

BEHAVIORAL PATTERNS IN DAIRY CATTLE AS
AFFECTED BY MANAGEMENT

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ABSTRACT

BEHAVIORAL PATTERNS IN DAIRY CATTLE AS AFFECTED BY MANAGEMENT

by John Fage Dietrich

This study was undertaken to investigate whether dairy cows enter the milking parlor in an established pattern and whether feeding and management practices would change certain behavioral patterns. An effort was made to ascertain the factors which are involved in social dominance behavior. Correlations were made between age, body weight, social dominance, and milk production with parlor entrance order in order to determine whether entrance order could be used as a criterion for the selection of dairy cattle.

In experiments where a concentrate mix was fed at various times before or after milking there was no change in the order in which the cows entered the milking parlor. Where the cows were milked and fed previous to the regular milking period, there was a significant change in the cows' entrance order. One probable explanation for this phenomenon is that there was a decrease in the intra-mammary pressure following milking which caused less udder stress to the cow, thus causing her to come into the milking line later. The milking and feeding of the cows once every other day did not change the cows' entry order.

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The daily feeding of thyroprotein at both the 15- and 30-gram levels had no significant effect on the cows' entrance rank. At the 15-gram level, there was a slight but non-significant difference in rectal temperatures and respiration rates between the thyroprotein-treated cows and those not treated. The cows treated with 15 grams of thyroprotein daily, increased in production approximately 12 percent. Cows fed 30 grams of thyroprotein daily increased in milk production nearly 11 percent. The fact that two cows exhibited moderate cases of mastitis may have accounted for the lack of a greater response in milk production at the 30-gram level.

When the cows received daily injections of a tranquilizer (Prephenazine) the cows' entrance order was not significantly changed. Neither did the use of this tranquilizer alter the expected normal decline of the lactation curve of the cows during this treatment.

When a herd of 40 Jersey cows were trained for 25 days to enter the milking parlor in a specific order, approximately 85 percent of the herd responded to the call of their herd number and entered the parlor in their assigned order. At the end of the 25-day training period, the cows reverted back to their original entrance order that they had established previous to the training period. These results indicate that training for 25 days had no appreciable

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effect on a permanent change in the milking parlor entrance order.

No significant correlation was found between entrance rank and social dominance of individuals in a Jersey and Brown Swiss herd. Correlation coefficients indicate very little association between age and entrance rank. Correlations between body weight and entrance rank, and milk production and entrance rank, were low. The fact that body weight and age were not highly correlated with entrance order indicates that young cows of lighter weights were entering the milking parlor at all segments of the entry order. The data presented in this study indicate that a high correlation exists between age and body weight and age and milk production. There seems to be little association between age and the order in which the cows entered the milking parlor.

A high negative correlation was found between body weight and dominance rank, and dominance rank and age, which indicates that older, heavier cows were the most dominant.

The result of a low correlation between milk production and the order in which the cows entered the milking parlor would indicate that entrance order could not be safely used as a criterion for the selection of high-producing cows.

BEHAVIORAL PATTERNS IN DAIRY CATTLE AS
AFFECTED BY MANAGEMENT

By

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INTRODUCTION

The problems which confront the management of a modern dairy herd are phenomenal in scope. Dairy herds are increasing in size in the United States, which makes management decisions more difficult. A number of studies are available on the behavioral patterns of small animals, but meager information has been reported on the behavior of dairy cattle. The patterns of behavior in dairy cow groups need further study.

The main objectives of this study were to determine (a) whether dairy cows enter the milking parlor in an established pattern, (b) to ascertain whether behavioral patterns could be changed by several feeding and management practices, (c) to determine some of the factors which are involved in social dominance behavior, and (d) to ascertain whether milking parlor entrance order was associated with age, body weight, social dominance, or milk production and to determine whether entrance order could be used as a criterion for the selection of dairy cattle.

REVIEW OF LITERATURE

Feed Intake on Appetite and Behavior

Little is known concerning the relationship of appetite to behavior in domestic animals. This is particularly true in dairy cows with reference to being able to change or modify behavioral habits and patterns by changing the feeding practices. This section of the review of literature deals with some of the physiological factors within the animal which are thought to affect the regulation of appetite and desire for food intake and their relationship to animal behavior.

Murray (1926) has defined appetite as an affective state with a natural longing or desire for food. In distinguishing between hunger and appetite, Quigley (1955) pointed out that hunger in humans and animals should be related to disagreeable sensations, and that appetite should be associated with pleasant sensations which influence the digestion of food. He describes hunger as a primitive, unconditioned mechanism which tends to induce the individual to ingest food. On the other hand, he suggests that appetite is founded on learning or memory of (1) the disappearance of hunger sensations and (2) their replacement by pleasant sensations associated with the comfortably filled stomach; of satiety, well-being, relaxation, and drowsiness. He also concluded that appetite is related

to the agreeable taste, smell, and appearance of food. In discussing appetite in dairy cattle, Huffman (1939) states that appetite is the total amount of dry mater actually consumed when the animal is offered as much food as it cares to eat.

Physiological Factors Which May Influence Appetite

Before the twentieth century, a number of theories were advanced to explain the origin of hunger and its effects on food intake. These theories were very vague and many of them without a good foundation.

Gastric contractions, hunger, and food intake

Investigations by Cannon and Washburn (1912) and Carlson (1916) showed that feelings of hunger pangs in humans were closely associated with hunger contractions of the empty stomach. They suggest that these contractions bring about the feeling of hunger. By surgical techniques in dogs, Sherrington (1900) demonstrated that total denervation or complete removal of the stomach had no dominant influence on the regulation of food intake. Similar findings were reported by Grossman and Stein (1948); however, they further stated that hunger pains could be abolished by total denervation or removal of the stomach of dogs, but even these operations did not abolish appetite or

influence food intake to any great degree. Two inhibitory mechanisms which could influence food intake were reported by Share (1952). The first was initiated by distending the stomach of the dog with a water-filled balloon or similar device, and the second was based on the caloric value of the food ingested. He concluded that gastric distention inhibited the amount of food the dog would eat. Furthermore, when the caloric content of the diet was increased over normal, the food intake likewise decreased.

Blood glucose level on appetite

Carlson (1916) advanced the idea that the fluctuating levels of glucose in the blood controlled appetite. He contended that in monogastric animals, the lowering of blood glucose between meals produced hunger pains which stimulated appetite and induced the animal to ingest food. The work of Bulatao and Carlson (1924) showed that hunger contractions could result from hypoglycemic conditions. They reported that glucose injections decreased hunger contractions, while injections of insulin augmented hunger contractions by lowering the blood glucose level. Contrary to these findings, Scott et al. (1938), when working with human subjects, found that blood sugar levels remained constant (within ± 5 mg. percent of the normal mean values), and that there was no association between hunger contractions and glucose levels. Quigley (1955) confirmed these findings in similar studies.

Mayer (1953, 1955) and Mayer et al. (1951) found that glucose injections decreased hunger and food intake in rats, and concluded that there are glucoreceptors in the hypothalamus which control hunger and food intake.

The relationship of blood glucose levels to the occurrence of hunger contractions was studied by Grossman and Stein (1948) and Janowitz and Ivy (1949). They concluded that there was some fluctuation in blood glucose level during hunger periods but hunger did not set in until the blood glucose level had started to rise. Janowitz and Ivy (1949) showed that hunger occurred, on the average, about 27 minutes after the lowest glucose level was reached.

Using medical students as experimental subjects, Fryer et al. (1955) showed that satiety values in reducing diets for humans did not agree with blood glucose levels. The highest satiety value was obtained with a diet high in protein and fat, and low in carbohydrate. On the other hand, the poorest satiety values were found in diets high in carbohydrates and low in protein. One possible explanation of these findings is that on a high carbohydrate diet, the blood glucose level reaches a peak earlier and is utilized by the body more rapidly.

The role of the hypothalamus on appetite

At least a century ago, physiologists postulated that a hunger center or centers existed somewhere in the

brain and these areas were sensitive to starvation conditions of the blood (low blood glucose levels). Hetherington and Ramson (1940), while working with rats, demonstrated that the area of the brain affected was the hypothalamus. By inflicting hypothalamic lesions in specific areas of the hypothalamus of rats, they observed a tremendous increase in food intake and obesity. These changes took place within three weeks after the lesions were established. Investigations by Hetherington and Ramson (1940) and Hetherington (1941) showed that when lesions were established in some areas of the hypothalamus, a decrease in food intake occurred; in fact, some rats refused to eat. Similar experimental techniques were used on cats by Anand and Brobecker (1951) and with dogs by Heinbecker et al. (1944), all showing similar results to those reported by Hetherington (1941) and Hetherington and Ramson (1940).

A new experimental technique was introduced by Hess (1932) which made it possible to electrically stimulate different parts of the brain. He found that it was possible to make discrete lesions in different areas of the hypothalamus. By his technique, he made an extensive study of the hypothalamic region in cats. Results of his work showed that stimulation in the area of the mamillothalamic tract resulted in a pronounced urge to eat. This urge to eat not only included natural food, but also indigestible materials. He reported that bilateral destruction of the

ventro-medial hypothalamic nucleus resulted in obesity. Similar investigations have been carried out by Hetherington (1941, 1944), Hetherington and Ramson (1940), Brobeck et al. (1943, 1948) and Heinbecker et al. (1944). All of these investigators reported that the obesity was due to increased food intake which resulted from stimulation or destruction of areas in the hypothalamus.

In experiments with cats, Delanda and Anand (1953) showed that they could increase food intake by electrical stimulation of the same area of the hypothalamus described by Brobeck et al. (1943). They reported no significant change in blood glucose levels during these experiments; however, they found that some cats increased their food intake as much as 700 to 1000 percent over normal intake during the course of the experiment. After the stimulation period was discontinued at the end of the experiment (usually 5-10 days), the cats returned to a normal food intake level. They reported that during the actual stimulation process the cats exhibited licking movements, swallowing responses, and that respiration rates increased somewhat, but no indication of pain, fear, or rage was observed. By electrical stimulation of the hypothalamic areas in sheep and goats ($\frac{1}{2}$ second every 5 seconds for an hour daily for a period of 5 to 10 days), Larsson (1954) observed mastication and licking movements, increased rumination movements, and in some cases some increased food intake.

Temperature on appetite

The role of the hypothalamus on the regulation of body temperature has been accepted by physiologists. A theory proposed by Brobeck (1948) suggested that food intake is also regulated by the temperature mechanism of the hypothalamus. Investigations by Brobeck (1948), using mature male rats, showed that when the rats were exposed to temperatures of 65 to 75° F. they increased their food intake and gained weight. When similar rats were exposed to 92° F. temperatures, food intake decreased, water intake increased, and the rats developed a fever and lost weight. He hypothesized that the hypothalamus was the seat of integrating factors for not only body temperature control, but food intake.

Kennedy (1952) proposed that the role of body fat reserves in rats has a great influence on the amount of food an animal will ingest. He found that young rats adjust their food intake to their energy needs and that the fat reserves remain constant. He readily admits that physiological factors such as heat, cold, stress, and hypothalamic lesions may alter normal food intake. He suggests that there are two possible ways the hypothalamus could achieve caloric control of food intake. First, by sensitivity to heat released in the body during metabolism of the food, and second, the indirect caloremity achieved by chemosensitivity of the circulating metabolites in the blood.

He concludes that there exists the possibility of specialized cells of the hypothalamus which may control food intake.

In the same investigation conducted by Kennedy (1952), the effect of lactation on food intake at different temperatures was studied. He found that by adding young nursing rats to the litter (up to 10 rats), food intake increased and apparently reached a peak under normal temperatures. By exposing lactating rats to low temperatures (34° F.), food intake again increased over that at normal temperatures. Thus, as cold temperature was superimposed on lactation, food intake was again increased. When similar lactating rats were subjected to hypothalamic lesions, food intake was not increased. When hypothalamic lesions were established, obesity did not occur during lactation; however, after weaning, the rats became obese. Some rats stopped lactating immediately when hypothalamic lesions were inflicted.

Dilution and bulk on appetite

A series of investigations from a biochemical standpoint were made by Mayer et al. (1951) and Bruce and Kennedy (1951); and they found that food intake was closely correlated with the caloric intake of food by rats. By diluting the rat's diet with inert materials, the food intake increased; conversely, as the caloric content of the

food increased, food consumption declined. They concluded that in rats, the food intake was closely related to the caloric requirements of the animals.

Adolph (1947) diluted a rat ration with materials such as water, clay, and cellulose shavings. He observed that the rats ate extremely large amounts of the ration; as much as 125 percent of their body weight when water was used to dilute the diet. Adolph (1947) also observed that the rats reduced their food intake when the dilution rate reached a level that the rats could not consume enough calories to supply their physical needs. From this investigation, Adolph (1947) concluded that the caloric content of the ration determines food intake in rats. Kennedy (1952) supports this conclusion.

Hoelzel (1930), using himself as the experimental subject, swallowed considerable amounts of cellulose, glass beads, sand, and cotton-wool to help fill his stomach. He found that his appetite still persisted and concluded that the fullness of the stomach and the caloric content has little effect on the urge for food intake.

After finishing a study on food intake in sheep, Blaxter (1960) concluded that in sheep, feed intake increases as the quality of the ration increases. He points out that when the fiber content of the roughage is high, feed intake declines. He further concludes that animals regulate their intake according to their energy needs.

Balch et al. (1953) suggest that appetite may be controlled by the amount of water the animal is allowed to drink. In studying the passage of hay in dairy cattle, he observed that by restricting the water to 60 percent of normal intake, appetite was depressed, but this had very little effect on the rate of passage of the hay through the digestive tract. In a similar study with dairy cows, Balch (1950) found that fine ground hay passed through the digestive tract faster than long or chopped hay. He suggested that passage was not correlated with the rate of digestibility.

Mäkelä (1956) found that roughages, such as hay, remain in the tract a longer time than green roughages, such as grass. He also reported that coarsely ground grains and chopped hay passed along the tract more slowly than finer ground materials. Ewing and Wright (1918) observed that when steers were fed long hay or silage, the feed stayed in the second and third stomach longer than when grains were fed either alone or in combination with roughages.

Castle (1956) reported that in mature sheep, under normal conditions, material passed along the alimentary tract in a constant pattern. Stained hay, when used as a marker in feed passage studies, resulted in the smaller fragments being excreted more rapidly than the larger pieces.

Dalton (1952), Dalton et al. (1953) and Hupp (1958) diluted the grain ration with water and found that dairy cows ate the diluted ration much more rapidly than the dry grain ration. Hillman (1959) in studying appetite for dry matter in hay with dairy cows, found that when dry hay was soaked for twelve hours in water, the dry matter consumption was essentially the same as that from dry hay. He concluded that the moisture content of the hay had no effect on the appetite for dry matter. When comparing appetites for dry matter in alfalfa hay versus alfalfa silage taken from the same field at the same stage of maturity, Hillman (1959) found that the cows ate more dry matter in hay than silage. He suggests that these differences in dry matter intake may be the result of a product produced during the fermentation process in the alfalfa silage which could depress the appetite for dry matter.

The Effects of Metabolic Stimulators on Behavior

The literature reveals that the feeding of thyroprotein, thyroxine and thyroid materials exerts multiple stimulatory effects on the physiological functions of animals. The review of literature presented in this section will deal primarily with the effects of these metabolic stimulators on the physiological behavior as it relates to respiration rate, heart rate, and milk production.

A number of excellent and authoritative reviews are available concerning the history and development of iodinated proteins and their effects on dairy cows. The reviews by Reineke and Turner (1942), Reineke (1946), and Thomas (1953) deal primarily with the effects of iodinated proteins on dairy cows, while the review by Blaxter et al. (1949) is concerned with the feeding of thyroactive materials to ruminants as well as nonruminants and poultry.

Thyroprotein on milk production

The first conclusive evidence that thyroprotein would increase milk production in normal dairy cows was reported by Reineke and Turner (1942) and Reineke (1942). The results of their investigations were soon confirmed by many other research workers. Many of the early experiments concerning the stimulatory effects of thyroprotein were carried out on a relatively short-term basis, 14-120 days. A review of the investigations to date indicate that the range of change in milk production would be between minus 8 to a plus 61 percent over the pretreatment level, with an average of about 20 percent. In terms of pounds of milk per day, the range would be from a minus five to a plus 15 pounds of milk. The range in time from treatment to the point of maximum increase in production may be between five and 60 days.

When thyroprotein was removed from the ration, there was a noticeable decline in milk production according

to Reece (1944, 1947), Booth et al. (1947), Van Landingham et al. (1944), Blaxter (1945b, 1946, 1948b), Gardner and Millen (1950), Hibbs and Krauss (1947), Reineke and Turner (1942).

Blaxter (1946) tried to overcome this drop in milk production by gradually reducing the thyroprotein content of the ration. Although he was not completely successful in preventing this decline, he did find that when the cows were fed liberally, during and following the experimental period, this decline was not so sharp.

The major portion of the investigations dealing with the feeding of thyroprotein to dairy cows have been carried out for less than 120 days. Reece (1947), Thomas et al. (1949), and Swanson and Knodt (1949) were the first to study the stimulatory effects of thyroprotein for a complete lactation, while Hyatt and Henderson (1948), and Thomas and Moore (1948, 1949), continued their investigations for more than one lactation.

Thomas et al. (1949) found that after milk production was stimulated with thyroprotein, persistency could be maintained for the remainder of the lactation, if the cow received about 125 percent of the maximum requirements of nutrients. They reported that if this extra feed is not fed, there is a drop in production, below what would be expected in cows not receiving thyroprotein in their rations. In the work reported by Reece (1947), and Swanson

and Knodt (1949), the thyroprotein levels were too low to expect a stimulation of lactation. The investigations by Swanson and Knodt (1949) did not indicate the amounts of T.D.N. the cows received; however, with thyroprotein dosage levels from 0.6 to 5.0 grams daily, no response in production was obtained.

The effect of thyroid-like stimulants on the fluctuating changes of the fat content of milk have been extensively investigated by Allen et al. (1948), Archibald (1945), Blaxter (1945a, 1945b, 1946), Booth et al. (1947), Folley and White (1936), Graham (1934), Herman et al. (1937, 1938), Owen (1948), Ralston et al. (1940), Reece (1947, 1950), Reineke (1942, 1943), Seath et al. (1945), Swanson and Knodt (1949), Thomas et al. (1949), and Van Landingham et al. (1946, 1947). Most of these investigators reported an increase in fat test, while only two, Hibbs and Krause (1947), and Leech (1950), found no significant change due to feeding thyroprotein.

The following factors have been reported which are responsible for variations in response to thyroprotein treatments in dairy cows.

Size of dose. Early work with thyroprotein shows that a wide range in dosage level was dependent upon the potency of the iodinated protein preparation. In recent years, these preparations have become more standardized and the amounts fed have ranged from 0.6 to 30.0 grams per

cow per day, depending upon the intent of the investigation. The normal daily dose is 1.0 to 2.0 grams per 100 pounds of body weight.

Reineke (1942), Reineke et al. (1946, 1949), Blaxter (1945a, 1945b), and Deansley and Parks (1945) showed there was a relationship between thyroidal activity and the milk stimulating action of various iodinated protein preparations. Reineke et al. (1944) showed that there was a direct relationship between the increase in milk production and the amount of thyroprotein fed. Work reported by Blaxter (1945b) showed that feeding 15, 20, or 30 grams of iodinated protein for a 21-day period gave increases in milk production of 17, 22, and 33 percent, respectively. In the same study, a 14 percent increase in milk production was reported by Blaxter (1945b), when a 15-gram dose was given each cow per day. When Hibbs and Krauss (1947) fed 15 grams of thyroprotein daily to Jerseys and 20 grams to Holsteins for 41 to 49 days, they received a 16 percent increase in production. When 10 and 15 grams were fed cows for 3 to 17 months by Reece (1947), production increased by 7.6 and 19.7 percent. A five percent increase was reported by Bailey et al. (1949) after feeding 15 grams of thyroprotein in the ration to cows for 21 days. Nearly 25 percent increase was recorded by Reece (1950) with a 15-gram dose when fed for 90 to 270 days.

A summer study was made by Gardner and Millen (1950), who fed 1.5 grams of thyroprotein per 100 pounds of body weight. They reported a 32 percent increase in 4 percent fat corrected milk on a 56-day treatment. A 10.5 percent increase in milk production was reported by Reineke and Turner (1942), with a 10-gram per day dose when fed for a period of three days. Reece (1944) fed 10 grams to cows for a three-week period and increased production eight percent. Using 1.0 to 1.5 gram per 100 pounds of body weight, Thomas and Moore (1953) secured a 16 percent increase in milk production.

Age and size of animal. Very little is recorded in the literature concerning the response of a particular size of dose that one might expect on different ages and sizes of animals. Investigations by Blaxter (1940, 1948a), Brody (1945), and Kleiber (1947) suggested that the dose of thyroprotein should be in proportion to the body weight of the animal since body metabolism is based on a decimal power of body weight. In a field trial carried out by Blaxter (1946), a small difference in response due to age was reported. In reporting work with six breeds of cows, he found that cows that had freshened two or three times gave smaller responses to iodinated protein stimulation than did older cows. Also, first calf heifers showed a lesser response than cows that calved two or three times. The average response of these cows in terms of pounds of

increased milk was 4.5, 5.5, and 6.9 for first calf heifers, second and third calf cows, and for old cows, respectively. Younger cows gave smaller increases in milk production than did older cows according to Booth et al. (1947).

Breed of cow. To date, there seems to be no significant difference in response to thyroprotein feeding between breeds of dairy cattle. A field trial conducted by Blaxter (1946) showed that breed differences were relatively small, but where thyroprotein was fed in proportion to body weight, he suggested that smaller animals might give a larger response than heavier animals. Although he found no significant difference in response between the breeds studied, there was a trend indicated. When production records were adjusted for stage of lactation and mean initial yield, Blaxter (1946) found a positive response in pounds of milk for mature cows as follows: Friesians, 5.22; Shorthorns, 5.90; Guernseys, 6.21; Jerseys, 6.41, and Ayrshires, 6.84.

Investigations by Archibald (1945) indicate slight breed differences, but he points out that individual differences within breeds are considerably greater than differences between breeds.

Individual differences between cows. Ralston et al. (1940), Herman et al. (1937, 1938), Graham (1934), and Hurst et al. (1940) were among the early investigators to

point out that there was a wide range in response to stimulation by thyroxine and thyroprotein. The single factor causing the greatest variation among cows, according to Blaxter (1946), was the yield of milk at the time the cows were put on experiment. He concluded that milk yield and stage of lactation were the two factors which were responsible for the wide variations in response to milk production when cows were treated with iodinated protein. Blaxter (1946) found that the higher producing cows responded with greater increases in pounds of milk than cows at lower levels of production. In his field trial, Blaxter (1946) reported that the "higher" producing cows produced two pounds more milk per day than the "lower" producing cows, when comparing the groups at similar stages of lactation. Archibald (1945) and Thomas et al. (1946, 1949) reported differences in response between cows of high and low producing abilities. Heifers did not increase in yield as much as did mature cows according to Blaxter (1946). He also reported that thinner cows gave greater responses than cows that were "fatter and more beefy," but these differences were not significant. Hibbs and Krauss (1946) also reported wide individual cow differences in response to thyroprotein feeding.

Stage of lactation and level of production. Investigations by Ralston et al. (1940), Herman et al. (1938), Graham (1934), and Blaxter (1945b) have demonstrated that

there is very little response in milk production when cows are stimulated with thyroidally active materials during the inclining phase or the extreme end of the lactation period.

With thyroxine injections, Ralston et al. (1940) found a smaller response at the peak of the lactation curve than when the production was declining. His work shows that after the eighth month of lactation, there was a gradual decline in lactation response. Blaxter (1945b) reported similar results when using thyroprotein as a stimulant for milk production. When comparing responses at different stages of lactation, Blaxter (1946) found that the cows stimulated with thyroprotein gave a greater response at the 20th week than cows stimulated at the 14th week of lactation.

T.D.N. intake on milk production response to thyroprotein

According to Moore (1958), the results may be very disappointing if extra nutrients are not supplied the cow when thyroprotein is fed. Moore (1946) was the first to specifically point out this fact. Hibbs and Krauss (1947) also found that increase in milk production was dependent upon the nutrient intake of the cow. Blaxter (1946), in an English field trial, noted that cows on a lower level of nutrition and poorer management gave smaller responses to iodinated protein feeding. Previous to these experiments, Graham (1934) observed that when dried thyroid was

fed to a cow he could check the rapid decline in milk production from the 19th to 28th weeks by adding sugar, honey, or milk fat to the ration of the cow. Thomas et al. (1949) reported that extra feed must be fed in order to maintain the production level when cows are stimulated with thyroprotein.

Thyroprotein on heart rate

There seems to be a wide range in normal heart rates of dairy cows. Investigations by Blaxter (1943) indicated that the lower range of normal heart rates may be near 40 and he suggested that it was not uncommon to find cows with heart rates of over 100 beats per minute after a large T.D.N. intake. Dukes (1955) suggests that the heart rate of cows at rest should be in the range of 60 to 70 beats per minute. There are many factors which are known to affect the heart rate of dairy cattle. Thomas (1949) reported a number of factors which may affect variations in heart rate in cows. Some of the factors are: level of T.D.N. intake, stage of lactation, stage of gestation, and estrus. Dukes (1955) shows that age has some effect on heart rate. His investigations show that after one year of age, in the normal bovine, there is a general decline in heart rate, but environmental factors play an important role here also. Blaxter (1943) concluded that there was a significant difference in heart rates of cattle, 5 to 7 beats while standing, compared to lying

down. He also observed increased heart rate in ruminating over nonruminating cows. Thomas and Moore (1951) found that the heart beat in normal cows ranged from 44 to 96 during lactation and 64 to 91 during the last 3 months of pregnancy.

The stimulatory effect of thyroxine, thyroid, or thyroprotein on heart rate has been observed by the following investigators: Reineke and Turner (1942), Ralston (1940), Jones (1935), Reece (1944, 1947, 1950), Bailey et al. (1949), McQuillan et al. (1948), Booth et al. (1947), Van Landingham et al. (1944, 1946, 1947), Blaxter (1943, 1945a, 1945b, 1946, 1948a, 1948b, 1948c), Allen et al. (1948), Gardner and Millen (1950), Hibbs and Krauss (1946), Seath et al. (1945), Mullick et al. (1948), Folley and White (1936), Swanson and Knodt (1949), Swanson (1949, 1951), Moore and Sykes (1943, 1947), Sykes et al. (1948), Owen (1948), Throbeck (1948), Hurst et al. (1940), Thomas (1949), Hoffman et al. (1947), and Leech (1950), Singh et al. (1958), Hindery et al. (1958), Allen et al. (1948).

Data presented by Bailey et al. (1949), Blaxter (1945a, 1945b, 1948), Thomas et al. (1949), Ralston et al. (1940), and Leech (1950) indicate that heart rate is dependent upon the size of dose given, the age of the animal, the heart rate of the animal before treatment, and the amount of T.D.N. consumed by the cow.

Work by Blaxter (1945a), when feeding 50 grams of iodinated protein to cows, showed that the maximum heart rate was reached on the twentieth day; however, no response was observed when doses at the ten-gram level were fed. By injecting thyroxine, Owens (1948) found that the cows in his experiment reached their maximum heart rate on the nineteenth day, with a range of 6 to 31 days for all cows. Folley and White (1936) observed that thyroxine-injected cows reached their mean pulse rate at the sixth day and exceeded the noninjected controls by 19 beats per minute. They report that the pulse difference disappeared within seven days after thyroxine injections were stopped.

Although most of the investigations in feeding thyroprotein, which have been reported, were conducted on a short-time basis, usually a few weeks, Thomas et al. (1949) was the first to study the effects of thyroprotein for the complete lactation. They reported that only cows which had been supplied with extra nutrients over their daily requirements maintained an increased heart rate. When the cows were limited to their daily requirements, the heart rate increased for a short time and then declined below the level of the untreated cows. From this work, they concluded that heart rate was in direct proportion to the total metabolism of the cow. In work with steers, Sykes et al. (1948) showed that the T.D.N. consumption and thyroprotein feeding were additive in their effect

on heart rate.

Thyroprotein on respiration rate and body temperature

Heat produced as a result of body metabolism, plus the effect of high environmental temperature, brings into play the body mechanisms which are responsible for dissipation of heat from the body. These factors directly or indirectly affect heart rate, respiration rate, and body temperature and thus, the behavior of the animal is affected.

Blaxter (1948a,b) and Thorbeck et al. (1948) demonstrated that thyroprotein was a stimulator which increased body metabolism and, thus, at adequate dosage levels, an increase in respiration and a possible increase in body temperature might be expected. This may be true especially when the environmental temperature is so great that the cow has difficulty getting rid of excess body heat. According to the investigations by McQuillan (1948), Swanson (1949, 1951), Moore and Sykes (1943), and Ralston et al. (1940), respiration rate was increased in cows when thyroprotein, thyroid material, or thyroxine was used to stimulate milk production.

Gardner and Millen (1950) reported no significant difference in respiration rates between treated and non-treated cows when the environmental temperature was 70° F. They did, however, find that at 88° F. the thyroprotein-treated cows averaged 17 more respirations per minute than

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the nontreated cows. A study by Blaxter (1945b) indicated that when the cows received a 30-gram dose of thyroprotein, their mean respiration rate was 8.7 respirations per minute over the control group.

By feeding 15 grams of thyroprotein to Jerseys and 20 grams to Holsteins, Hibbs and Krauss (1947) found that respiration in the treated cows was increased 5.4 respirations over the nontreated animals. When thyroprotein was fed at low levels, 0.6 to 5.0 grams per day, Swanson and Knodt (1949) found no increased response in respiration rate. Using 50-gram doses in cows, Blaxter (1945b) observed an average increase of 6.7 respirations per minute in his treated over his control group. He reported that the maximum increase in respiration rate was reached on the 12th day of treatment. In a similar experiment, using the 50-gram dosage level, Blaxter (1945b) found that the treated cows averaged 12.8 more respirations per minute than the nontreated cows.

The stimulatory effect of thyroprotein on respiration has been demonstrated; however, the extent to which this product affects respiration is relatively unknown in dairy cattle since little work has been done where feed intake and environmental temperature has been accurately controlled.

A number of investigators, including Blaxter (1945a, 1945b, 1948), Gardner and Millen (1950), Seath et al.

(1945), Folley and White (1936), Swanson (1949, 1951), Ralston (1940), and Hindery et al. (1958) observed an increase in rectal temperature when thyroprotein was fed. No significant change in rectal temperatures were reported by McQuillan (1948), Allen (1948), Swanson and Knodt (1948) and Jones (1935). In the study by Swanson and Knodt (1948), the dosage was too low to expect a response.

Dukes (1955), citing the work of Woolridge, states that the average rectal temperature in dairy cows was 101.5° F. with a range of 100.4 to 102.8° F. A trial conducted during the winter months by Blaxter (1945b) showed that thyroprotein-treated cows had an increased rectal temperature of only 0.14° F. above the nontreated cows. In a similar experiment where the cows received 50, 30, and 15 grams of thyroprotein, the treated cows had an increased temperature over the control group of +0.32° F., +0.12° F., and +0.11° F., respectively.

Seath et al. (1945) found that cows on a 15-gram dose at a mean ambient temperature of 88.2° F. had an average increased rectal temperature of 0.68° F. over the control group. Gardner and Millen (1950), in studying the effects of thyroprotein on lactation in midsummer, reported that there was no significant difference in rectal temperatures between the treated and nontreated groups at the start of the experiment. However, during the experiment when the environmental temperature was 70 to 76° F. and

the treated cows received two grams of thyroprotein per 100 pounds of body weight, the treated cows' average temperature was 103.4° F., while the controls averaged 102.8° F. They also found that when the environmental temperature was 90° F., the treated cows' rectal temperature averaged 105.1° F. while the control group averaged 102.3° F. A two-year study by Swanson (1951) showed a somewhat higher rectal temperature for the thyroprotein-treated cows when comparing them to his control group.

Thyroprotein effects on weight losses in cows

Many of the early experiments with thyroxine, thyroid, or thyroprotein were carried out on a short-time basis and although, from a visual observation, the treated cows appeared to lose weight, only a few experiments were conducted wherein body weights and feed intakes were accurately recorded. The amount of weight loss that should occur when cows are fed thyroprotein is dependent on the size of dose, length of experimental feeding, nutrient intake and the individuality of the cow. Blaxter (1945b) demonstrated that great losses in body weight could be prevented by feeding extra T.D.N. when feeding thyroprotein to cows. Moore (1946) found that when T.D.N. was limited to Morrison's maximum requirements, the body weight loss would be great. Investigations by Thomas et al. (1949) show that the thyroprotein-treated cow should receive 125 percent of her daily requirements if she is to maintain her

normal body weight.

Observed harmful effects of thyroprotein

One of the largest investigations with thyroprotein feeding was carried out by Blaxter (1946) on farms in England. He noted that when effective doses of thyroprotein were fed, there was an increase in loss of body weight, nervousness, high respiration rates, exophthalmia and diarrhea. These abnormalities were found in greater frequency in the cows that gave the greatest response in milk production. In working with large doses of thyroprotein in sheep, Blaxter (1948a, 1948b) noted a decreased digestibility of the ration, negative nitrogen balance, negative calcium and phosphorus balance, increased heart rate and heart size, decreased body weight, increased respiration rates, decreased tidal air volume, increased sensitivity to high environmental temperatures.

Throxine injection into milking cows by Owen (1948) resulted in an increase in urine volume and feces that were more moist than in the untreated animals. Blaxter (1945b) reported that when cows were treated with 50 grams of thyroprotein they became very irritable; one cow exhibited muscular tremors and twitchings, three of the four cows on treatment exhibited sweating and a tired feeling and wanted to lie down during the milking period. Distinct swelling of the udder was observed when the cows were maintained on a 50-gram level. Reports by Thomas et al. (1954)

show that cows on a 15-gram dosage of thyroprotein tend to be too tired to eat hay.

In feeding thyroprotein to dairy calves, Millen et al. (1948) noted abnormally high respiration and pulse rates, high temperatures, some diarrhea and slow body weight gains. Investigations by McQuillan (1948), Blaxter (1945b, 1946) indicate that the animals fed thyroprotein were more nervous and easier to excite than nontreated animals. In a 3-year study, Leech and Bailey (1953) found that cows on a 15-gram per day dosage level had shortened lactation periods, increased digestive disturbances, and increases in incidences of milk fever and grass tetany. It would appear from the literature, that when thyroxine, thyroid, or thyroprotein is given to dairy cows, they exhibit characteristics of a hyperthyroid animal. At adequate dosage levels, the physiological functions of body metabolism are increased which include respiration, pulse rate, milk production, a decrease in body substance, and in some cases, increased rectal temperature.

Tranquilizing Drugs on the Behavior of Animals

In recent years, there has been an increased interest in the use of tranquilizing drugs as agents for the reduction of anxiety, tension, excitement, fear, and aggressiveness in both human and animal patients. The

information concerning the effects of tranquilizers on patterns of animal behavior is limited. The review of literature presented here, deals with two specific tranquilizers, prephenazine and reserpine, and their effects on animal behavior.

Prephenazine (Trilafon)

Prephenazine is a relatively new tranquilizer marketed by the Schering Corporation and sold under the label of Trilafon. The chemical name for this drug is 1 - (2 - hydroxyethyl) - 4 - [3 - 2 (chloro - 10 phenothiazinyl) - proplpiperazine₇.

Perphenazine is an extremely potent drug, a chloro-promazine derivative, which is of phenothiazine origin. This tranquilizer, according to Young (1958), apparently acts upon the midbrain by altering the transmission of nerve impulses enroute to the higher cortical centers. Since most behavioral activity requires coordination of several centers of the brain, altered transmission of any impulse may change or eliminate the expected response. Young (1958) concluded that prephenazine reduced excitement, anxiety, tension, fear, and aggressiveness and caused the patient to become somewhat indifferent to environmental stimuli and thus more adaptive to its environment. This drug has also been shown by Irwin (1958) to be particularly valuable in controlling manifestations of nervousness, viciousness, and psychomotor overactivity.

Under the effects of prephenazine, the patient was still aware of his surroundings and did not lose his appetite according to Irwin (1958).

Effects on behavior. Young (1958) reported that prephenazine was different from many of the sedative drugs in that the patients showed less relaxation of muscles and thus were able to move around and resume normal activity. Crundwell (1958) reported that perhenazine was an excellent preanesthetic particularly on aged, fevered, toxic, and excitable animals and where painful conditions of surgery were to be practiced. He indicated that this tranquilizer quieted the nervous, noisy, or unruly animal and reduced the tendency of the animal to resist restraint in preparation for surgery. Crundwell (1958) also suggested that prephenazine inhibited vomiting in canine surgery and had no depressing effects on respiratory and cardiac functions as was often the case with some tranquilizing drugs. Respiration was almost invariably increased in rate and depth when prephenazine was used as a preanesthetic.

Irwin (1958) pointed out that prephenazine possessed antishock and anti-inflammatory actions which protected animals from the effects of bacterial infections, or toxins and antishock activity. Folley et al. (1958) cited examples of feeder steers shipped by railroad after being treated with 75-150 mg. of prephenazine and showed that the treated group had fewer cases of shipping fever and

considerably less loss in body weight. Walker (1958) found that feeder steers lost 3 percent less weight than the controls when treated with 160-175 mg. of prephenazine previous to shipment by rail. Folley et al. (1958) and Walker (1958) suggested that this difference in weight loss was due to the treated animals being free from fretting, excitement, stress, and fear during shipment. Bailey (1958) also reported less shipping fever in treated than in untreated feeder cattle when trucked for five hours.

Bailey (1958) pointed out that with 100 to 125 mg. doses of prephenazine per animal, cattle can be dehorned, treated for various types of teat surgery, the nervous animals broken to the milking machine, and vicious animals calmed down for foot surgery and pregnancy examinations. He also stated that for major surgery a local anesthetic was needed in addition to the regular dosage of prephenazine.

Variations in dosage levels. Shultz (1958) and Heldlund and Little (1959) found that there was a wide range in response to prephenazine when comparing different species of animals. They reported that sheep required greater doses than cattle, and swine were more sensitive to smaller doses than either sheep or cattle. High environmental temperature and excessive excitement seemed to increase the effectiveness of the dose according to Heldlund and Little (1959). They also pointed out that age

and temperament may also determine the dosage level. Younger and less aggressive animals took smaller dosage to get the desired effects. Bailey (1958) suggested that age of animal within a species appeared to be the predominating factor in determining proper dosage level for prephenazine. Snyder (1958) proposed that age, body weight, and degree of excitation should be considered when selecting the proper dosage level for prephenazine. He observed that, if the animal was old, the dosage should be decreased, while if the animal was extremely hypertensive, the dosage should be increased.

Lethal toxicity levels of prephenazine have been determined in small animals, such as mice, rats, and dogs.

The lethal dosage levels of prephenazine when administered intravenously were 37, 38, and 51 mg. per kg. in mice, rats and dogs, respectively. Oral doses required about three times these amounts in order to cause death to these animals. There were no indications as to what might be the lethal dosage levels for large animals such as cows and horses.

Reserpine (Serpasil)

Reserpine has been studied in this country since the early 1930's but it has come into use as a clinical therapeutic drug for treating schizophrenic human patients only since the middle 1950's. According to Kline et al. (1957), this drug is replacing barbiturates in the treatment of highly disturbed psychotic human patients. According to Schlittler et al. (1955), reserpine is one of a

dozen or more alkaloids isolated from the roots of a wild shrub discovered in India about 400 years ago. This alkaloid is an indole derivative with a chemical formula of $C_{33}H_{90}O_9N_2$. Further investigation revealed that the basic pharmacological action of reserpine is by a sedative hypnotic effect, antihypertensive activity, increased peristalsis and hypothermia.

Earl (1956) reported that the properties of reserpine were so unique that it could be classified separately from the other drugs normally used as sedatives. Chen et al. (1954), Plummer and Earl (1955), and McIlwain (1957), Williams and Young (1958) pointed out that the tranquilizing effects of this drug seemed to be mediated through the depression of the central nervous system. Studies by Trapold et al. (1954) indicated that one of the apparent sites of action for this tranquilizer is the hypothalamus since a lowering of body temperature has been observed when this drug was used at effective dosage levels.

Effects on behavior. Although there are isolated reports of the effects of this tranquilizer on large animals such as cattle and horses, the major studies have been with small animals and humans. In general, when high doses of reserpine were administered there was a noticeable hypnotic effect on the animal. In large animals, the legs are spread apart and there seemed to be a complete detachment by the animal from all environmental influences according

to Earl (1956). Also, when small animals were under the influence of reserpine, they could be placed in unusual positions in which they remained until they were further disturbed. All patients under the influence of this tranquilizer seemed to show only a moderate amount of interest in their environment according to Ferguson (1955) and McIlwain (1957). Under normal dosage levels, reserpine has been reported to lower blood pressure in both animals and humans as reported by Plummer et al. (1955), Schneider and Earl (1954), McIlwain (1957), and Earl (1956). Observations by Earl (1956) indicated that respiratory rate was lowered. He also noted an increased frequency of defecation with softer stools but no diarrhea was observed when the animals were on high dosage levels. In dogs, there have been reported a noticeable increase in muscular rigidity, tremors, salivation, micturition, emesis, and defecation when single doses at high levels were administered. Kahan (1955) reported that severe tremors over the whole body for two days were observed in a dog that had taken an extremely high dose of reserpine. Earl (1956) found that high doses seem to produce psychomotor disturbances, that is, rhythmic head movements in monkeys and constant chewing and swinging of the head in cattle.

In general, when reserpine was used at a therapeutic level, all animals showed a decrease in aggressiveness, and in cattle, a paralysis of the rumen. At high dosage levels,

horses showed violent colic and digestive disturbances.

Aggression on Social Organization and Behavior

Anyone who has worked with animals for any length of time has probably observed that there is a social order or organization within the group which is based on the domination of one animal by another. The object of the review of literature of this section is to bring together the information concerning the factors which are responsible for social dominance in a group and determine their effects on behavior. Studies concerning sexual behavior have been intentionally omitted from this review.

Dominance orders were discovered and recorded by Schjelderup-Ebbe (1913, 1922, 1935). Since these early reports of social organization and dominance, studies have been made in chickens by Allee (1942, 1951), Allee et al. (1939, 1940), Allee and Guhl (1942), Douglass (1944), Collias (1943), Guhl and Eaton (1953), Guhl and Warren (1946), Guhl (1949, 1950, 1951, 1958), Guhl and Allee (1944), Hale (1948), Komai et al. (1959), Masure and Allee (1934), Murchison (1935, 1936), Potter (1949), Sanctuary (1932), Schjelderup-Ebbe (1923, 1924), Vogel (1944), and Wood-Gush (1955); in elk by Altman (1952); in rats by Barnett (1951), and Grant (1958), and Hall and Klein (1942); in mice by Ginsbury and Allee (1942), Scott (1944, 1945);

in turkeys by Hale (1953); in geese by Boyd (1953); in pigeons by Masure and Allee (1934), and Vogel (1944); in dogs by James (1939) and Chambers (1956); in wild rabbits by Southern (1947); in shrews by Crowcraft (1955); in lizards by Evans (1936) and Carpenter (1960); in chimpanzees by Crawford (1942); in monkeys by Chance (1956); in wild birds by Marler (1955); in sheep by Scott (1942, 1943, 1944); in goats by Scott (1946); and Katz (1937); in cattle by Woodbury (1941), Schein and Fohrman (1955), Brownlee (1939, 1940, 1950, 1954, 1957, 1958), and Guhl and Atkeson (1959).

Marler (1955) also cites references which indicate that there is a dominance order in fish. Free (1955) found a dominance order in bees and suggested that this order probably existed in other types of insects as well. Evans (1936) and Carpenter (1960) studied the dominance order in lizards and concluded that a social hierarchy existed in other forms of reptiles as well. From these studies one may hypothesize that there exists a dominance order in almost all types of animals known to man. Since the effect of social dominance on behavior in domesticated animals is the major interest for this review of literature, our discussion in this section will be directed to that general area of interest.

According to Guhl (1953), hens are aggressive and display this trait by fighting and pecking. In a small

flock, one hen pecks all of the other hens in her pen without being pecked in return; another hen is pecked by all and pecks none. Other hens in the group may be arranged in a dominance order between these two according to the number of birds each pecks. This ranking of despotism or "bossism" forms a dominance order known as the "peck-order." Guhl (1953) pointed out that it was not unusual for this hierarchy to deviate from a straight line; that is, there may be pecking triangles and in the larger experimental flocks of chickens (10 to 25 birds) there may be minor pecking orders or groups within the flock.

Allee (1953) reported that when a number of strange birds were placed together in a pen, fights occurred by twos until each bird had engaged all others. The winner of each contest thereafter had the right to peck the loser. Some individuals gave way without fighting and others often challenged the winner repeatedly before dominance relations were settled. Definite dominance-subordination patterns become habitual, and thus the peck-order is established.

Guhl (1958) and Allee (1953) reported that male chicks established dominance-subordination relationships earlier than females. They noted that male chicks in small groups developed a peck-order at about eight weeks of age while the females developed theirs at about ten weeks.

Allee (1932) reported that as a boy on the farm, he was able to rank the individual cows into a herd order

based on the domination of one animal by another. Woodbury (1941) referred to the herd organization of cattle as a "hook-order" if the cows had horns, and a "bunt-order" if they were dehorned. He observed that in the "hook-order" the size and shape as well as the sharpness of the horns had much to do with the social rank established by the cow. In the "bunt-order" Woodbury (1941) also suggested that strength concomitant with age and development were the most important factors in aiding the cow to attain and maintain her social rank in the herd.

Investigations by Schein and Fohrman (1955) showed that a social organization existed in a herd of dairy cows and reported a number of factors which influenced social dominance relationships. A four-year study by Guhl and Atkeson (1959) showed that dairy cows did organize themselves into a dominance order of the "bunt-order" type.

Factors which may influence attainment of social status

Guhl (1953) suggested a number of factors which may be involved in the success or failure resulting from fights between birds of the same sex, breed, or species. These factors were first listed by Schjelderup-Ebbe (1935) and reviewed by Allee, Collias, and Lutherman (1939) and Collias (1944). Some of these factors are: (1) body-weight or physical strength of the individuals involved; (2) fear of one individual for another, thus the frightened opponent gives way without a contest; (3) both contestants

based on the... (1941) found... "good" and... "bad" order... the... had... suggested... that... was... main... (1952) showed... that... and... and... that... the... type...

Factors which may influence strength of social status

Paul (1957) suggested a number of factors which may be involved in the success or failure resulting from fights between birds of the same sex, breed, or species. These factors were first listed by Schjelderup-Pedersen (1955) and reviewed by Allee, Collins, and Imbrey (1948) and Collins (1946). Some of these factors are: (1) body-weight or physical strength of the individuals involved; (2) fear of one individual for another, thus one individual opposes river... of a... (3) both...

may show fear of their opponent, but the bird which recovers from fear first may win; (4) birds may differ in state of health, fatigue, or severity of molting; (5) age or its inseparable factor of skill is an advantage; (6) location of contest makes a difference, a bird fights better in its own home area; (7) even in strange surroundings, a bird is more successful in the presence of its penmates.

Some of these same factors have been observed to have an influence of attaining social dominance within other species besides chickens. Schein and Fohrman (1955) found a highly significant correlation between dominance rank in the herd and weight of the animal. They failed to show that the combination of age and weight were casually or coincidentally related to rank. They did, however, point out that age was a good index of seniority which is based on the length of time in the herd, but they suggested that aggressiveness was probably one of the more important factors in the establishment of social rank. They also pointed out that weight may be an index of strength, but agility was equally important in a contest between cows.

Guhl and Atkeson (1959) found that there was a highly significant correlation between bunt-order and body weight and seniority in a herd containing Jersey, Holstein, Guernsey, and Ayrshire cows. They reported that when young cows were introduced into the milking herd, there was the usual sparring or fighting but the older cows won the

contests, probably because they were heavier or more experienced than the newcomers.

It may be of interest to note that in the animal kingdom at maturity, the male is usually dominant to the female. In species which exist as flocks or herds, there is a division according to sex and there is a dominance order in each sex group. Altman (1952) observed that elk herds divide themselves into two dominance orders according to sex and the dominance order established within each sex group is usually based on size and age. Boyd (1953) also noted a twofold dominance order in wild geese. This dominance order was due to age and sex of the birds. Chance (1956) found that monkeys divide themselves into two dominance groups according to sex and the establishment of a dominance order here was again based on age and weight of the animal. Carpenter (1960) observed that males were dominant to female lizards and weight seemed to be the major factor for attaining and holding the highest social standing in a group.

Scott (1942, 1943, 1944, 1946) observed that age and size were the most important factors for attaining social rank in both sheep and goats. Scott (1944), while training mice to fight, found that males do not fight females. Guhl (1949) observed the same when studying dominant behavior in chickens. Chance (1956) observed that hungry male monkeys do not fight the females for the food

when food is placed in a cage after a fasting period. In contrast to these findings, Crowcraft (1955) found that the female shrews seemed to be dominant to the males except during estrus periods when they then became more receptive to the male advances. The estrus period seems to affect the aggressive action of most females and they become less afraid of their social superiors at this time. Schein and Fohrman (1955) suggested that during estrus, the sex drive in cattle superseded social organization characteristics. Under normal conditions, the subordinate animal will avoid the dominant animals, but when in estrus, she readily approaches and mounts her superiors without fear of punishment.

Social status and productivity

The advantages of high social position in a flock of chickens has been noted by Masure and Allee (1934), Guhl et al. (1945), and Allee (1953) and have been discussed for vertebrates in general by Collias (1944, 1950). In general, they observed that birds ranking high in the hierarchy had precedence at the food trough, the nest, the roost, and the dusting areas and possessed a greater freedom of the pen. Sanctuary (1932) found that hens in the upper half of the peck-order layed more eggs than those of the lower social order. Studies by Guhl and Warren (1946) showed that the most aggressive cocks have a greater

freedom to mate and thus, sire more chicks. On the other hand, the birds on the lowest position in the social order may be harassed to the point of starvation. Guhl (1953) also obtained statistically significant correlations between rank and the number of eggs produced. Also, there was a statistically significant correlation between the number of eggs produced and the frequency of feeding.

Guhl and Allee (1944) demonstrated the value of social order on a flock of hens by regularly removing a bird in longest residence and replacing it with a stranger. By this method, the members of the flock were undergoing a steady change of membership and were not given an opportunity to formalize their individual dominance relationships. They concluded from this investigation that flocks which were well integrated socially pecked less, gained more weight, consumed more feed, and laid more eggs than hens in flocks which were kept in a constant state of reorganization.

In a study of social dominance relationships in dairy cows by Schein and Fohrman (1955), the relationship between social rank and milk production was inconclusive.

Physical alteration on aggression

Hale (1948), when working with mature White Leghorn hens, performed a series of experiments to determine the effect of debeaking on social behavior. One half or more of the upper beak was removed with an electric debeaker.

In one experiment, five unacquainted debeaked hens were placed in a pen and five normal hens placed in another pen to serve as controls. Both groups of hens formed a social order in the usual fashion by fighting and bluffing. After the peck-order was established, the debeaked hens pecked one another at a considerably higher rate than the normal controls. Over a ten-day period, 58 percent of the pecks delivered by the debeaked birds were ignored by their subordinates, whereas, less than 1 percent was ignored among the controls. These results indicated that debeaking does not inhibit pecking nor the formation of a peck-order but demonstrated a decreased effectiveness of the altered beak as a means of exercising social control. A similar experiment by Hale (1948), with a larger group of birds, showed that debeaking did not alter aggressiveness, but the debeaked birds had a more difficult task of maintaining their social order. There was no indication that debeaking the birds reduced social tension. They kept on fighting to maintain their social position.

Guhl (1953) suggested that the existence of a peck-order is evidence that the birds recognized one another. He found that the recognition of hens in a pen was based essentially on the features of the head, since a subordinate bird did not avoid its superiors until the latter's head was raised and visible. Schjelderup-Ebbe (1922) reported that when the comb of a hen was turned to the other

side and bound, the hen was attacked as a stranger by its penmates, even by its inferiors. Returning the comb to its normal position restored the former social relationships. Guhl (1953) removed the comb from a hen which ranked at the midlevel in the pecking order. When returned to her pen two days later she was attacked as a stranger by all the flock. The dubbed bird returned the attack of her inferiors but avoided her superiors. From these investigations, both Allee (1953) and Schjelderup-Ebbe (1922) concluded that the head and neck of the bird, particularly the comb area, was the main feature for recognition between birds.

Woodbury (1941) observed that when a cow's horns were removed, this cow lost her high social rank because of a lack of proper defensive weapons to protect herself. Dove (1936) suggested that changing the horn from the corners of the head of a bull to the center of the head could give the animal unlimited possibilities when using the horn as a defensive weapon against natural horned animals.

Inheritance and social aggression

The extent to which certain traits in behavior are either inherited or learned has been in question for some time. Evidences by Thorpe (1948) suggest that certain types of behavior may have a genetic background. Fennell (1945) found that in fighting, gamecocks were shiftier, faster and less clumsy than domestic cocks. He also noted

differences among varieties of gamecocks in their methods of attack. Breed differences in fighting behavior were also reported by Potter (1949).

Guhl and Eaton (1948), when studying the problem of the inheritance of aggression in White Leghorns, concluded from their results that the evidence for the inheritance of aggressiveness was inconclusive. Komai et al. (1959) studied six strains of four breeds of chickens and concluded that social aggression appeared to be genetically variable enough within strains to allow selection for these traits. He found that social standing for six strains had a repeatability of 0.85 which indicated that differences in aggression among strains were largely determined by hereditary differences.

Hall and Klein (1942) found that aggressiveness in rats seemed to be a very stable trait. Rats bred for aggressiveness were found to be more aggressive than those selected for timidity. They concluded that inheritance did play an important role in the aggressiveness of rats.

Hale (1953), when studying mating behavior and aggressiveness in turkeys concluded that they could select strains which were more sexually active and less aggressive than is normally found in unselected flocks.

James (1939) concluded that genetics played a great role in aggression in dogs and that some breeds have been bred to exhibit aggressive behavior.

EXPERIMENTAL PROCEDURE

A total of 13 trials were carried out to determine the effect of certain management practices on the order in which cows entered the milking parlor. The Brown Swiss and inbred Jersey herds owned by Michigan State University were used for this study. Both herds were housed in a loose housing system and milked in milking parlors. Each herd was fed, housed, and milked as a separate unit. Previous to milking, both herds were penned in a separate holding area, and two cows entered each time the parlor door was opened. In the normal milking routine, the cows were fed concentrates in the parlor, the udders were washed with warm water, and the strip cup was used to check for abnormal milk. The order in which each cow entered the milking parlor was recorded at each milking for three years with the inbred Jerseys and for eleven months with the Brown Swiss herd. The weekly entrance order rank was calculated by adding the entry order of each cow for the 14 milkings each week. The cow with the lowest total entry score was ranked first and the next lowest second, until all of the cows were ranked.

Feeding Concentrates and Parlor Entrance Order

Several trials were conducted in which the concentrates were fed at different times before or after milking.

Feeding concentrates previous to parlor entrance

The purpose of this trial was to determine whether the feeding of the concentrate mix previous to the milking process and not feeding the concentrate mix in the parlor would alter the order of the cows entering the milking parlor.

In this trial twelve Brown Swiss cows were selected and paired according to their stage of lactation, age, and on their known rank as determined by their previous order of entering the milking parlor. All of the cows had freshened within 150 days. The two groups were designated as Experimental and Control. The Experimental group was fed concentrates twice daily in a straw shed which was isolated from the herd. After this group had consumed their concentrates they were let back into the barnyard to mingle with the herd previous to being put in the holding area in preparation for milking. The cows in this group were allowed to enter the parlor but no concentrate was fed to these cows in the milking parlor during this trial. The Control group was handled, fed, and milked in the usual manner. This trial was continued for four weeks. The order in which the cows entered the milking parlor both night and morning was recorded for all cows in the herd as was true with all previous and subsequent trials. The weekly ranks of the two groups of cows were compared to see if feeding previous to milking affected the order in

which they entered the milking parlor.

Feeding concentrates once daily after milking

The object of this trial was to determine whether the time and place of feeding the concentrates had any effect on the parlor entrance order of the cows included in this study.

Six Brown Swiss cows previously designated as the Experimental group were fed the full day's ration of the concentrate mix in an isolated shed after the morning milking. They were allowed to enter the parlor to be milked but the concentrate mix was not fed to these cows in the milking parlor at any time during this trial. This trial was continued for 3 weeks and the entrance order for the Experimental group was compared to their entrance order for the three previous weeks.

Feeding concentrates every other day

The primary object of this trial was to determine whether the place and interval between concentrate feedings had any effect on the order of cows entering the milking parlor.

Six Brown Swiss cows known as the Experimental Group were fed a two day's ration of a concentrate mixture in the milking parlor. This experiment was carried on for two weeks, and their entrance order during this trial was compared with their previous two-week period.

Milking Practices and Entrance Order

Two trials were conducted to determine whether the interval between milkings would have an effect on the order in which the cows entered the milking parlor.

Milking once daily and entrance order

This trial was carried out in order to determine whether the cow pushed to the head of the milking line and entered the parlor ahead of her mates because of an assumed increase in udder pressure.

Four Brown Swiss cows were selected that were in relatively high production and were milked once daily at the morning milking. The purpose was to build up the internal pressure of the udder. At the evening milking when the experimental cows were not milked they were allowed to enter the parlor but not allowed to enter the milking stall. The mean parlor entrance order rank of these cows was compared to 14-day periods pre- and post-experimental. Also, the mean rank and standard deviation were calculated for the A.M. and P.M. milkings.

Time of milking and entrance order

The hypothesis was made that the internal pressure of the udder of a cow caused her to push ahead of her stable mates and thus enter the parlor toward the head of the line. This experiment was carried out to test this hypothesis.

Four different Brown Swiss cows were selected from the herd that were in high production and ranked among the first few cows to enter the milking parlor. Those four cows were fed and milked in an adjacent milking parlor and returned to the Brown Swiss herd previous to the regular milking period. They were allowed to mingle with the herd previous to being penned in the holding area. The experimental cows were allowed to enter the parlor but not permitted to enter the milking stall or eat any concentrate in the parlor during this two-week trial. The mean entrance order rank for this period was compared to 14-day pre- and post-experimental periods.

Thyroprotein Feeding and Entrance Order

Two trials were conducted to determine whether the feeding of thyroprotein would alter the entrance order of the cows entering the milking parlor. These two trials were carried out using two levels of thyroprotein treatment.

Feeding 15 grams of thyroprotein and entrance order

The hypothesis was made that since thyroprotein was a metabolic stimulant the feeding of this product would cause an increased aggressiveness and alter the order of the cows entering the parlor. The purpose of this trial was to test this hypothesis.

In late May the Experimental group of Brown Swiss cows was fed 15 grams of thyroprotein daily, mixed with their regular concentrate mix which was fed in the milking parlor during the milking process. Respiration rates and rectal temperatures were recorded two hours before the evening milking for both the Experimental and Control groups of cows to determine if the thyroprotein-treated cows were responding to the stimulatory treatment. This trial was continued for two weeks. The entrance order rank of the Experimental and Control groups were compared to determine whether there was a significant change in their entrance order during the treatment period. Comparisons were made of the Experimental cows using a change in rank from a previous two-week period as the criteria for change in entrance order.

High thyroprotein level and entrance order

The primary purpose of this experiment was to ascertain whether high levels of thyroprotein would change the entrance order by stimulating appetite and thus cause the cows to enter the parlor ahead of their normal order.

Four other Brown Swiss cows were selected which had milked more than 120 days and which had consistently entered the milking parlor near the middle or toward the end of the line. These cows were fed 15 grams of thyroprotein daily in their concentrate ration for the first

week and 30 grams daily for the second week. This trial was carried out in August and no additional concentrate was fed during this trial. This trial was continued for two weeks. Milk production response was used as the criterion for the effectiveness of the thyroprotein treatment; however, changes in each cow's rank when compared to her own 14-day pre- and post-experimental periods, were used as the criteria for change in entrance order.

Entrance Order as Affected by a Tranquilizer

The purpose of this experiment was to determine whether a tranquilizer would alter the order in which the cows would enter the milking parlor. Five cows were selected in the Brown Swiss herd on the basis of age, stage of lactation, and the rank of entering the milking parlor. Intra-muscular injections of Trilafon were administered in the muscular region of the cow's rump, about two hours before the evening milking. During the first three days of treatment 100 mg. per day was administered to each cow. For the next three days 125 mg. doses of the tranquilizer were given. All cows were milked, fed, and handled in the usual manner. The entrance order for each cow during the treatment was compared to her entrance order a week previous and a week following treatment.

The Effect of Training on Entrance Order

The purpose of this experiment was to determine whether or not the entrance order could be changed by training the cows to enter the milking parlor in a trained order. By the use of the random number technique 40 cows in the inbred Jersey herd were given an entrance order number and trained to come into the parlor in this order. The training period consisted of 25 days. In the early part of the training period the cows were called by their herd number and led into their assigned order for entering the milking parlor. Later when most of the cows had learned their order, the attendant called their herd number for the lineup. The entrance order 4 weeks prior to training was compared with the entrance order 4 weeks following treatment.

Factors Which May Affect Entrance Order

The purpose of these trials was to determine whether age, body weight, milk production, and dominance rank had any effect on milking parlor entrance order.

Age, body weight, and dominance

The hypothesis was made that age and body weight were the prime factors for determining the dominance rank in a herd of cows. This trial was carried out to determine if this hypothesis was true.

Five Brown Swiss cows ranging from $6\frac{1}{2}$ to $9\frac{1}{2}$ years of age and weighing 1460 to 1630 pounds were paired with each other using the feed pail technique. Five pails of concentrate were tied at one end of the holding area. The six cows were freed and allowed to exert their dominance characteristics with each other by dominating the five feed pails. With this procedure one cow, the least dominant of the group, and one feed pail was eliminated for each contest. This continued until only the most dominant cow remained. Later this system was modified and the cows were tied near each other in pairs and tested by setting a pail of concentrate between them to determine which of the pair was the dominant animal. Each pair was tested three times during each contest and repeated three consecutive days. From these results the dominance order was established.

The effect of age on dominance rank

The purpose of these trials was to ascertain whether the age of the cow was associated with the social dominance rank and parlor entrance order. Two separate trials were conducted using six Brown Swiss cows for each trial which were selected on the basis of their age which ranged from $2\frac{1}{2}$ to $8\frac{1}{2}$ years. They were tested for dominance by using the feeding pail and paired technique previously described. In the first trial each pair of cows was

live feed groups. This procedure was used, the least
dominant of the pair and one feed pair was eliminated.
For each group of six cows contained until only the most domi-
nant cow remained. After this system was modified and the
cows were divided into each other in pairs and tested by feed-
ing a pair of cows. Tests between them to determine which
of the pair was the dominant animal. Each pair was tested
three times during each contest and repeated three consecu-
tive days. From these results the dominance order was es-
tablished.

The effect of age on dominance rank

The purpose of these trials was to ascertain whether
the age of the cow was associated with the social domi-
nance rank and prior entrance order. Two separate trials
were conducted using six brown Swiss cows for each trial
which were selected on the basis of their age which ranged
from 18 to 24 years. They were tested for dominance by
using the feeding pair and paired technique previously
described. In the first trial each pair of cows was

tested three times during each contest. This procedure was repeated for eleven days and dominance order of the cows was established. In the second trial each pair of cows was tested three times at each contest for 5 consecutive days.

Social dominance and entrance order in Brown Swiss cows

The purpose of this trial was to determine whether the order of entrance into the milking parlor and social dominance among individuals was closely associated.

Three pairs of Brown Swiss cows, two from the top, two from the middle, and two from the bottom rank of the herd were selected on the basis of their parlor entrance order rank. Each pair was tested three times during each contest. These contests were repeated eleven times during each contest and the cows were ranked according to their dominance.

Social dominance and entrance order of inbred Jerseys

The purpose of this trial was to determine whether social dominance in the inbred Jersey herd of cows was associated with their entrance order.

In this trial ten inbred Jersey cows were selected which had been in the milking herd continuously for two or more lactations during a time when entrance order was being recorded. Only 13 cows in the herd met this requirement. They ranged in age from 5 to 12½ years and their entrance

order rank ranged from 3rd to 24th. These 10 cows were paired for similar entrance order rank. The feed technique using paired cows at the feed pail previously described was used to determine the dominance of one animal over another. Each cow was paired with each other cow in the group for a total of 45 paired observations. Each of the 45 possible pairs of cows contested the feed pail three times each day for a total of 5 days. This means that 675 such contests were used to determine the dominance rank of the 10 selected cows.

RESULTS AND DISCUSSION

The results obtained in 13 trials concerning techniques used in attempts to alter the milking parlor entrance order of dairy cows and a discussion thereof will be presented under six main headings as outlined in the experimental procedure:

- (1) Feeding Concentrates and Entrance Order
- (2) Milking Practices and Entrance Order
- (3) Thyroprotein Feeding and Entrance Order
- (4) Entrance Order as Affected by a Tranquilizer
- (5) The Effect of Training on Entrance Order
- (6) Factors Which May Affect Entrance Order

Feeding Concentrates and Entrance Order

Three trials were conducted to determine whether the feeding of the concentrate mixture to the cows at various times previous to, or following the milking process, had any effect on the order in which the cows entered the milking parlor.

In Table 1, data are presented which show the mean entrance order of 12 cows in a herd of 25 which are described in the procedures. The Experimental group received their concentrate mixture previous to the time of milking and were not fed in the parlor. Even though there are minor changes in the ranks of both groups of cows, these

TABLE 1

The Effect of Feeding the Concentrate Mixture Previous to Milking, on the Milking Parlor Entrance Order

Cow No.	Mean Entrance Order	
	<u>14-day Pre-expt. Rank*</u>	<u>24-day Expt. Period Rank*</u>
<u>Expt. Group</u>		
3021	3	5
3008	19	22
379	11	13
3002	8	14
3035	15	15
3034	20	21
<u>Control Group</u>		
387	5	4
3031	17	16
3019	13	12
3010	15	17
3022	1	1
3036	10	9

* This rank is an average entrance order for each cow in a herd of 25 cows.

There was no significant change in the entrance order rank in either the Experimental or the Control group when a 14-day pre-experimental period was used for comparison.

changes were not significant for either the Experimental or the Control cows when compared to their mean entrance rank for a previous two-week period.

The data for a second trial are presented in Table 2 which indicate the effect of feeding a concentrate once daily on milking parlor entrance order. In this 21-day trial the mean entrance order rank was not significantly different from the mean rank for a 21-day pre- or post-experimental period.

TABLE 2

Milking Parlor Entrance Order Rank Resulting From Feeding Cows a Concentrate Mix Once Daily, After the Morning Milking

Cow No.	Mean Entrance Order		
	Pre-expt.*	Expt.*	Post-expt.*
	Period	Period	Period
	Rank	Rank	Rank
3021	6	6	8
3008	19	21	18
379	10	9	7
3002	11	15	10
3035	18	19	20
3034	17	18	18

* 21-day periods.

Means are not significantly different.

In another trial the same group of cows were fed a concentrate mix once every other day to ascertain whether

this practice would affect the order in which the cows entered the milking parlor. The data presented in Table 3 indicate no significant difference in the mean entrance rank when comparing the experimental period with 14-day periods pre- and post-experimental, or when comparing the Experimental group with their Control group.

TABLE 3

The Observed Milking Parlor Entrance Order of Cows Fed
A Concentrate Mix Once Every Other Day, And
Their Controls Which Were Fed Twice Every Day

Cow No.	Mean Entrance Order		
	Pre-expt.*	Expt.*	Post-expt.*
	<u>Period</u>	<u>Period</u>	<u>Period</u>
	Rank	Rank	Rank
<u>Expt. Group</u>			
3021	8	6	7
3008	21	22	21
379	9	8	8
3002	15	10	15
3035	19	23	21
3034	18	18	17
<u>Control Group</u>			
387	5	5	3
3031	20	17	18
3019	13	11	13
3010	14	15	16
3022	2	2	3
3036	7	9	9

* Mean rank for 14-day periods.

Means are not significantly different from each other.

The data taken from three trials and presented in Tables 1, 2, and 3 indicate that the entrance order of the cows in these trials was not changed significantly by feeding a concentrate mix at different times before or after the milking process.

Milking Practices and Entrance Order

The object of these two trials was to determine whether milking the cows at different times and intervals had an effect on their milking parlor entrance order. The data presented in Table 4 were taken from a trial where four cows were milked and fed in another milking parlor in an adjacent barn, previous to the regular milking period for the herd. These cows were then returned to the herd, penned in a holding area, and allowed to enter the milking parlor at the regular milking period, but were not allowed to enter the milking stall at any time during the experiment. The data presented in Table 4 indicate a significant difference in the mean entrance order when comparing 14-day experimental period with the 14-day pre- and post-experimental periods.

The data presented in Table 5 show the mean entrance rank and standard deviations of four cows that were milked and fed once daily in the A.M. but not fed or milked in the P.M.

TABLE 4

The Milking Parlor Entrance Order Resulting from Milking,
And Feeding A Concentrate Mix Previous To
The Regular Milking Period

Cow No.	Mean Entrance Order		
	Pre-expt. Period	Expt. Period	Post-expt. Period
	Rank	Rank	Rank
3012	6*	14*	5*
3022	2	9	10
3030	5	10	6
3037	1	2	1

* Each figure represents a mean of 28 observations for 14 days on each cow.

Difference in means are significant at the one per-cent level of probability.

TABLE 5

The Mean Rank and Standard Deviations of Cows Fed and
Milked Once Daily in the A.M. But Not Fed
And Milked in the P.M.

Cow No.	Milking	Mean* Rank	Standard Deviation
380	A.M.	12.7	5.28
	P.M.	8.7	8.08
3021	A.M.	9.0	2.67
	P.M.	10.5	3.20
3031	A.M.	7.4	6.75
	P.M.	17.0	6.99
3015	A.M.	15.0	3.55
	P.M.	12.6	3.79

* Each figure represents a mean of 14 observations for each A.M. and P.M. on each cow.

The A.M. and P.M. mean ranks are not significantly different.

Discussion

The data in Table 4 suggest that when cows are milked and fed previous to their normal daily milking period, they significantly changed their milking parlor entrance order. One possible explanation for this decline in entrance order, which was exhibited by all four cows, is that when the cows were milked previous to their normal milking routine, there was a decrease in the internal pressure in the udder. This decline in udder pressure could have relieved the udder stress, and thus removed the stimulus for entering the parlor in the usual order. Likewise, the change in location of the milking process from where the cows were normally milked may have altered the normal stimulus for entering the milking parlor in their usual order. Perhaps the vigorous rubbing of the udder during the cleaning procedure and previous to milking gives the cow a great feeling of well being that man has failed to recognize. The same milker milked the cows in the adjacent barn that normally handled and milked the cows in their regular routine. This milking and udder massage may have lessened or modified the stimulus for the cows normal entry into the milking parlor.

The data presented in Table 5 were taken on cows that were near the end of their lactation and thus the theoretical increase in the internal pressure of the udder was not sufficient to cause an increased stress and cause

Discussion

The data presented in Table I are taken from the
and the present study. The data are presented in Table I
almost identical. The data are presented in Table I
The possible cause of the difference between the two
which was not observed in the present study. The
were mixed. The data are presented in Table I
was a difference between the two studies. The
decline in the present study. The data are presented in Table I
stress. The data are presented in Table I
in the present study. The data are presented in Table I
mixing. The data are presented in Table I
have shown that the data are presented in Table I
factor in the present study. The data are presented in Table I
of the subjects. The data are presented in Table I
mixing. The data are presented in Table I
has failed to be mixed. The data are presented in Table I
the adjacent data have normally mixed and mixed. The data are presented in Table I
in their respective positions. The data are presented in Table I
may have occurred or modified the stimulus for the data. The data are presented in Table I
and entry into the mixing period. The data are presented in Table I
The data presented in Table I are taken from the
that were near the end of their incubation and from the
theoretical interest in the thermal processes of the data
was not sufficient to cause an isolated stress and cause

them to push toward the head of the milking line. Although there was some change in the entrance order, these changes were not statistically significant. It should be pointed out that there were wide individual deviations on entrance ranks. This seems to be characteristic of some cows that do not seem to follow a normal established pattern, while others do.

Feeding 15 Grams of Thyroprotein and Entrance Order

Two trials were set up to determine whether thyroprotein feeding would change the order in which the cows entered the milking parlor. The data in Table 6 show the mean entrance rank of six cows for an experimental period of 14 days compared to 14-day pre- and post-experimental periods when 15 grams of thyroprotein were fed to each cow.

During this trial 15 grams of thyroprotein were fed each day to the experimental group. The control group was composed of cows of the same age, stage of lactation, and similar entrance order as the experimental cows. The data presented in Table 7 show the mean weekly rectal temperatures of the experimental and control cows. Rectal temperatures, respiration rates, and milk production were used as a criteria for thyroprotein stimulation.

TABLE 6

The Observed Milking Parlor Entrance Order of Cows
Fed 15 Grams of Thyroprotein Daily

Cow No.	Mean Entrance Order		
	Pre-expt. Period	Expt. Period	Post-expt. Period
	Rank	Rank	Rank
3021	8*	8*	8*
3008	20	23	20
379	13	9	15
3002	9	14	9
3035	21	17	21
3034	2	1	6

* Each figure represents a mean of 28 observations for 14 days per cow.

Means are not significantly different.

Milk production records were kept on the cows fed 15 grams of thyroprotein. Weekly production data are presented in Table 8.

TABLE 7

The Effect of Feeding 15 Grams of Thyroprotein on
Rectal Temperature and Respiration Rate

Cow No.	Mean Rectal Temperature Degrees F.	Mean Resp. Rate Resp./min.
<u>Expt. Group</u>		
3021	101.81*	34.3*
3008	101.75	33.0
379	101.70	27.1
3002	101.55	30.1
3035	101.95	35.8
3034	101.75	28.5
<u>Control Group</u>		
387	101.70	26.1
3031	101.68	28.8
3019	101.96	33.3
3010	101.55	32.3
3022	101.83	29.8
3036	101.70	31.1

* Each figure represents a mean of six observations. The means for these groups are not significantly different from each other for either the respiration rates or the rectal temperatures.

TABLE 8

The Effect of Feeding 15 Grams of Thyroprotein
on Milk Production

Cow	Milk Production in Pounds Per Week			
	Week Previous to Treatment lbs./wk.	First Week of Treatment lbs./wk.	Second Week of Treatment lbs./wk.	Week Following Treatment lbs./wk.
3021	133.6	146.4	152.8	160.6
3008	145.4	173.9	164.9	132.1
379	141.3	150.9	177.2	173.8
3002	255.8	300.8	328.0	314.9
3035	212.4	247.7	284.5	266.2
3034	203.0	213.5	242.8	246.5
Total	1091.5	1233.2	1350.2	1294.1
Percent Change From Pre-treatment		+11.3	+12.3	+11.8

A second trial using 15 grams of thyroprotein for each cow per day during the first week and 30 grams during the second was conducted to determine whether amounts greater than 15 grams per cow per day would have any effect on the parlor entrance order rank.

The mean entrance order rank for a 14-day trial and for pre- and post-experimental periods of two weeks are shown in Table 9.

TABLE 9

Milking Parlor Entrance Order Observed When Cows Were
Fed 15 and 30 Grams of Thyroprotein Daily

Cow No.	Mean Entrance Order		
	<u>Pre-experimental*</u> Rank	<u>Experimental*</u> Rank	<u>Post-experimental*</u> Rank
3002	20	20	19
3018	15	16	13
3014	18	17	16
371	16	11	12

* Each figure represents 14 days and 28 observations.
No significant difference between means.

Milk production records were kept on the cows receiving 15 and 30 grams of thyroprotein. Table 10 shows the variation in production for the various weeks under consideration.

TABLE 10

Milk Production by Weeks of Cows Fed 15 and
30 Grams of Thyroprotein Daily

Cow No.	Week Previous to Treatment lbs./wk.*	First Week of Treatment lbs./wk.*	Second Week of Treatment lbs./wk.*	Week Following Treatment lbs./wk.*
3002	249.6	251.5	271.5	247.4
3018	455.6	475.2	522.5	529.1
3014	452.0	477.8	535.1	521.3
371	372.6	407.6	459.7	465.0
Total	1529.8	1612.1	1788.8	1762.8
Percent Change From Pre-treatment		+10.5	+11.7	+11.5

* Pounds of milk per week.

Discussion

The data presented in Tables 8 and 10 indicate a 10 to 12 percent increase in milk production when either 15 or 30 grams of thyroprotein were fed per cow each day. Although the roughage intake was not measured, there was no noticeable change in the roughage available to the cows during the period of these trials. Also, there was no change in the amount or quality of the concentrate mix.

One possible explanation for the lack of an increase in rectal temperature and respiration rate was that the environmental temperature during the warmest part of the

day seldom exceeded 80° F. during the time that these data were taken. Labored respiration and increased rectal temperature would not normally be expected since cattle can readily eliminate their excess body heat at this environmental temperature.

The data presented in Tables 6 and 9 indicate that at the 15 and 30-gram level of thyroprotein feeding, the cow's appetite and milk production may not have been sufficiently stimulated to cause her to seek a more advanced position in the milking order.

Entrance Order as Affected by a Tranquilizer

The purpose of this trial was to determine whether a tranquilizer would affect the animal to the extent that her order of entering the milking parlor would be altered. The data presented in Table 11 indicate the change in weekly entrance order when comparing the week on treatment with a seven-day period, pre- and post-experimental. The data in Table 12 indicate the response in milk production when a tranquilizer was used.

Milk production records were recorded for the cows on the tranquilizer treatment. The data found in Table 12 show the weekly production level for each of the cows on treatment and the percent change in milk production from the pre-experimental period.

TABLE 11

Milking Parlor Entrance Order of Cows Injected
With A Tranquilizer

Cow No.	Mean Entrance Order		
	<u>Week of Pre-Treatment Rank</u>	<u>Week of Treatment Rank</u>	<u>Week of Post-Treatment Rank</u>
3036	2*	1*	4*
3037	4	4	2
3038	6	15	8
3031	1	6	11
3034	3	2	1

* Each figure represents a mean of 14 observations for each cow per week.

No significant difference between means.

TABLE 12

The Effect of a Tranquilizer on Milk Production

Cow No.	Pounds of Milk Per Week		
	<u>Week Previous to Treatment lbs./wk.</u>	<u>Week of Treatment lbs./wk.</u>	<u>Week Following Treatment lbs./wk.</u>
3036	238.2	234.6	230.9
3037	184.5	174.4	172.1
3038	226.9	217.8	203.1
3031	192.0	191.4	185.5
3034	216.5	224.0	197.2
Total	1058.1	1042.2	988.8
Percent Change From Pre-Treatment		- 1.5	- 6.6

Discussion

The data presented in Table 11 reveal no significant change in the order in which the cows entered the milking parlor when injected with a tranquilizer two hours previous to milking. The effect of a tranquilizer on milk production is shown in Table 12. Although there was a small percentage difference in the general decline in production during the treatment period compared to the week following the tranquilizing treatment, this difference was not statistically significant.

The Effect of Training on Entrance Order

The object of this trial was to ascertain whether cows could be trained to come into the milking parlor in a specific order and if this order would be maintained after the training period was completed. The data in Table 13 show the trained order, the mean entrance order rank for a four-week period previous to the training period, and the mean entrance order rank for a four-week period following the training.

Discussion

During the training period an attendant was stationed at the entrance to the milking parlor to call out the cow's barn number and to discourage the more aggressive

TABLE 13

The Effect of a Trained Order on the Milking
Parlor Entrance Order

Cow No.	Mean Entrance Order		
	<u>4-Week Pre-expt. Rank</u>	<u>Trained Order (Experimental) Rank</u>	<u>4-Week Post-expt. Rank</u>
75	11	1	4
54	18	2	16
42	5	3	5
82	22	4	19
13	30	5	23
65	15	6	18
45	19	7	32
69	14	8	15
60	31	9	24
84	25	10	20
30	28	11	22
5	24	12	29
71	3	13	3
37	6	14	2
64	12	15	12
72	16	16	8
76	20	17	21
80	17	18	6
47	13	19	17
86	21	20	26
24	27	21	30
73	4	22	14
50	8	23	9
78	9	24	13
83	26	25	28
74	2	26	10
67	23	27	25
40	7	28	7
77	29	29	31
53	10	30	11
81	1	31	1
14	33	32	33
85	32	33	27

Entrance order was not significantly changed.

cows from entering before their assigned order. Between the 10th and 15th day of the training period, the cows began to respond to a call of their barn number and came to the entrance of the milking parlor when called. About 70 percent of the herd responded when called by the 15th day. Approximately 15 percent of the cows at this time found their places in the trained order without being called. There were, however, approximately 15 percent of the herd that would not respond to a call of their barn number, nor did not seem to care when they entered the milking parlor.

By the 25th day of training, the cows in the first one-third, middle third, and the last one-third of the herd would enter the milking parlor in their respective groups but could not be depended upon to always maintain their trained order. When the attendant was not present at the entrance of the milking parlor, the trained order seemed to disappear and the more aggressive cows entered first. These observations would seem to indicate that the more aggressive cows enter the parlor first and thus aggressiveness has an important influence on social organization in a herd of cattle.

The data presented in Table 13 indicate that although the cows were trained to enter the milking parlor in a specific order for 25 days, this training had little effect on their subsequent entrance order.

Factors Which May Affect Entrance Order

The purpose of these trials was to determine whether age, body weight, milk production, and dominance rank had any affect on the entrance order of the cows into the milking parlor. An effort was made to determine what factors were associated with the expression of social dominance.

The data presented in Table 14 show the ranks by weeks for each cow in the Brown Swiss herd, for a 44-week period. This table is presented to demonstrate the consistent mean order in which each cow entered the milking parlor each week. The same consistent week-to-week entrance order was observed with the inbred Jersey herd. One cow was observed to enter the milking parlor first for 80 consecutive weeks in a herd of 30 or more cows.

Thirteen Brown Swiss cows from a herd of 25 were ranked according to their known dominance rank and these data are presented in Table 15, page 82. The milk production for each cow was the actual production for the first 305 days during the time of this study. The entrance rank used in this table was the mean entrance rank for each cow for the 44 weeks of this study.

In Table 16, page 83, data are presented that were taken from a trial where 10 inbred Jerseys from a herd of 35 were selected that had been in the milking herd for two or more lactations and that had known entrance ranks.

TABLE 14

Weekly Entrance Order by Weeks for a Brown Swiss Herd
for 44 Consecutive Weeks
Part A

Cow No.	Weeks								
	1	2	3	4	5	6	7	8	9
Ranks									
387	1	2	2	3	2	1	2	4	3
380	2	1	1	1	1	6	3	2	2
3021	3	3	4	4	4	2	1	3	4
399	4	4	3	5	3	7	4	6	10
379	6	6	7	6	6	5	5	7	8
3000	5	5	5	2	5	3	6	9	5
3012	7	8	6	10	11	18	20	21	18
3031	8	15	11	17	17	13	16	13	13
3030	9	7	8	9	8	8	8	8	9
3016	10	9	9	8	7	10	9	10	11
3010	11	18*	18*	18*	18*	18*	21*	20	17
3015	12	13	12	7	9	9	10	11	12
385	13	11	10	11	12	18	19	19	19
3019	14	16	13	12	10	14	12	14	14
3008	15	12	16	16	14	15	17	17	16
3014	16	14	14	14	16	11	14	15	15
3018	17	17	15	15	13	17	19	18	18
335	18	10	17	13	15	16	15	12	20
3002						4	7	5	6
371							13*	16*	17*
3022							11	1	1
3035									7
3036									
3034									
3037									
3038									
Herd Size	18	18	18	18	18	19	21	21	22

* Dry Cow.

TABLE 14--Continued

Part B

Cow No.	Weeks								
	10	11	12	13	14	15	16	17	18
	Ranks								
387	4	5	2	5	3	7	3	3	6
380	6	1	3	2	1	2	2	2	2
3021	2	2	4	3	4	6	5	5	3
399	8	4	6	6	5	4	4	6	1
379	12	9	9	11	14	10	15	13	18
3000	3	6	5	4	Sold-----				
3012	11	12*	12*	7*	9*	3*	7*	24	5
3031	13	14	20	17	15	14	18	18	22
3030	5	7	7	9	7	5	6	7	10*
3016	10	11	10	12	10	13	9	10	9
3010	18	16	15	15	16*	16*	16*	15*	15*
3015	14	15	13	14	13	9	8	9	19
385	23	22	22	19	19	19	19	20*	23*
3019	15	20	18	13	11	15	10	12	16
3008	17	17	21	18	23	23	21	23	21
3014	16	18	16	21	18	12	14	16	13
3018	21	21	19	23	17	18	17	17	20
335	22	22	23*	23*	24*	22*	22*	23*	22*
3002	7	8	8	8	12	20	11	14	12
371	19*	19*	17*	19*	8*	17*	20*	4	7
3022	1	3	1	1	2	1	1	1	8
3035	9	13	14	16	20	11	12	19	14
3036	20	10	11	10	6	8	13	11	11
3034		20	21	21	22	21	17	16	21
3037								8	4
3038									
Herd Size	23	24	24	24	23	23	23	24	24

* Dry Cow.

TABLE 14--Continued

Part C

Cow No.	Weeks								
	19	20	21	22	23	24	25	26	27
	Ranks								
387	5	5	5	4	5	4	6	3	2
380	6	4	3	5	4	3	5	6	7
3021	7	9	7	7	6	5	7	8	6
399	3	8	9*	10*	8*	12*	11*	11*	11*
379	8	6	6	9	13	8	8	7	8
3000	Sold-----								
3012	4	2	1	3	2	6	2	5	3
3031	21	24	23	22	20	17	17	21	12
3030	9*	13*	13*	11*	10*	11*	9	10	4
3016	12	11	10	8	16*	24*	14*	12*	13*
3010	18*	16*	16	13	14	14	16	19	15
3015	14	14	14	14	11	13	15	13	18
385	23*	23*	22*	23*	24*	21*	18*	17*	25*
3019	15	17	15	15	12	10	10	15	21
3008	19	18	21	20	23	23	22	20	24
3014	17	15	19	18	19	20	19*	22*	20*
3018	22	22*	17*	21*	22*	19*	20*	23*	23*
335	24*	24*	24	17	21	16	25	18	22
3002	11	10	11	16	18	18	13	14	16
371	10	7	8	6	7	7	12	4	9
3022	2	1	4	1	3	2	3	2	5
3035	20	20	18	24	17	22	24	25	17
3036	13	12	12	12	9	9	4	9	10
3034	20	19	20	19	15	15	21	16	14
3037	1	3	2	2	1	1	1	1	1
3038					25	25	23	24	19
Herd Size	24	24	24	24	25	25	25	25	25

* Dry Cow.

TABLE 14--Continued

Part D

Cow No.	Weeks								
	28	29	30	31	32	33	34	35	36
	Ranks								
387	6	3	9	6	8	7	14	8*	15*
380	3	8	2	5	6	12	15	9	8
3021	11	6	10	8	9	5	8	13	11
399	8*	10*	19*	10*	7	10	9	10	10
379	9	14	13	16	23	22	20	22	12
3000	Sold-----								
3012	2	4	11	9	17	6	6	7	4
3031	19	16	5	15	12	11	7	4	5
3030	10	7	8	7	5	8	5	5	7
3016	15*	19*	18*	18*	18*	21*	23*	20*	21*
3010	16	15	14	14	13	16	10	17	16
3015	13	11	12	12	16	13	11	14	13
385	21*	24	24	24	22	23	24	23	23
3019	20	13	15	17	19	20	18	16	18
3008	22	20	21	23	21	24	22	24	24
3014	23*	23*	23*	21*	25*	19	21	21	22
3018	24*	21	17	19	14	15	17	15	14
335	25	25	25	25	24	25	25	Sold-----	
3002	12	12	6	11	15	17	16	19	20
371	4	17	16	13	10	9	13	12	17
3022	5	2	1	4	4	3	2	3	6
3035	18	22	20	22	20	14	12	11	19
3036	7	5	7	3	2	1	3	6	2
3034	14	9	4	2	1	4	4	2	1
3037	1	1	3	1	3	2	1	1	3
3038	17	18	22	20	11	18	19	18	9
Herd Size	25	25	25	25	25	25	25	24	24

* Dry Cow.

TABLE 14--Continued

Part E

Cow No.	Weeks								
	37	38	39	40	41	42	43	44	45
	Ranks								
387	14*	9*	14*	14*	12*	18*			
380	13	8	6	11	16*	9*	7*	6	
3021	10	10	8	6	13*	15*	12*	10	
399	6	5	7	4	5	8	8	12	
379	22	22	20	22	18*	22*	14*	17	
3000	Sold-----								
3012	8	21	4	7	6	10	16	18	
3031	4	4	10	13	9	6	1	11	
3030	9	12	5	5	4	5	5	5	
3016	19	13	12	15	Sold-----				
3010	12	11	17	16	17	13	10	15	
3015	15	14	16	17	19*	20*	19*	14	
385	24	23	23	23	23	17	20	21	
3019	18*	19*	22*	21*	22*	21*	22*	20	
3008	23*	24*	24*	24*	24*	23*	21*	22	
3014	21	18	19	19	14	16	17	16	
3018	16	15	18	18	15	12	13	9	
335	Sold-----								
3002	20	20	21	20	20	19	18	19	
371	17	16	15	12	10	14	11	7	
3022	11	17	11	9	7	7	3	3	
3035	5	7	13	10	11	11	9	13	
3036	1	1	2	3	3	2	1	4	
3034	3	2	3	1	1	3	2	1	
3037	2	3	1	2	2	4	4	2	
3038	7	6	9	8	8	6	15	8	
Herd Size	24	24	24	24	23	23	22	22	

* Dry Cow.

TABLE 15

Thirteen Brown Swiss Cows from a Herd of 25 Are
Ranked According to Their Known Dominance Order

Cow No.	Dominance Order Rank	Age Mo.	Milk Prod. (Actual) lbs.	Body Wgt. lbs.	Entrance Order Rank
371	1	114	13,740	1540	7 (10)*
379	2	102	9,850	1630	8 (11)
385	3	96	10,370	1535	13 (22)
399	4	78	11,230	1460	4 (6)
380	5	102	11,720	1520	2 (2)
3030	6	36	11,570	1190	5 (7)
3036	7	30	11,420	1270	3 (5)
3018	8	54	11,990	1320	12 (21)
3012	9	60	10,340	1490	6 (8)
3010	10	54	9,710	1340	11 (18)
3015	11	54	8,920	1550	9 (12)
3022	12	48	9,520	1220	1 (1)
3035	13	30	9,320	1110	10 (17)

* Figure in () indicates the mean entrance rank for 44 weeks for each cow in a herd of 25 cows.

The entrance ranks used in this table are the mean ranks for the two or more lactations that they were in the herd. Milk production recorded in this table for each cow was the actual 305-day production for the last year of the experiment. The dominance rank was determined by the paired,

TABLE 16

Ten Inbred Jersey Cows from a Herd of 25 Ranked
According to Their Known Social Dominance Order

Cow No.	Dominance Order Rank	Age Mo.	Milk Prod. (Actual) lbs.	Body Wgt. lbs.	Entrance Order Rank
37	1	92	10,720	1330	1 (4)*
27	2	101	8,560	1130	4 (12)
60	3	63	9,390	1070	9 (24)
13	4	150	9,150	1180	10 (25)
30	5	97	11,160	1090	8 (19)
80	6	53	9,100	1050	2 (6)
99	7	41	7,030	1090	7 (18)
50	8	70	8,860	1130	3 (11)
65	9	59	7,870	950	6 (15)
64	10	61	8,130	930	5 (14)

* Figures in the () indicate the mean entrance ranks for the last lactation during the experiment.

feed pail technique. Correlation coefficients between pairs of factors which may influence the social position in the herd are shown in Table 17.

Discussion

Observations during these trials have shown quite clearly that dairy cows organize themselves into an order for entering the milking parlor, and this order is expressed in a relatively constant pattern of behavior from

TABLE 17

Correlation Coefficients Between Pairs of Factors Which
May Influence Relative Social Position in a Herd

	Jersey Herd		Swiss Herd	
	n	r	n	r
Age: Body Wgt.	35	0.71**	25	0.68**
Age: Dom. Rank	10	-0.52	13	-0.79**
Age: Ent. Rank	35	0.30	25	-0.03
Age: Milk Prod.	35	0.55**	25	0.32
Body Wgt.: Dom. Rank	10	-0.79**	13	-0.63*
Body Wgt.: Ent. Rank	35	0.25	25	-0.04
Body Wgt.: Milk Prod.	35	0.58**	25	0.28
Dom. Rank: Ent. Rank	10	0.03	13	0.42
Dom. Rank: Milk Prod.	10	-0.58*	13	-0.65**
Ent. Rank: Milk Prod.	35	0.08	25	-0.27

* Significant at the five percent level of probability.

** Significant at the one percent level of probability.

week to week. There does not seem to be a high correlation between dominance, as measured by the paired, feed pail technique, and entrance order. Correlation coefficients were calculated for two different breeds of dairy cattle. With the Brown Swiss herd the correlation between entrance rank and dominance was 0.43 while with the inbred Jersey herd it was 0.03. Neither of these correlations

were significant, however the correlation on the Brown Swiss herd approached significance.

Guhl and Atkeson (1959) reported a significant correlation between entrance order and social dominance when using the bunt-order technique as a measure of dominance. They also reported that their cows were driven into the barn and not given the choice of entering the barn at will, which may have affected the entrance order somewhat. The cows in our experiment entered the milking parlor from a holding pen and the milker exercised no control over the order in which the cows entered the parlor. Also, Guhl and Atkeson were working with a mixed herd which consisted of Ayrshires, Jerseys, and Holsteins which probably had greater variability in size and nervous temperament than the herds used at Michigan State University. These factors could have accounted for the frequency of butting and thus a high correlation between dominance and entrance order.

Correlation coefficients presented in Table 17 indicate that a high correlation exists between age and body weight and age and milk production of the cows in both herds studied. Also, there seems to be very little association between age and the order in which the cows entered the milking parlor.

Correlations between body weight and entrance rank, and milk production and entrance order are low. The heaviest, oldest, and highest producing cows tend to rank highest

in the social dominance order. Schein and Fohrman (1955) and Guhl and Atkeson (1959) have shown that body weight and age are closely associated and these were the main factors in determining social dominance in dairy cattle. These same factors have also been reported to have the most influence on determining dominance in many species of birds and wild animals.

The fact that body weight and age were not highly correlated with entry order seems to indicate that the younger cows of lighter weights were entering the milking parlor in all segments of the entry order. This also suggests that although the older and heavier cows are the most dominant, this dominance is not expressed in the milking order, or that the younger, less dominant cows ignore the butting and pushing and thus enter the parlor in the order of their own preference. Observations in these trials indicate that both explanations are correct. Careful observations of both herds indicate that some of the older, more dominant cows were content to wait until near the end of the milking order and enter the milking parlor without the usual pushing and butting. Young cows were observed to push themselves into the milking order and endure the punishment of the older cows in order to maintain their position in the milking order.

The part that habit plays in the formation of a social pattern in cattle is not known. In the experiment

reported here, young cows which have freshened for the first time do not seem to have an established pattern of entering into the milking parlor for the first few weeks after entering the herd. Apparently it takes a few weeks to establish an entry order and once this order is established it is difficult to change. Training cows for an order which is different from one already established was not successful in one of the trials reported in this thesis. How these patterns of behavior are established is not clearly understood.

SUMMARY AND CONCLUSIONS

The results of this investigation have clearly shown that dairy cows organize themselves into an order for entering the milking parlor, and this order is expressed in a relatively constant pattern of behavior from week to week.

Feeding a concentrate mixture either before or after milking did not have any significant effect on the order in which the cows entered the milking parlor. Neither did the feeding of concentrates once every other day have any effect on a change in entrance order.

Milking and feeding the cows previously to their regular milking period did significantly change the cows' entrance rank. This phenomenon can possibly be explained on the basis of a decreased intra-mammary pressure following milking which resulted in less stress to the cow, thus causing her to come into the milking line later. The milking and feeding of the cows once every two days did not change the order in which the cows entered the milking parlor.

The daily feeding of thyroprotein at both the 15 and the 30-gram levels had no significant effect on entrance rank. At the 15-gram level there was a slight but non-significant difference in rectal temperatures and respiration rates between the thyroprotein-treated cows and those not treated. The cows treated with 15 grams of thyroprotein

daily, increased in production approximately 12 percent when compared to a week previous when no thyroprotein was fed. Cows fed 30 grams of thyroprotein daily increased in milk production nearly 11 percent. Two of the cows on this treatment exhibited moderate cases of mastitis. This may account for a lack of a greater response in milk production at the 30-gram level.

Daily injections of a tranquilizer (Prephenazine) did not significantly change the parlor entrance rank of the cows in this experiment. The use of this tranquilizer did not alter the expected normal decline of the lactation curve of the cows during this treatment.

By the use of the random number technique, 40 cows were given an entrance order number and trained for 25 days to enter the milking parlor in a specific order. Approximately 85 percent of the herd responded to the call of their herd number by the end of the 25th day and entered the parlor in their assigned order when called. At the end of the 25-day training period, the cows reverted back to their original entrance order that they had established previous to the training period. The results of this trial indicate that training for a period of 25 days had no appreciable effect on a permanent change in the parlor entrance order.

No significant correlation was found between entrance rank and social dominance of individuals in Jersey

and Brown Swiss cattle. The data presented in this study indicate that a high correlation exists between age and body weight and age and milk production. There seems to be little association between age and the order in which the cows enter the milking parlor. Correlation coefficients indicate little association between age and entrance rank. Correlations between body weight and entrance rank, and milk production and entrance rank, were low. The fact that body weight and age were not highly correlated with entrance order indicates that young cows of lighter weights were entering the milking parlor at all segments of the entry order.

A high negative correlation was found between body weight and dominance rank, and dominance rank and age, which indicates that older, heavier cows were the most dominant.

A low correlation coefficient between milk production and milking parlor entrance order would indicate that entrance order could not be safely used as a criterion for the selection of high-producing dairy cows.

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