished to each cage through an automatic watering system.

Light was supplied by four, fluorescent fixtures each containing four, 40-watt, cool-white tubes and the on-off cycle was regulated by a timing device. Light intensity was not measured. Exposure to artificial light began on July 20 and the light was reduced proportionately daily so that the imposed day length on October 1 corresponded to the actual day length on December 1. This program was designed to shorten the normal mink growing-furring cycle by about two months. Reduction of light was continued until October 19 at which time total daily light exposure was 7½ hours. The day-length was thereafter kept constant until pelting during the first week of December. The three groups of control males reared outside were exposed to the natural light conditions at 45° North latitude with the longest day being about 15½ hours and the shortest 8¾ hours from sunrise to sunset. These mink were housed in pens 14″ wide x 18″ high x 30″ long located in open sheds and supplied with an 8″ x 10″ x 7″ wire nest box. Excelsior was provided as nesting material from early October to pelting. Animals were watered twice daily in a cup attached to the pen.

All mink were fed a "conventional" type growing-furring ration with composition as shown in Table 1.

This ration supplied approximately 42% crude protein, 23% fat, 8.5% ash, 0.4% crude fiber, and 26% nitrogen-free extract, on a dry basis. Animals were fed once daily on top of the pen, and feed was redistributed among animals within the groups in the morning for all groups.

Table 1. RATION COMPOSITION (Experiment 1)

Ingredient	%
Chicken offal	8
Beef liver	3
Beef tripe	10
Sole (whole fish)	20
Rockfish (whole fish)	25
Turbot (whole fish)	25
Oat groats	9

(Vitamin E as d-alpha-tocopheryl acetate, 50,000 I. U. per pound, was premixed in the oat groats to supply a level of .01% to the ration before the addition of water.)

RESULTS AND DISCUSSION

Animals reared either under artificial lights or under the natural light environment were pelted in early December. There was no evidence of early fur development in the former group and, in fact, individual animals showed varying degrees of pelt unprimeness which possibly resulted from ammonia fumes present in the light-controlled facility. There appeared to be a trend for animals reared in corner pens where air circulation was reduced to show more unprime fur than those more centrally located.

Males reared under controlled, artificial light were uniformly larger (as indicated by average values shown in Table 2) in both body and pelt lengths and in body weights taken at the end of the trial.

Fur color as judged by a commercial fur grader was considered poorer for the light-controlled animals, although fur quality was graded generally better in mink raised under controlled lighting. Both groups of female mink exposed to artificially shortened days also failed to develop fur early. Adult females reacted similarly to young females, indicating that lack of response could not be attributed solely to age and stress of body growth. Although the objectives of this experiment were not achieved, many problems associated with construction of a semi-controlled environmental facility

Table 2. AVERAGE SIZE AND FUR VALUES (Experiment 1)

	Groups	
	Controlled light	Natural light
	6A, 6B, 6C	6D, 6E, 6F
Final body weight (gm)	1954	1865
Final body length[1] (cm)	43.4	42.7
Pelt length[1] (cm)	71.7	70.6
Fur color[2]	2.7	2.3
Fur quality[2]	1.9	2.1

[1] Measured from tip of nose to base of tail.
[2] Fur color and quality, taken from pelts, were rated by a professional fur grader from 1 (best) to 4 (poorest).

became apparent and it was considered worthwhile to repeat the experiment.

EXPERIMENT 2 (1966) (2)

The objective of this second experiment was similar to that of the first, i.e., to accelerate the winter furring cycle and to assess the effects of regulated light patterns on body growth and fur characteristics, but the experimental design was not confounded with other treatments as before.

METHODS AND MATERIALS

Ten, standard-dark, randomly selected, male, mink kits were subjected to controlled lighting from July 20 to December 14. A similar group was reared outside as controls under conditions previously described. The semi-controlled environmental facility was the same as used in the previous trial, but with modifications designed to overcome difficulties noted. The ventilation system was rearranged so that the air intake manifold was placed above the pens and the air exhausted by a fan mounted in the floor. This setup prevented any fumes from the lagoon beneath the pens from reaching the mink. A water-tight, wooden trough, 22″ deep, was installed as a lagoon to collect waste materials and was emptied at approximately monthly intervals. Four 150-watt, incandescent bulbs were installed as a light source replacing the fluorescent lights used previously, as it was considered possible that the spectrum emitted from the latter type might not be suitable for promoting fur development.

Day lengths were shortened proportionately so that the length on October 1 coincided with the actual day length on December 1. Reduction of the day length continued until October 31 at 6½ hours light exposure and was kept constant thereafter until pelting.

The ration fed (composition shown in Table 3) differed somewhat from that of Experiment 1 and was analyzed to contain 33% protein, 22% fat, 2.3% fiber, 7.5% ash, and 35% nitrogen-free extract on a dry basis.

Table 3. RATION COMPOSITION (Experiment 2)

Ingredient	%
Chicken offal	10
Beef liver	3
Beef tripe	10
Rockfish (carcass)	25
Turbot (whole fish)	25
Lard	2
Oat groats	20
Wheat bran	5

(Vitamin E as d-alpha-tocopheryl acetate, 50,000 I. U. per pound, was premixed in the dry components to supply .01% of the ration before the addition of water.)

Results and Discussion

Again the objective of hastening winter fur growth was not achieved; in fact, pelting had to be postponed for two weeks, and a few individuals were not entirely prime then. Males raised inside averaged slightly heavier (1989 gm. vs. 1925 gm.), but shorter (43.3 cm. vs. 44.8 cm.) than control males raised outside. Average fur color was judged darker than that of mink raised conventionally (1.8 vs. 2.3), subjectively assigned on a scale of 1 (best) to 4 (poorest), and average fur quality was almost identical (1.7) subjectively assigned on a similar scale. The negative results encountered in this trial, as well as in the first trial, led to the premature conclusion that factors other than shortening light exposure apparently influenced fur growth in young mink, although it was not understood why the light patterns imposed would actually delay fur development.

EXPERIMENT 3 (1967) (3)

Because of the negative results encountered in Experiments 1 and 2, it was determined that a further experiment would be designed to explore effects of extremes of light exposure on the winter fur growth cycle in the mink. Also under investigation was the effect of artificial light when regulated to the pattern of natural daylight.

Methods and Materials

Four groups of standard-dark, mink kits were subjected to the lighting regimes shown in Table 4, from August 10 to early December at which time they were pelted.

Each group was composed of animals which had littermates within each other group. The light control facility was the same as described previously except that it had been divided into three rooms which permitted maintaining separate lighting patterns. One room was larger (dimensions approximately 5′ x 17′) and contained 10 cages; two other rooms (5½′ x 6′) each contained 5 cages.

Group 6A received light supplied from four 150-watt, incandescent bulbs regulated by a time clock programmed to natural day length for this area, not considering any time for twilight. Group 6B received no light except for short exposure to a small, red, darkroom bulb during feeding. Group 6C received continual light from two 100-watt, incandescent bulbs. Air was exchanged continually by a floor-mounted exhaust fan and wastes were handled by the lagoon system. All groups received a ration similar to that used in Experiment 2 except that thiamine HC1 was added at .0025% (as fed basis).

Results and Discussion

All animals were removed from the various light treatments and immediately pelted on December 5 except group 1A which had been pelted on December 1. Average growth and fur data of males are presented in Table 5.

Continued exposure to light seemed to create a stress on the mink and they appeared to be more excitable than others raised under controlled lights. Also, as a group, their feed consumption was below that of other groups and was reflected in final body weights. Conversely, animals raised without a light source were relatively quiet, consumed large amounts of feed, and grew well. Fur quality

Table 4. Light Exposure Plan (Experiment 3)

Group	No. of Mink	Light Treatment
67 - 1A	5 males, 5 females	Natural light, normal day length
67 - 6A	5 males, 5 females	Artificial light, normal day length
67 - 6B	5 males	No light
67 - 6C	5 males	Continual artificial light

Table 5. Average Size and Fur Values (Experiment 3)

	Groups			
	1A (Outside)	6A (Inside)	6B (Dark)	6C (Light)
Final body weight (gm)	1894	1794	1922	1524
Final body length[1] (cm)	43.9	43.1	43.1	42.0
Pelt length[1] (cm)	71.4	71.9	72.5	69.7
Fur color[2]	2.0	1.6	2.0	2.0
Fur quality[2]	2.0	2.2	1.8	3.0

[1] Measured from tip of nose to base of tail.

[2] Fur color and quality, taken from pelts, were rated by a professional fur grader from 1 (best) to 4 (poorest).

values were judged best for animals raised in the dark and poorest for mink exposed to continual light.

Pelts from animals raised conventionally (group 1A) were completely prime, as is evident from Figure 2.

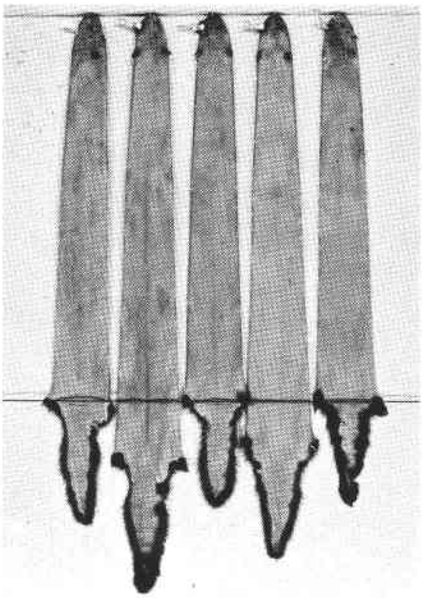

Figure 2. Pelts of male mink (group 1A) raised under natural light and normal day length.

Pelts of littermate mink (group 6A) raised under artificial light controlled to outside conditions showed fur which was not fully developed—two pelts were classed as slightly and two pelts as moderately unprime. The other male and five females in this group, however, were prime (Figure 3).

Animals raised without light (group 6B) had fully developed fur when pelted; and since they were not examined earlier in keeping with the original experimental design, it was not known when the winter furring cycle was completed (Figure 4).

Fur of animals receiving continual light (group 6C) was completely un-

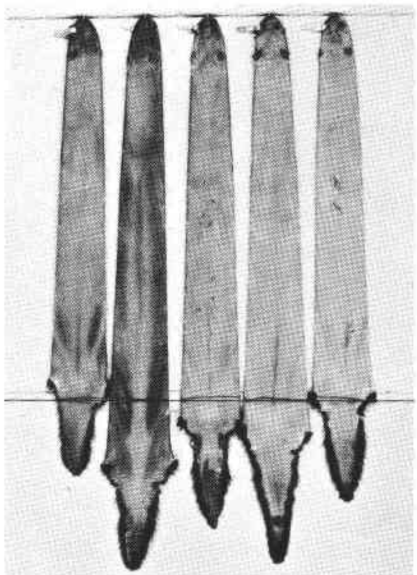

Figure 3. Pelts of male mink (group 6A) raised under artificial light and normal day lengths.

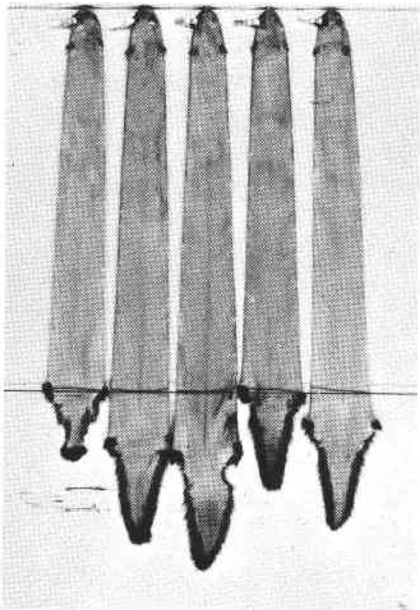

Figure 4. Pelts of male mink (group 6B) raised with no light from August 10 are completely prime.

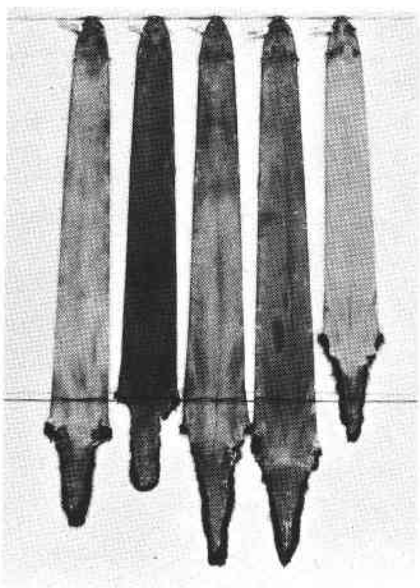

Figure 5. Pelts of male mink (group 6C) raised under continual light from August 10 are generally not prime.

developed and the pelt leather was black; one was severely and three were moderately unprime (Figure 5). These animals were shedding actively when pelted, although they began to shed as early as other groups. The fifth mink in the group (far right pelt in Figure 5) was actually placed in continual light on September 1 as a replacement for an animal that had escaped. This animal failed to grow and it was not certain that winter fur growth was ever initiated.

It was concluded from the results of this experiment that the winter fur growth cycle of the mink kit can be initiated and completed in the absence of light after August 10; and, further, that supplying light continually interferes with the fur development process. It was not clear why exposure to a natural day length pattern using artificial light should retard winter fur priming.

EXPERIMENT 4 (1968)

Since from the previous trial it was learned that the winter pelage of mink would develop in the absence of light, a fourth experiment was conducted to provide information on lighting patterns which would accelerate the triggering of the winter fur growth cycle.

Methods and Materials

Four groups of 5, standard-dark, mink kits were established so that littermates were in each group. There were also 5 paired females each in groups 6A and 6C. Three groups were raised under regulated lights and, additionally, a control group was raised under natural light. The experimental design follows in Table 6.

Animals were weaned and placed in light-controlled housing on June 21, the longest day of the year. Facilities were those used for the previous experiments except that wooden nest boxes (8″ x 8″ x 13″ inside dimensions) replaced the plastic ones previ-

Table 6. LIGHT EXPOSURE PLAN (Experiment 4)

Group	No. of Mink	Light Treatment
68 - 6A	5 males, 5 females	Natural light, normal day length
68 - 6B	5 males	Artificial light, 1 hour exposure
68 - 6C	5 males, 5 females	Artificial light, progressively decreased exposure
68 - 6D	5 males	Artificial light, 9 hours exposure

ously used. Midway through the trial, the one-inch-square wire mesh used for pen bottoms was replaced with 1″ x 2″ vinyl-clad wire mesh to facilitate cleaning. Outside cages were smaller (10½″ wide x 15″ high x 24″ long) than those used before and were fitted with an automatic watering system.

Light in each room was from incandescent bulbs which furnished a maximum of from 12 to 22 foot candles to the animals, depending upon cage location. The lighting cycle for each room was regulated by a separate time clock. Light exposure patterns provided are illustrated in Figure 6.

Group 6B received minimum daily light exposure, although sufficient to allow for necessary feeding and cleaning; group 6D received a daily amount of light roughly equivalent to the shortest day of the year at this latitude (45° N); and group 6C received an accelerated shortening of day length, as previously used but beginning earlier in the year. (Actually, extrapolation of earlier data resulted in an inadvertant increase in exposure time initially.) All animals were fed the same ration as used in experiments 2 and 3 (including thiamine). So that progress of fur growth could be easily observed, animals were sheared over the right hip on August 8.

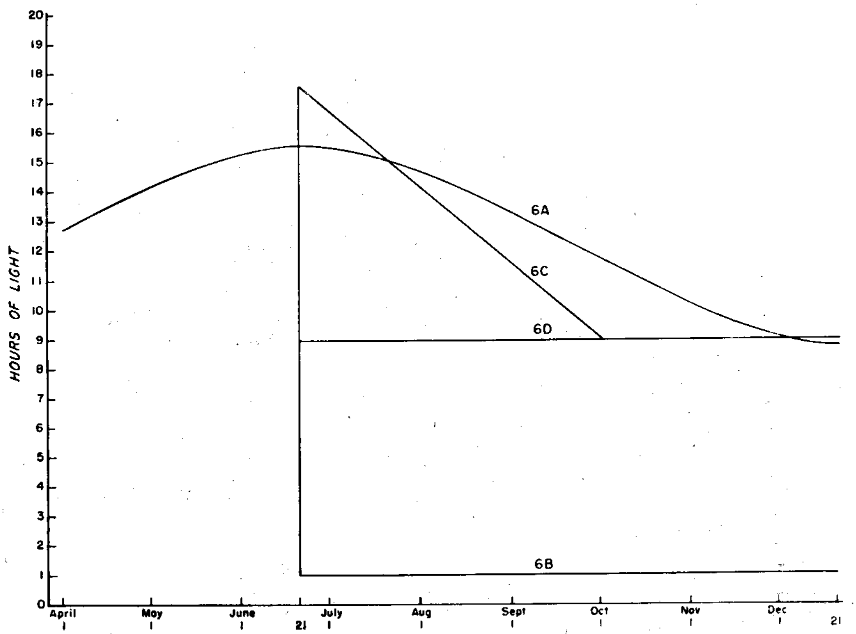

Figure 6. Light exposure patterns (Experiment 4).

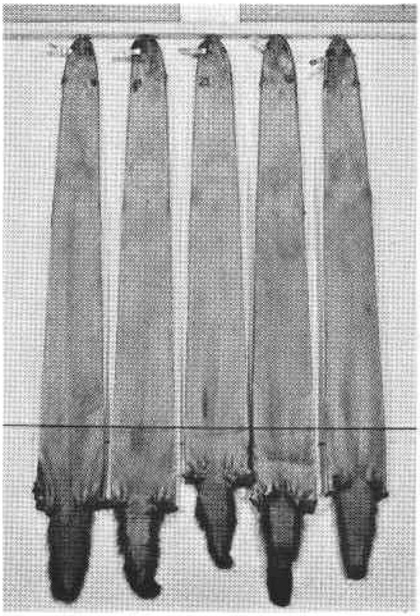

Figure 7. Group 6A—pelts of male mink kits raised under natural lighting conditions and pelted December 9.

Results and Discussion

It became apparent within a few days after animals were sheared that fur was rapidly growing in those receiving either 1 or 9 hours of light daily (groups 6B and 6D). Fur shedding was first noticed in these groups during early August as contrasted to late September for other groups. Mink in groups 6B and 6D were fully prime and were pelted on October 1, whereas those in groups 6A and 6C were not considered prime until early December and were pelted on December 9. Photographs of male pelts from all groups are presented to show that no melanin pigments remained in the skin at time of pelting, one criterion of a prime pelt.

Growth curves of animals in all experimental groups are presented in Figure 11. Animals raised with exposure to a constant day length of either 1 or 9 hours grew at about the same rate, but showed evidence

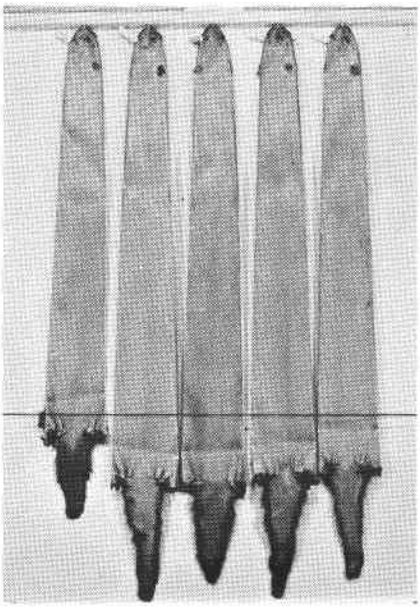

Figure 8. Group 6B—pelts of male mink kits raised from June 21 exposed to one hour of artificial light per day and pelted October 1.

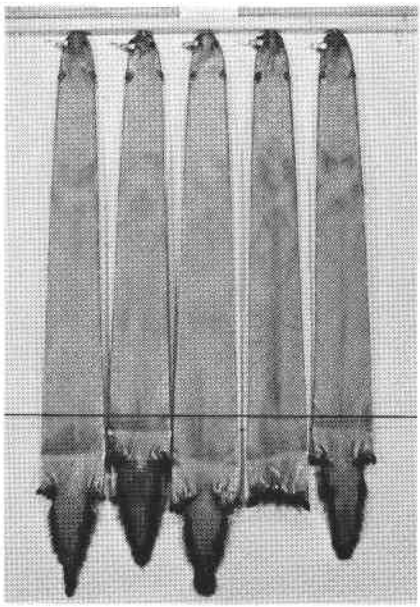

Figure 9. Group 6C—pelts of male mink kits raised from June 21 exposed to artificial lights decreased proportionately daily and pelted December 9.

of reaching full body size earlier than either controls (6A) or those receiving proportionately decreasing day length (6C), although the latter two groups reached a higher final weight by the time they were pelted. Average final weights and lengths and fur data for males are found in Table 7.

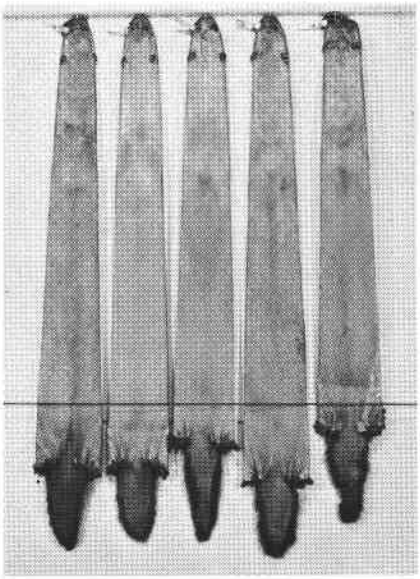

Figure 10. Group 6D—pelts of male mink kits raised from June 21 exposed to 9 hours of artificial light per day and pelted October 1.

It is evident that animals pelted in October weighed somewhat less than those pelted during the normal season; however, body lengths were similar. Pelt lengths reflect body weights more than body lengths and were also shorter than control animals; but, nevertheless, averaged approximately 30 inches in length and are classed as #1's according to the international size grading system.

Fur color and quality scores of early pelted mink were below those of mink raised conventionally. Lower quality, in part at least, resulted from clipping the tips of the guard fibers which were actively growing when animals were sheared over the left hip on August 8. Also, most animals pelted in October showed some degree of matting which was considered a management problem not necessarily related to early furring. Length of fur fibers was measured for each animal and averages presented in Table 8 suggest that underfur fibers from mink with early developed fur may be slightly shorter, although this point requires more ex-

Table 7. AVERAGE SIZE AND FUR VALUES (Experiment 4)

Group	6A (Control)	6B (1 hour)	6C (Decreased)	6D (9 hours)
Final body weight (gm)	2322	2002	2246	2060
Final body length[1] (cm)	43.8	43.9	44.6	43.9
Pelt length[1] (cm)	77.9	75.8	77.4	75.6
Fur color[2]	2.0	2.6	3.0	2.2
Fur quality[2]	2.0	2.4	1.8	2.4

[1] Measured from tip of nose to base of tail.
[2] Fur color and quality, taken from pelts, were rated by a professional fur grader from 1 (best) to 4 (poorest).

Table 8. AVERAGE FUR FIBER LENGTH (Experiment 4)

Group	6A	6B	6C	6D
Date pelted	Dec.	Oct.	Dec.	Oct.
Guard fur length (mm)	23.8	23.2	24.4	23.8
Underfur length (mm)	13.8	13.0	14.2	13.2

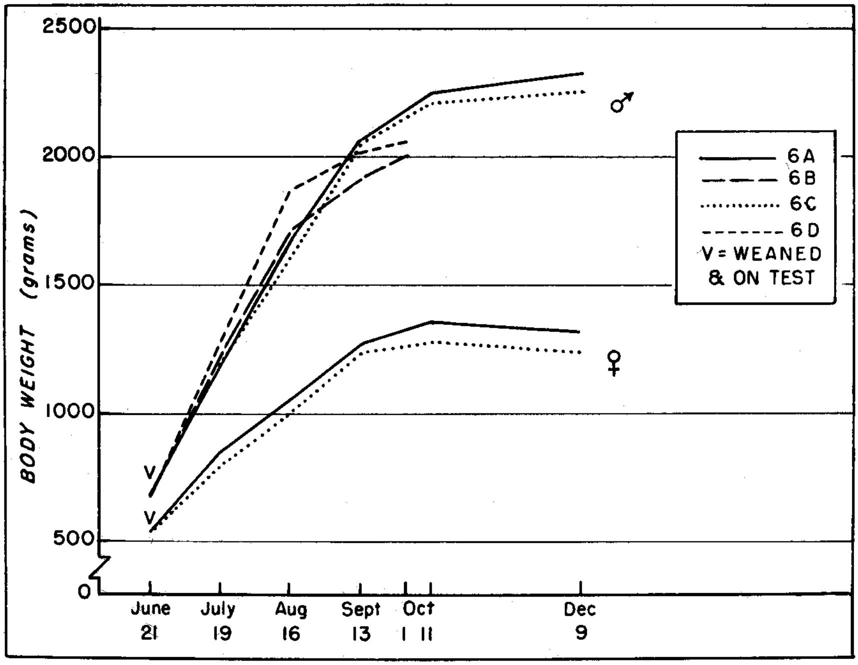

Figure 11. Growth curves of groups 6A-6D (Experiment 4).

tensive data before firm conclusions can be drawn.

The occurrence and severity of wet belly was substantially reduced in males pelted in October as compared with those pelted in December, as is evident in Table 9. Figures 12 and 13 show the belly side of pelts taken in October and December, respectively. This apparent difference is most easily explained as a direct result of the reduced length of time available for the animal pelted in October to develop the wet belly condition.

The objectives of this experiment were considered achieved in that the winter furring cycle was advanced fully two months by shortening the day length to either 1 or 9 hours beginning June 21. These results were in part effected as a result of beginning the experiment earlier than in previous years, although the key was considered to be providing the necessary physiological trigger by significantly reducing light exposure. It appears entirely unnecessary and, in fact, ineffective to gradually withdraw light. The optimum artificial day length, between 0 and 9 hours, at least, would seem to depend primarily upon management considerations. Proportional reduction of light was without effect on inducing early fur development in any of the trials carried out.

Table 9. Wet Belly Incidence and Severity (Experiment 4)

Group	6A	6B	6C	6D
Date pelted	Dec.	Oct.	Dec.	Oct.
Wet belly incidence (affected/total)	5/5	1/5	5/5	4/5
Wet belly severity*	2.8	1.0	2.4	1.3

* Graded from 1 to 3 depending on size of pigmented area surrounding urinary orifice.

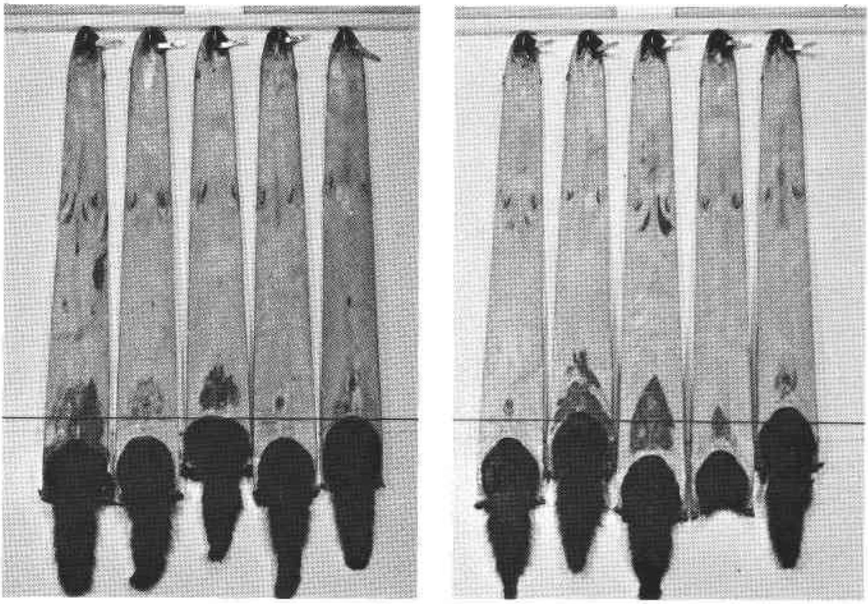

Figure 12. Note high incidence and severity of wet belly in males pelted in December (groups 6A, 6C).

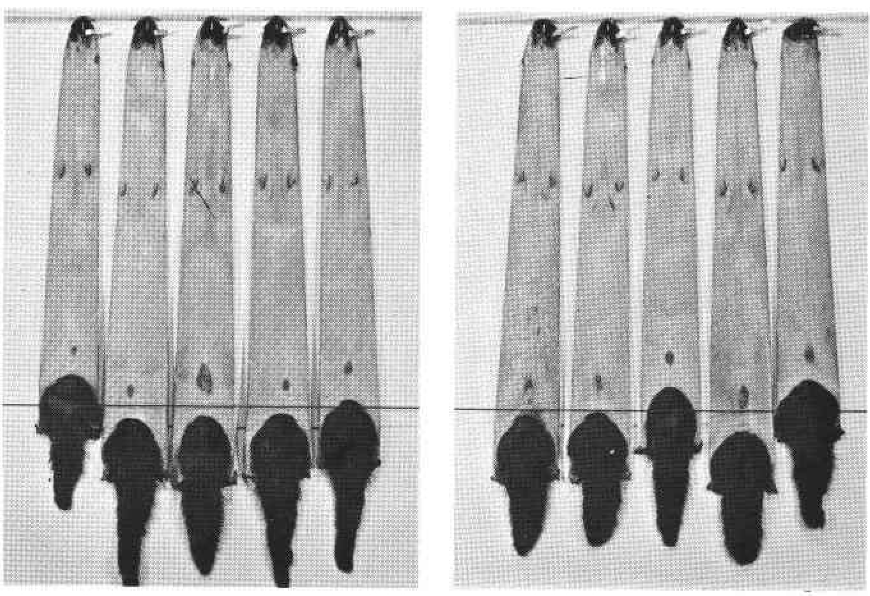

Figure 13. Compared with male mink pelted in December, groups 6B and 6D, pelted in October, show considerably lessened occurrence and severity of wet belly.

GENERAL DISCUSSION

It has been well established that various physiological functions are influenced by the environment to which birds and mammals are exposed. Research on the effect of light in relation to the furring cycle of several animal species has been carried out previously by other investigators. The pioneer work in this field was begun in 1934 by Bissonnette with ferrets, although he later (1939-1944) also used mink and weasels. From his experiments he concluded that hair growth cycles of these species were dependent upon the seasonal activity of the anterior hypophysis as stimulated by light exposure and that the influence of temperature, if any, was minimal (4, 5, 6). Bassett and coworkers, during the time period 1944-48, were able to induce early fur growth in adult and young foxes by manipulation of lighting patterns. After several experiments they determined that a decreased exposure to light was necessary for early development of winter fur, although increasing the normal light exposure prior to July also had this effect. They were very interested in the practical aspects of early furring and were able to shorten the time necessary for winter fur growth of foxes by up to 8 or 9 weeks (7, 8, 9). Hammond in 1948-49, though primarily interested in reproduction, was able to promote early fur development in adult mink by imposing a 6 hour daylength beginning June 17 (10). Research reports by Russian workers as early as 1964 indicated their interest in, but limited initial success with, investigating effects of manipulation of furring cycles in mink by adjusting light patterns (11). Travis undertook research in this same general area in 1967 by doubling the rate of change which occurs in the normal light cycle. By this procedure he was able to advance the priming date of the winter fur of adult mink from the normal late November period to October 6 (12).

Perhaps the unique feature of the research results contained in this report lies in the attempt at the application of these basic findings. We have demonstrated that accelerated furring of young mink is possible by providing the necessary triggering mechanism; in our case decreasing the day length from approximately 16 to 9 hours or less provided the necessary trigger. This may be accomplished in other ways, such as suggested by Bassett and Travis, and there is need for further research in this area.

Results of this research can have considerable practical significance for the mink industry, especially if answers can be found to certain basic problems. The economic potential in reducing costs of production is very great. Feed costs can obviously be reduced if 45 to 60 days can be eliminated from the necessary feeding time. For example, if feed were available at 6¢ per pound and 2/3 pounds per mink were used per day, this would amount to $2.40 saving per mink for a 60-day period. There are other potential savings in labor, storage, equipment use, etc. The avoidance of adverse weather conditions is perhaps one of the most attractive possibilities. Mink pelted in early October would be exposed to very few cold days. Mortality caused by the stress of cold weather would also be eliminated. Disease loss should be reduced by virtue of shortening the life span.

There would, undoubtedly, be problems if light control were included in the management scheme. Light control suggests either construction of special facilities or modification of existing facilities. The feasibility of conversion of existing mink sheds needs to be determined. It would seem, without too much thought given to the mater, that existing sheds could be converted. The first consideration is to exclude light. It may be unnecessary to shorten day length beyond nine hours; however, the optimum shortening needs to be worked out. Other important considerations are ventilation, avoidance of ammonia fumes, cooling, etc.

There are other problems—it is possible that new rations will have to be formulated. The mink is required to do in five months what normally occurs in seven. This puts a definite stress on the animal and, in all likelihood, increases the nutritional requirements. This may be essentially important in the formulation of newly developing, dry rations. Another tentative problem concerns the effect on the breeding cycle of potential breeders so exposed. This is unknown at present, although we do know that testicular development in males pelted in October was considerably advanced over animals not so regulated which were checked on the same date. Until further information becomes available, one may have to keep potential breeding stock separated and under natural lighting conditions. An important aspect deserving immediate attention is determination of basic fur characteristics, i.e., length and density of guard and underfur, fur color, etc., for mink raised under lighting conditions that accelerate the furring cycle. The pilot studies reported here used too few animals to make definite conclusions on this point.

As with all things that are new and promising, there are many apparent obstacles in the path to success. Further research will dispense with some of these quickly, others will be less amenable to solution. But with continued efforts to uncover basic mechanisms involved, control of the physical environment of animals to increase production efficiency as well as product quality will become commonplace in the future.

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Exploring the Feasibility of Accelerating Pelt Production in Mink --- 1969 Progress Report *

Principles of advancing the winter furring cycle of mink have been established by a series of research trials conducted at the Oregon State University Experimental Fur Farm beginning in 1965 (1, 2, 3, 4). These trials were exploratory in nature and were primarily geared to establishing methods which would trigger early initiation of the winter furring cycle; consequently limited numbers of animals were used. Briefly, these experiments showed that reducing the animal's daily exposure to light to 9 hours or less on or about the summer solstice would hasten the development of the winter fur by up to 60 days, whereas more gradual light reduction schedules were ineffective. Body growth and fur characteristics of mink raised under conditions which promote early fur development appeared good, but since so few animals were involved, these points required verification.

Larger-scale research trials were needed to check the feasibility of accelerating fur production of mink on a ranch basis. Pertinent questions for this research included the following: How does the quality of fur produced by accelerating the fur growth cycle compare with that of animals reared more naturally? Do standard dark and mutation mink respond equally to early furring methods? Is there a sex difference in response? Can dry diets be used effectively for mink reared in this manner? Is the management system employed with early furring practical and economically feasible for the mink rancher?

To answer these questions a rather extensive experiment employing sizeable numbers of dark and mutation mink, both male and female, fed conventional and dry rations, was designed and conducted during the 1969 season at Oregon State University.

* The research reported herein was supported by funds provided by The Mink Farmer's Research Foundation, Milwaukee, Wisconsin, under the project "Investigation of Environmental Factors Affecting the Life Cycle of the Mink."

EXPERIMENTAL

METHODS

The experimental design is depicted in Table 1. This is a factorial experiment with two types of housing (conventional and controlled lighting), two types of mink (standard dark and sapphire), and two rations (conventional and dry). There were 8 groups: 4 were comprised of 25 male and 25 female stardard-dark, kit mink each and 4 each containing 8 male and 8 female sapphire mink kits. Animals were selected so that paired littermates were present within groups on both types of housing; i.e., group 1A animals (reared conventionally) were

Table 1. EXPERIMENTAL DESIGN—1969 MINK RESEARCH

		RATION			
		Conventional		Dry	
		Dark	Sapphire	Dark	Sapphire
HOUSING	Conventional	1A 25M; 25F	1C 8M; 8F	4A 25M; 25F	4C 8M; 8F
	Controlled lighting	1B 25M; 25F	1D 8M; 8F	4B 25M; 25F	4D 8M; 8F

littermates of group 1B animals (reared under controlled lights); 1C were littermates of 1D; etc. There were a few exceptions to this in the case of sapphires where numbers were limiting.

Housing consisted of a light and temperature controlled (LTC) facility containing 220 pens (10½" x 24" x 15") and a conventional mink shed with similar type pens. The LTC building was converted from an existing two-row, 100-foot-long, mink pelter shed which was completely encolsed to exclude outside light. The light seal provided was essentially complete in that only very few, minor light leaks could be detected. A light-tight roof was provided by using metal roofing attached to an insulating underlayment of fiber board with seams covered with black felt roofing paper. Ventilation was supplied by the variable speed blower of an evaporative-type air cooler which forced air through a nylon reinforced-plastic duct system running the length of the building and provided with evenly spaced outlets. Air was exhausted from the building through ports fitted with light traps employing baffles to interrupt the light rays from outside. These ports were located near the ground level along the sides of the building to prevent any ammonia fumes present from being drawn past the animals. Exterior and interior views of this LTC facility are provided by Figures 1 and 2.

To guard against extremely high temperatures, the evaporative cooler was set to operate automatically whenever the temperature within the building reached 80° F. Temperatures, however, were cool enough during the 1969 summer so that the cooler was only activated four or five times. Sawdust was used under the pens for moisture absorption, and waste materials were removed three times weekly to prevent accumulation of ammonia fumes. This procedure was not considered practical and was done only to insure that such fumes did not

Figure 1. Exterior view of LTC (light and temperature control) experimental mink shed showing evaporative cooler which provides ventilation and cooling, as required, to the building. Ports for exhausing air, fitted with light traps, are visible along the lower wall.

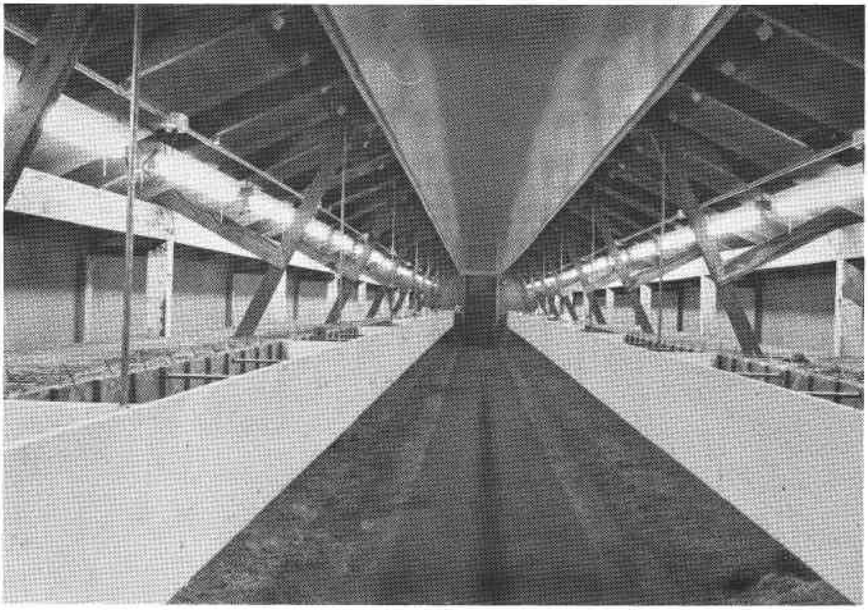

Figure 2. Interior view of the LTC facility showing the overhead, nylon-reinforced, plastic air duct. Fluorescent fixtures can be noted running the length of the building, but are unnecessary to successful operation.

interfere with experimental results. Light exposure in this facility was regulated by a time clock set so that animals received 6 hours daily exposure (from 9 a.m. to 3 p.m.) This amount of light was chosen arbitrarily from previous experiments because it was short enough to initiate early furring, yet provided sufficient time to feed and care for the animals. Mink kits were separated from litters and placed in individual pens in LTC and conventional housing; darks on June 27 and sapphires on July 2.

Two rations were employed as indicated by the experimental design. Ingredients and chemical composition of these diets are given in Table 2.

Young kits were maintained on a lactation early-growth ration after separation and until July 11. At this time the formula listed as conventional was used for all experimental groups. The dry ration formula was not used until August 1 because of difficulty in obtaining necessary ingredients. The composition of the conventional ration was altered on August 16 as noted to exclude the blood meal which was found to be unpalatable to the mink. Animals were fed *ad libitum* once late each day and feed was redistributed among all animals within each group the following morning. Water was provided to animals by an automatic watering system.

The dry ration was formulated to approximate the amino acid composition of the 1968 conventional control diet. All dry ingredients were mixed together and stored dry in bags. Sufficient water was added prior to feeding for proper consistency. To prevent excessive loss of the rehydrated feed, a one-inch wire mesh was placed over the feeding grid thereby increasing the surface and preventing feed from falling through. Ground popcorn and monosodium glutamate were added to improve the physical consistency and to increase palatability of the ration, respectively.

Body weights of animals were taken initially and at 4-week intervals until pelting on October 10 for light-controlled animals and until October 24

Table 2. COMPOSITION OF CONVENTIONAL AND DRY EXPERIMENTAL RATIONS

CONVENTIONAL RATION

Ingredient	% (wet basis) from July 11	% (wet basis) from Aug. 16
Chicken offal	33	33
Beef tripe	....	10
Rockfish carcass	33	33
Lard	4	1
Molasses	6	5
Oat groats	12	12
Blood meal	6	....
Barley	6	....
Wheat bran	....	6
	100	100
Vitamin E*	.01	.01

Proximate Analysis	after Aug. 16 % (dry basis)
dry matter	37.3
crude protein	30.9
crude fat	22.6
crude fiber	2.7
ash	7.4
NFE	36.4

DRY RATION

Ingredient	% (wet basis) from Aug. 1
Herring meal	25
Chicken meal	10
Linseed meal	5
Oat groats	30
Wheat bran	4.5
Lard	16
Molasses (cane)	6
Brewer's yeast	2
Ground popcorn	1
Trace mineral salt	.25
Monosodium glutamate	.25
	100.00
Vitamin E*	.03

Proximate Analysis	% (dry basis)
dry matter	52.8
crude protein	34.4
crude fat	23.3
crude fiber	2.1
ash	6.5
NFE	33.7

* d-alpha-tocopheryl acetate (50,000 I. U. vitamin E per pound).

and finally at pelting for animals exposed to natural light. Feed consumption records were maintained and include the daily weight of wet feed offered minus the amount not eaten and weighed back. Feed wastage which could not be accounted for is also included in these data.

RESULTS

As noted in earlier studies, the growth rate of mink raised in conditions of controlled light was more rapid in the beginning than that of littermates raised under conventional lighting conditions. It was observed that animals receiving 6 hours of light daily had begun to actively shed their summer fur by August 12. During this shedding period it was necessary to remove the loose fur from the LTC building with a vacuum cleaner to prevent sealing the ¼″ wire mesh covering the exhaust ports. Fur of mink raised in the light-controlled environment was considered prime and animals were pelted on October 10. This was 10 days later than antici-

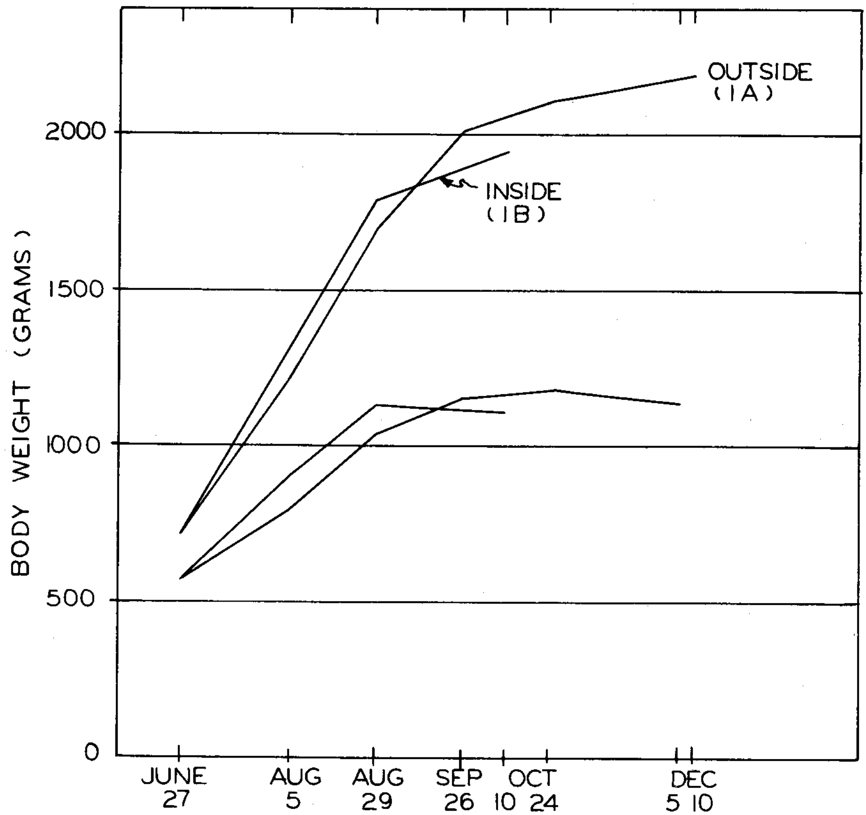

Figure 3. Growth curves of standard-dark male and female mink fed the conventional ration and raised either in a light-controlled environment (group 1B) or in a natural environment (group 1A).

pated and resulted, at least in part, from the week's delay in starting the experiment due to incompleted building construction. Mink raised under conventional housing conditions were judged prime and were pelted either on December 5th or 10th, two months later.

Growth

Growth curves of dark mink raised in either controlled or natural lighting conditions (groups 1A and 1B, conventional ration) are provided by Figure 3. Several points which have been noted before and seem to be typical are apparent from these curves. These are: 1) The rate of growth for mink exposed to controlled lighting is more rapid and only at maturity falls below that of animals exposed to natural light. 2) Forced early maturity is evidenced by the slowing of body growth in advance to that of animals raised under a natural light regime. 3) Mink are ready for pelting approximately two months prior to conventionally raised animals.

Growth curves for sapphire mink are presented in Figure 4. These were fewer animals involved and consequently it may be more difficult to draw conclusions, but the growth pattern as seen with dark mink was not evident. This was especially so with males where growth of animals in either environment was gen-

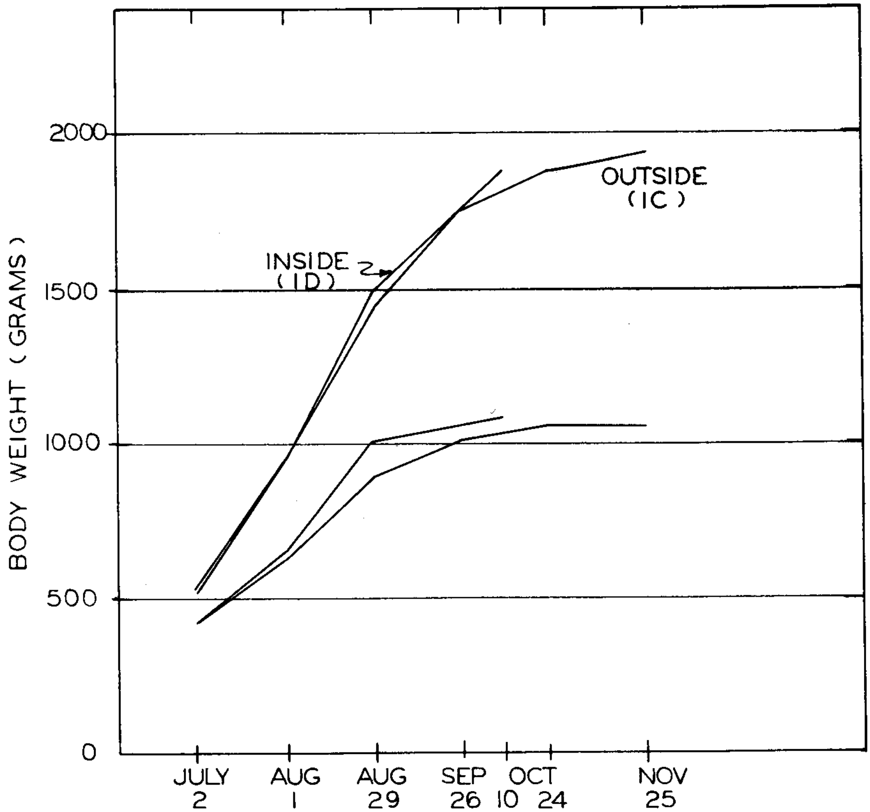

Figure 4. Growth curves of sapphire male and female mink fed the conventional ration and raised either in a light-controlled environment (group 1D) or in a natural environment (group 1C).

erally equivalent. There did not appear to be a marked tapering off of weight gains indicating early maturity as with darks, and sapphire males appeared to be growing even at time of pelting. Sapphire females raised under controlled lights were actually larger than normally raised females. These observations may have significance, especially in view of furring patterns and quality of fur exhibited by sapphire animals.

Average weight and length data for animals of all experimental groups is tabulated in Table 3.

Animals raised under controlled-lighting conditions were generally lighter in final body weight than animals raised conventionally. For example, dark males raised under restricted light exposure averaged about 10% less in weight than dark, control males raised conventionally. Weight differences, however, for dark females and sapphire males and females were of lesser magnitude. Even though body weights of dark males raised under conditions of controlled lighting and pelted in October average almost one-half-pound less, pelts of these animals were only slightly shorter (1.4% less) than those of males pelted in December; sapphire males raised in the light-controlled facility actually averaged 0.5% larger.

Fur

Pelts of animals taken in October or December were fleshed and dried—

Table 3. SIZE DATA

		Housing			
		Conventional		Light Control	
		Ration			
		Conv.	Dry	Conv.	Dry
		Groups			
DARK MINK		*1A*	*4A*	*1B*	*4B*
Ave. final weight (gm)[1]	Males	2190	1956	1944	1765
Ave. final weight (gm)[1]	Females	1140	1051	1111	956
Ave. pelt length (cm)[1,2,3]	Males	74.7	71.8	73.5	69.5
SAPPHIRE MINK		*1C*	*4C*	*1D*	*4D*
Ave. final weight (gm)	Males	1934	1705	1879	1641
Ave. final weight (gm)	Females	1049	1033	1081	974
Ave. pelt length (cm)	Males	68.0	62.8	67.6	63.9

[1] Note: for conversion 454 gms. (grams) = 1 pound
2.54 cm. (centimeters) = 1 inch
[2] Measured from tip of nose to base of tail.
[3] Pelt length is not presented for females since many were saved as breeders and not pelted.

darks leather side out, sapphires fur side out—by a commercial pelting company. All identifying marks were removed and the pelts were intersorted and submitted to professional fur graders who were instructed to independently evaluate fur color and fur quality and provide an estimate of the pelt value. Results of this evaluation are presented in Table 4.

Color and quality scores were not averaged for females as many were selected as breeding stock and not pelted. Results indicate that these fur graders were unable to detect any difference in quality of fur between pelts of dark male mink produced in October or in December. On the other hand, sapphire males pelted in October did show slight but consistently poorer fur quality scores than those pelted in December. As there were relatively few sapphires involved in this experiment, verification of this finding is needed. Fur color for dark males was also scored uniformly poorer for males which had been pelted in October, a difference which was not repeated in objective tests for melanin concentration.

Table 4. SUBJECTIVE FUR COLOR AND QUALITY SCORES

	Housing			
	Conventional		Light Control	
	Ration			
	Conv.	Dry	Conv.	Dry
	Groups			
DARK MALES	*1A*	*4A*	*1B*	*4B*
Ave. fur color score*	2.24	2.19	2.70	2.74
Ave. fur quality score*	1.44	1.38	1.43	1.35
SAPPHIRE MALES	*1C*	*4C*	*1D*	*4D*
Ave. fur quality score	1.71	1.40	2.00	1.86

* Fur color and quality were rated independently from 1 best to 4 poorest.

In addition to subjective evaluation of fur color for dark, male mink, fur samples were obtained and the intensity of fur pigmentation was determined by the method of measuring melanin granule concentration (5). As a further measure of fur quality, length of guard and underfur fibers of experimental animals was measured. These results appear in Table 5.

Melanin values as indicative of pigment intensity show only minor differences in fur color of dark males in contrast to subjective evaluation of fur color. Though not presented, individual melanin values show a very strong correlation between littermates. Underfur fiber length appears to be slightly but consistently shorter for early furred mink—a trend evident in both darks and sapphires.

Feed Consumption

Curves of average daily feed consumption of dark and sapphire animals fed the conventional ration are presented in Figures 5 and 6 respectively.

These illustrate an average of male and female consumption and are therefore intermediate in amount. The unpalatability of the original formula containing blood meal is very evident as the mid-July decline. Once this material was eliminated from the ration, feed consumption increased rapidly. Feed intake peaked in mid-August for both darks and sapphires; after this time there was a noticeable tapering off in the amount of feed consumed by animals reared in the light-controlled shed. Feed consumption of these animals terminated on October 10 with pelting. The rise in feed consumption for dark mink reared with natural lighting conditions in early December reflects pelting of the females on the 5th. Males were pelted on the 10th.

Economics

Total feed consumption data, estimated feed costs, and estimated pelt

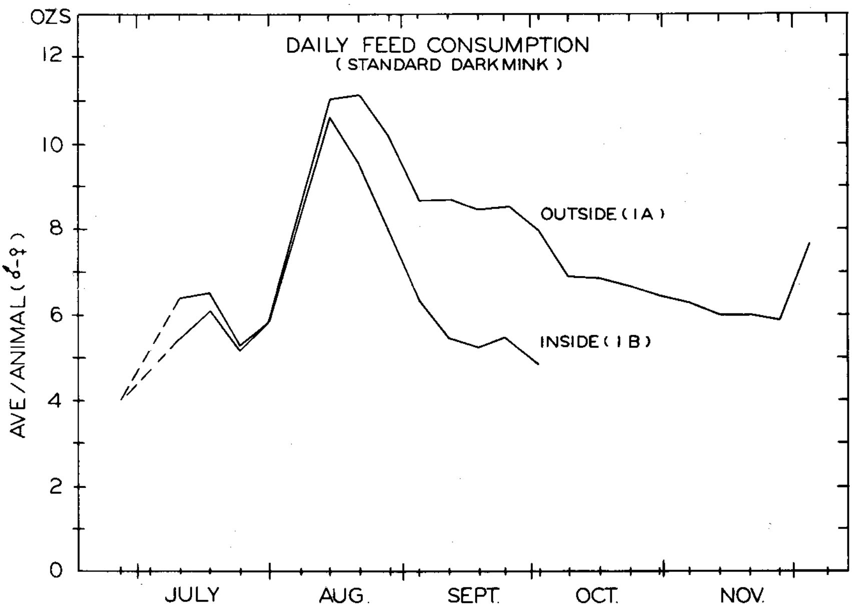

Figure 5. Average daily feed consumption of standard-dark mink (male-female average) fed the conventional diet and raised either in a light-controlled environment (group 1B) or in a natural environment (group 1A).

Table 5. OBJECTIVE FUR COLOR VALUES AND LENGTH OF FUR FIBERS

	Housing			
	Conventional		Light Control	
	Ration			
	Conv.	Dry	Conv.	Dry
	Groups			
DARK MALES	*1A*	*4A*	*1B*	*4B*
Fur color (melanin value)[1]	120	127	119	119
Guard fur length (mm)[2]	23.3	23.2	23.5	23.0
Underfur length (mm)	13.4	13.3	13.1	12.8
SAPPHIRE MALES	*1C*	*4C*	*1D*	*4D*
Guard fur length (mm)	24.9	22.9	23.3	22.5
Underfur length (mm)	13.9	13.6	12.9	12.9

[1] Melanin values are reported as optical density units per mg. hair and were determined according to methods presented in the 1968 MFRF progress report (5).
[2] Note: for conversion 25.4 mm. (millimeters) = 1 inch.

sale prices are presented for each experimental group in Table 6. Feed consumption and feed cost figures represent male-female averages as data were collected in that manner. Estimated pelt sale prices are given for males only since many females were not pelted. Pelt sale prices were estimated in early January, 1970, and would, undoubtedly, be lower under

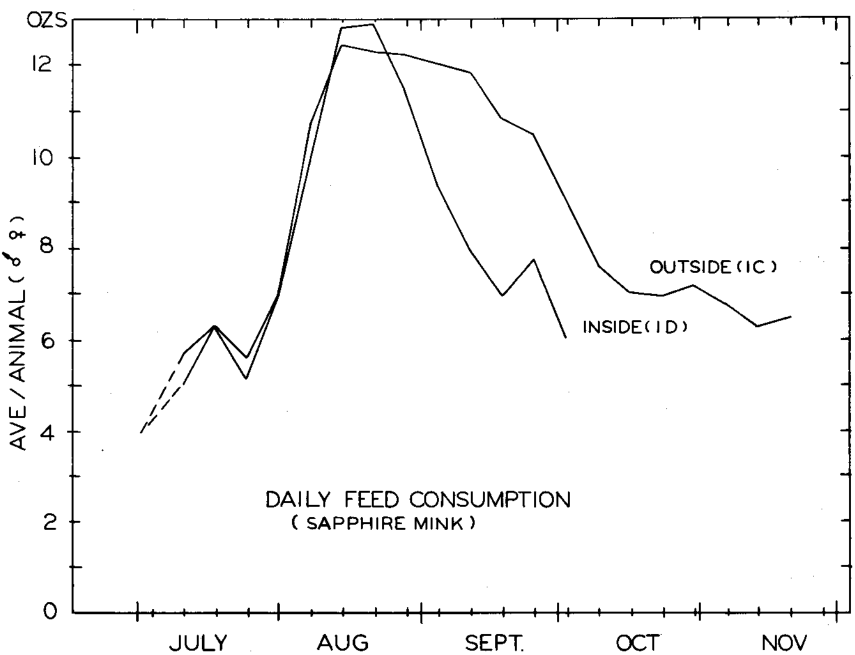

Figure 6. Average daily feed consumption of sapphire mink (male-female average) fed the conventional diet and raised either in a light-controlled environment (group 1D) or in a natural environment (group 1C).

Table 6. Feed Costs and Pelt Prices

	Housing			
	Conventional		Light Control	
	Ration			
	Conv.	Dry	Conv.	Dry
	Groups			
DARK MINK	*1A*	*4A*	*1B*	*4B*
Total feed consumed (lbs./mink)	71.1	54.4	38.0	32.4
Estimated feed cost* ($)	4.26	3.26	2.28	1.94
Wet belly incidence, males (%)	92	57	78	26
Estimated pelt sale price, males ($)	15.92	17.32	15.52	17.08
SAPPHIRE MINK	*1C*	*4C*	*1D*	*4D*
Total feed consumed (lbs./mink)	75.4	59.7	47.5	40.1
Estimated feed cost* ($)	4.52	3.58	2.85	2.41
Wet belly incidence, males (%)	42	20	33	0
Estimated pelt sale price, males ($)	15.56	15.46	13.95	14.66

* Feed costs were figured at 6¢/lb., wet basis.

present market conditions. Wet belly incidence is also presented as it bears heavily on the pelt prices estimated.

Pelt sale prices were only slightly (approximately 2%) lower for light-restricted males as opposed to conventionally raised males for dark mink. Sapphire pelt prices, on the other hand, reflect the lower fur quality observed for the early primed animals. Improved prices for dark male pelts produced on the dry ration were definitely influenced by the lesser amount of wet belly in these animals.

Discussion and Conclusions

The prospect of producing fully prime mink fur in early October is an attractive possibility. It is apparent from the research data presented that there is definite potential to develop a mink management system which enables the early production of pelts. Such a system, if workable, could have many definite economic advantages. In addition to primary savings in feed costs, there are other potential savings in labor, storage, equipment use, mortality from disease, and exposure to cold weather, etc.

Results with dark mink are extensive enough to conclude that these animals will weigh less when pelted, but will probably stretch almost as far down the board. Also, fur quality of standard darks looks sufficiently good to warrant embarking on field trials which will provide final answers as to the feasibility of producing mink skins this way. Even though many females were kept for breeding studies in conjunction with these trials and pelts were not available for measurement, there was no indication that females are any less suited than males for early pelting.

Although it is recognized that sapphire numbers were limiting in this trial, there would appear to be some problem in extending early furring methods to sapphire and possibly other mutation mink. Since sapphire kits are whelped later than darks, they are physiologically younger when placed in conditions of restricted light; consequently the stress on these mink is even greater than for darks. Under normal conditions sapphire mink appear to develop a fully prime fur coat before the fur of dark mink is considered prime and consequently are pelted earlier. (This may not, however, be entirely true.) Under conditions of accelerated fur development it was noted that the dark mink entered and completed the furring cycle prior to the sapphires. Growth curves of darks showed evidence of body maturation by slackening of growth; sapphires were still growing rapidly when pelted. This points to the possibility that things are being rushed too much for sapphires. Certainly these observations deserve further research.

Little space has been devoted to the obvious differences in performance of mink fed conventional and dry rations, and it is concluded that since maximum production (especially growth) was not achieved with the dry ration formula the formula is not optimum; however it must be considered that since dark pelts especially were valued considerably higher, due to a lower occurrence of wet belly, perhaps a ration permitting maximum growth may not be the best formula. It is evident that the mink's nutritional requirements under conditions of accelerated furring are increased as the animal is concurrently undergoing the stress of body growth and fur development. Therefore dietary requirements of animals under these physiological conditions need to be investigated to permit maximum production with controlled lights. Once requirements are established it will be possible to devise rations, both conventional and dry, which are suitable for accelerated fur production.

There is need for further information related to design of practical, light-controlled, mink sheds which will require a minimum of capital investment. This may involve construction of new facilities or conversion of existing ones. Design of two additional types of such facilities which will allow control of the light environment are in progress. Cost of conversion of the research shed used in this experiment was approximately $2,000 excluding labor. This was excessive as it contained a complete fluorescent lighting system which is unnecessary for a pelter shed. The threshold level of darkness required for fur development is an especially important fact which needs to be known for design of facilities. At this point one can only guess at the intensity of light that can be tolerated during periods of darkness by the mink actively growing fur.

There were some problems encountered with the controlled light environment system used. These included a slight dust condition which occurred initially and was caused by the layer of sawdust beneath the pens and too rapid an air movement. Loose fur created a similar situation just prior to pelting. Practical manure disposal is a problem which needs to be worked on and solved. Congregation and breeding of flies posed no problem in the experimental shed, presumably because the facility was cleaned routinely and often.

For accelerated fur production to be entirely feasible the breeding behavior of mink raised under this management system should be unaffected, but if not, at least predictable. Experiments are currently in progress which are designed to provide information on this. The results appear promising but are too preliminary to report here.

Continued investigation of the effects of environmental factors which influence the life cycle of the mink offers tremendous potential to the mink rancher and could ultimately revolutionize the industry.

(See back cover for References Cited)

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