

# SOCIAL DOMINANCE RELATIONSHIPS IN A HERD OF DAIRY CATTLE

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## Statement of Problem

Most people realize that if two animals are within each other's range of perception, be it visual, olfactory, tactile or other, then the behaviour of each is somewhat modified with respect to the other. Further, when two or more animals of the same species live in close proximity to each other, then there may exist a pattern of group behaviour fully as complex as the behaviour of the individuals comprising the group.

Dairymen have for years recognised the economic importance of the behaviour of their animals. Such phrases as "fidgety cows," "nervous temperament," "milk from contented cows" and the like, bear testimony to this recognition. However, few dairymen have applied deductions drawn from the actions of the individual cows to the behaviour of the herd as a group; indeed, few investigators have recognized the distinction between a group pattern and a group of individual behaviour patterns. The object of this study, therefore, is to describe a type of social organization existing within a herd of dairy cattle, and to explore the effects of this organization on the behaviour of the individuals.

Little has been reported on the social behaviour of ruminants until fairly recently, when Scott and his co-workers began series of experiments on social organization and leadership in sheep and goats (Scott, 1942, 1946). Alverdes (1935) described the behaviour of herds and packs, with particular emphasis on sex and mating behaviour in many species of free-living mammals but made little mention of dominance relationships. More closely concerned with ruminants, Altmann (1952), noted organizational trends in the social behaviour of free living elk. A certain amount of intensive investigation into the organization and behaviour of deer was initiated by Darling (1937), and interest in this group has continued through the years (Darling, 1952).

An understanding of dominance orders in

dairy cattle seems to have been taken for granted by Woodbury (1941) when he discussed how the rank or "hook" order of the herd changed upon dehorning the "boss" cow. Actually, the writers can find no direct reference to dominance orders in cattle prior to Woodbury's article. Dove (1936) discusses the relative merits of a one-horned cow over a two-horned cow, but no mention is made of dominance orders as such. Woodbury's conclusions (*loc. cit.*) were that the "hook" order in horned cows was largely determined by the size, shape and effectiveness of the horns; in dehorned cows, the "bunt" order was determined largely by strength and tenacity in pushing, with tenacity being a somewhat loosely defined variable. During the period from 1944 to 1948, Guhl and his co-workers (Guhl *et. al.*, 1948) started a detailed study of "bunt order" in a large dairy herd with emphasis on the physical and physiological factors affecting intra-herd relationships. Unfortunately this work was never completed, nor was any part of it published. Somewhat more recently, Hancock (1950) recognised the importance of taking "herd laws" in consideration when conducting grazing studies. In the same article, he emphasised the point by delineating the dominance order existing in his herd of ten pairs of monozygotic twins. Other than these few reports, the authors know of no intensive, large scale study of herd behaviour from a "dominance order" point of view.

## Background Information

To understand the methods used in this study, it is necessary first to have a clear picture of the management routines and herd composition at this station, and second to be generally familiar with manifestations of "normal" individual behaviour patterns. This study was conducted at the Iberia Livestock Experiment Station, Jeanerette, Louisiana, a field station owned and operated by the Dairy Husbandry Research Branch, Agricultural Research Service, U.S. Department of Agriculture.

### Management Routines

For convenience of management, the herd is divided into five major groups, each group representing a particular stage in the development or physiological state of the animal. These groups will best be understood by tracing the development of a typical animal from birth through her first lactation period.

Generally, parturition occurs on pasture; within a few hours after birth, the calf and her mother are placed together in an 11 by 12 foot stall. From this stall, the calf can neither see nor smell any other herd animal except her mother. They remain together for three days, during which time the calf receives the benefit of the colostrum, or "first milk."

Three days post-partum the calf is permanently dehorned (electrically) and isolated in a 3 by 5½ foot stall. She spends 30 days in this stall, from which she can hear others and see the heads of young calves in adjoining stalls; it is possible for two adjacent calves to nose each others' head regions.

After 30 days of age, the calf is transferred to a 5 by 11 foot stall which she will generally share with one or two other calves of about the same age. In this, the "two month stall," the calf has a little more space to romp, and can easily observe other calves up to six months of age. In addition, she can nose, sniff or otherwise investigate her stallmate or even calves in adjacent stalls.

At the age of three months, the calf is introduced into what is termed the "young group," a group of 10-15 heifers between three and six months old. The young group pen inside the barn is only about 11 by 35 feet, but it adjoins a one-quarter acre outdoor lot, with free access from inside to outside. Except for being born outdoors, this is the calf's first introduction to green grass and direct sunlight. At six months of age, she is weaned and transferred to the "middle group," which is comprised of 6 to 12 month old heifers. This group is allowed considerably more space both indoors and outdoors and the animals do a limited amount of grazing on their one acre lot. The size of this group varies from 10 to 19 animals.

When the heifer reaches one year of age, she is transferred to the "front group," which spends all of its time on pasture. This group consists of nulliparous heifers over 12 months of age plus a few dry cows which are due for breeding or calving; the average size of this group is about 35 animals, but this figure may vary from

15 to 50 animals. The front group subsists entirely on pasture herbage which is supplemented with grain-feeding during December, January and February. The heifer is bred for the first time during the first heat period observed after she is 18 months old. Breeding is strictly controlled and copulation is brief: the heifer is stanchioned in a breeding chute and after a short period of vaginal sniffing and licking, the bull will generally mount quickly and complete coitus.

About a month pre-partum, the heifer is transferred to the "wet" or milking group, which consists of all the cows in milk. This is by far the largest single group on the farm, and averages about 70 animals. During the major portion of this investigation, the wet group was made up of Jerseys and Sindhi × Jersey halfbreed cows. The young, middle, and front groups were made up of Jersey and crossbred (Jerseys with varying amounts of Red Sindhi blood) cows and heifers.

As mentioned above, parturition occurs out on pasture, and the cow spends the first three days post-partum in isolation with her calf. After the three-day isolation period, the cow is returned to the wet group and milked twice daily (at 4 a.m. and 2 p.m.) for the remainder of her lactation. A daily record of productivity, in terms of pounds of milk, is kept for each cow as long as she is in the herd. It is perhaps pertinent to note at this point that she generally will not see her calf again until the calf in turn is ready to calve more than two years later.

At the first observed heat period three months post-partum, the cow is again bred and, assuming successful conception, is therefore pregnant throughout most of her lactation. Ideally, the cow should bear a calf each year and lactate for 10½ months out of 12. The cow is dried 305 days post-partum.

When the cow is finally dry, she is transferred to the "bayou group," which generally consists of pregnant dry cows more than 30 days pre-partum. When calving time draws near, she is re-introduced to the wet group. Most animals, after bearing the first calf, spend most of their lives with the wet group and only one or two months of the year with the bayou group. As a consequence, the turnover in the bayou group is rapid and the social pattern often does not get a chance to stabilize for any period of time. Group size varies from six to 20 animals, averaging about 15 individuals.

Some cows, however, go dry in less than 305 days (some milk for as few as 100 days) and therefore they spend correspondingly longer periods of time with the bayou group. One cow was used solely for breeding purposes (a damaged udder obviated profitable milking) so that except for about 45 days at calving time, she spent the entire year with the bayou group. Occasionally to facilitate management, the bayou and front groups are combined for several months. At other times, those heifers from the front group which are not due for breeding or calving are put with the bayou group. When this is done, the bayou group contains about 25 to 35 animals, while the front group will consist of about 10-15 animals.

Briefly summarizing, it is important to recognize that the calves used in this study began their social lives (large group conditions) at three months of age; thereafter they were rarely, if ever, by themselves for any appreciable period of time.

#### **Behaviour of the Individual**

Before we can attempt to interpret group behaviour patterns, we must have a clear understanding or at least a recognition of the normal individual behaviour patterns. However, since Brownlee (1950, 1954) has already described normal behaviour patterns in cattle, the ensuing discussion will serve to emphasize only those patterns that are pertinent to aggression and social organization.

In cattle, movements that are (subjectively) termed "aggressive" generally follow a definite sequence, each phase of which the author chooses to define as follows: the *approach*, which may be active or passive; the *threat*, or "aggressive intention movement" (Tinbergen, 1952); the *physical contact* (the actual fight) which is followed by victory or defeat.

There is no need to dwell long on the point of *passive approach*, since cattle are extensive wanderers and cross each other's paths any number of times daily. Occasionally, instead of ignoring each other on passing, two cows will engage in a brief manifestation of contesting behaviour. Such contests are usually brief and often go no further than the *threat* stage; however, it is the opinion of the author that these encounters are significant and decisive. (This point will be dealt with more fully during the discussion of "group" behaviour).

*Active approach*, on the other hand, implies purposeful behaviour and as such requires

detailed description and discussion. When a cow is re-introduced to a group after an absence of several weeks or months, she is generally quickly approached and surrounded by many of the group, most of which exhibit investigatory behaviour patterns. A few cows, however, will exhibit "aggressive" behaviour (hard breathing, head lowered, slow deliberate movements, occasional pawing) and move slowly toward the introduced cow. When this aggressive approach occurs, it is fairly safe to predict that *physical contact* will occur between the two animals unless the newcomer flees; the author has termed this action the "active" approach, or "challenge" to distinguish it from the more common and casual "passive" approach. An *active approach* may be made over distances as much as 30 yards, and implies that one animal approaches another for the express purpose of carrying the fight pattern sequence to completion.

The next step of the sequence, the *threat*, can be engaged in only when the contesting animals are within about five feet of each other. In the threat, one of the contestants exhibits aggressive behaviour directed toward the other, i.e., head lowered to about halfway between the normal position and the ground, eyes directed towards the opponent, and the broad forehead on a plane perpendicular to the ground facing the opponent. Despite the fact that all animals at this station are permanently dehorned at birth, all the movements of the threat position would serve to direct the horns towards the opponent, just as if horns were present. The threatened cow has but two alternatives: she may respond by returning the threat in a similar manner (head down, etc.) whereupon direct physical combat ensues; or, more commonly, she will exhibit alarm reactions and retreat. In the alarm reaction, she will lurch out of range of the threatener, with head up, and often will direct all her activities to leaving the immediate vicinity of the aggressive cow. Commonly, a threat is a rather rapid occurrence and is easily overlooked by the casual observer.

Direct physical contact between two animals (aside from accidentally brushing against each other) involves either *butting* or active *fighting*. Frequently, the one action involves or closely follows the other, and thus they are often indistinguishable. However for the purposes of this dissertation, a distinction, perhaps artificial, is made. Butting occurs when one animal uses its forehead to direct a blow at another

animal, without any retaliatory action on the part of the struck animal. The entire episode is usually brief, since the struck animal will manifest every desire to escape from the aggressor. The butt pattern clearly follows the *threat*, since threat-position as described above is mostly concerned with readying the forehead (horns) for the blow.

Whereas butts are non-retaliated blows, fights occur when the struck cow strikes back. A fight sometimes occurs following a passive approach, but more often follows the active approach. In both instances, the fight is preceded by the threat, wherein *both* animals exhibit the threatening, aggressive position of head down, snorting, and slow deliberate movements. They may circle each other in this fashion for as few as five seconds or as much as ten minutes, with their foreheads parallel and less than about four feet apart. At some point in the circling, the fight will suddenly erupt. There will be much shifting of position for a better footing and an attempt by one or both to direct its forehead (horns) for a flank rather than a frontal attack. The animal that can successfully manoeuvre itself around the other so as to be able to hit its opponent in the side is invariably the one that will win the encounter. The flanked animal will make an effort to bring its opponent back to the frontal attack, and if this fails she will flee. When flanking attempts are unsuccessful, the opponents will bring all their weight to bear on each other through the forehead. At this turn of events, the lighter animal is clearly at a disadvantage and steadily loses ground, unless she makes up in agility for what she lacks in weight. Upon flight the defeated animal is chased or followed by the victor for a variable period of time.

A *fight* may consist of but one encounter or more commonly a series of encounters. The actual encounters do not persist for more than about one minute at a time and invariably end with one animal taking flight to regain position. The number of severe encounters will vary directly with the evenness of the match. Two well matched cows may struggle over a period of hours and even days. The interval between encounters may vary from but a few seconds to five minutes. During this interval they will often manifest grazing behaviour patterns despite the fact that the contestants are in a highly excited state; this is accompanied by the customary wandering, but all the while the

contestants are both close to and wary of each other. This particular type of diversion agrees well with what Tinbergen (1952) has termed a "displacement activity." Unsuccessful efforts have been made by the writer to try to ascertain whether the between-encounter grazing actually involves the ingestion of grass or is merely a nosing of the ground.

An interesting variation of the fighting pattern occurs when two animals are engaged in rather severe combat. Neither Guhl *et al.* (1948) nor Hancock (1950) make reference to this type of action, and for lack of any other name, the author has termed it the *clinch* manifestation of fight behaviour. In this type of activity, two closely matched contestants have been fighting for some time and one or both show signs of fatigue. They are head to head, and as described above, the more aggressive is manoeuvring for a flanking position. Suddenly, the less aggressive will let her opponent slip its head to her flank but at the same time she will turn her body so that she is standing directly alongside and parallel to the more aggressive animal. In the same "slipping" motion, she will lower her head to a position between the hind leg and the udder of the more aggressive cow, with her forehead on a plane parallel to the ground. As long as she is beside her opponent, the other cow cannot inflict a serious blow since she cannot get into position. The more aggressive animal will make every effort to orient herself perpendicular to her opponent so that she can deliver a telling blow, but she is hampered by the nose in her udder (perhaps interfering with the hind leg movement) and the fact that the less aggressive animal will slide and turn with every effort of the aggressor. The *clinch* seems to be ideal for avoiding damaging blows while pausing for a brief rest, but is not manifested very often since most of the fights are quickly decided.

The younger animals also show manifestations of contest behaviour, but the contests are more of the play-fight type without any decisive outcome (see Brownlee, 1954, for a discussion of play in cattle).

#### Analysis of Social Rank

##### Experimental Technique

Observations were routinely made of different groups in the herd (young, middle, front, bayou or wet) in such a manner that each group was observed for at least one hour each week. During the observational period, a note was

made of every contest that could be clearly discerned as such by the observer. The observer was located so that he could see most, if not all of the animals at one time, which usually involved taking a position on top of a truck in the field. Two persons commonly carried out the observations; one continually observed and called out the contests, while the other observed and recorded the contests. On some occasions the recorder could not keep pace with the contests being called out, and thus many contests went unrecorded; on other occasions, the cows were artificially stimulated to induce contesting during periods of lull. For this reason, it is felt that the actual number of contests recorded *per se* is not of much value as an index of herd excitement or even of an animal's aggressiveness. However, this point will be more fully dealt with in a later section.

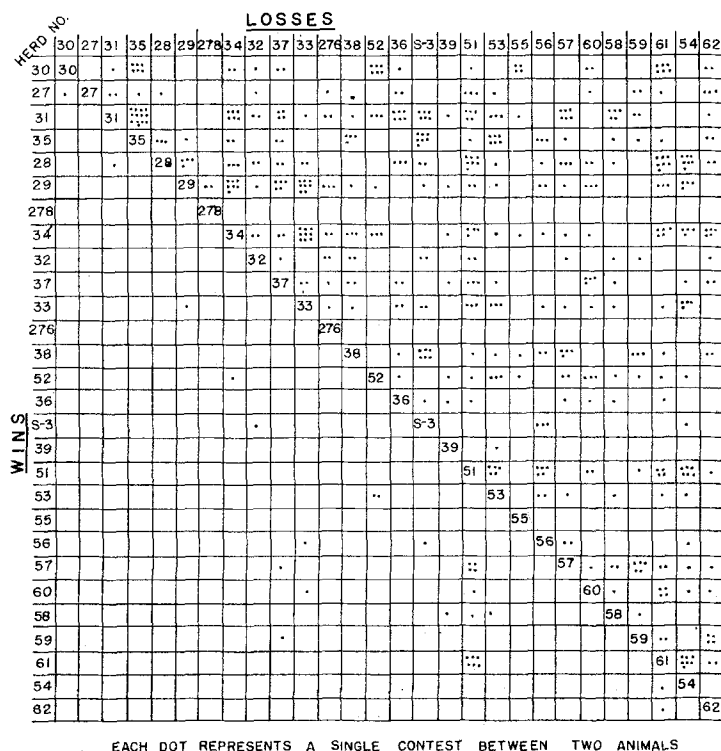
It is felt that since the animal is normally accustomed to human proximity the presence of the observer had no effect on the eventual outcome of a contest. This was confirmed by occasionally observing some of the groups from such a position whereby the animals exhibited no awareness as to the presence of the observer; the patterns of behaviour observed under these conditions were indistinguishable from those noted when the observer was in full view of the animals. Similarly, the time of day and weather conditions had no radical effect on the observed contesting behaviour. Observations were usually carried out on pasture while the groups were engaged in normal routine activities, although occasionally, a group would be moved to a new pasture to stimulate contesting behaviour.

### Herd Order

Allee *et al.* (1949) state that the "contemporary organization of vertebrate groups. . . is based on the application of three general principles: the holding of territory; domination-subordination; and leadership-followership." Organization as such implies a bond, in that the movements, behaviour or activities of each individual are not completely

independent of the others in the group. Thus, we can easily remove a paper clip from a box of clips (an unorganized group) since each unit is independent of the others. However, if the group were "organized" by fastening the clips together, we could not manipulate one clip without affecting some (in a large group) or all (in a small group) of the other clips. The ensuing discussion is based on a "domination-subordination" type of organization within the herd.

The dominance relationship between two cows can be readily ascertained from direct physical contests; to this end, close to 5,000 individual contests within the herd have been recorded by this observer. These were plotted on a large "master chart" on which was entered every animal in the herd. A section of the master chart, showing the details of the marking system, is presented in Fig. 1. Each dot represents an individual contest: by reading across the chart one can determine the victories won by an individual, while reading down would determine her defeats. For example, the chart shows (Fig. 1) that SX34 won three contests



EACH DOT REPRESENTS A SINGLE CONTEST BETWEEN TWO ANIMALS

Fig. 1. A representative section of the Master Chart.

over SX38, while she lost two contests with SX35. As more contests were recorded (and therefore more information made available), the order of the animals was rearranged in an effort to get as few dots as possible to the left of the diagonal. In this manner, the animals would automatically be arranged into what is commonly termed a straight-line peck-order, wherein the alpha, or dominant animal of the group, wins contests from all the others and loses to none; the beta animal wins from all the others except the alpha animal; the gamma animal wins from all except the alpha and beta; and so forth down the line until the omega animal is reached, this individual winning no contests and losing to all the others consistently. The terminology is that used by most workers in the field of social organization and was popularized by Allee (1942) in his work on peck order in domestic fowl. Since the particular terms apparently fit the situation in dairy cattle remarkably well, they will be used freely in the ensuing discussion.

The order is demonstrated by the chart (Fig. 1). If no order existed, then it would not be possible to arrange the chart so that more than about 50 per cent. of the dots would lie to one side of the diagonal. However, of the 4,935 contests recorded, only 248, or about 5 per cent. are to the left of the diagonal. A statistical test is not necessary, in this case, to show that this deviation from 50 per cent. is far from being merely a "chance" arrangement.

It was not possible to stage a contest between every pair of animals of the herd; indeed, this would require over 13,000 contests for a herd of 163 animals. In addition, some of the animals died or were otherwise removed from the herd during the course of the experiment. Furthermore, because of the age spread in the herd many of the older animals had never been together in the same group with the very young animals, and so physical contests were not possible. For these reasons it was necessary to assume that if Cow A dominated Cow B, and Cow B dominated Cow C, then Cow A automatically dominated Cow C (if there were no contests recorded between A and C); this assumption was used as a working rule in organizing the chart.

#### Observational Errors

Every effort was made to keep the amount of error in the observational system down as much as possible, since the errors themselves were difficult, if not impossible to track down

and correct. It is pertinent at this time to mention the three main sources of error and the methods of minimizing them.

Perhaps the largest source of error stemmed from a subjective misinterpretation of objective fact. Although the outcome of most of the contests was clearly defined, some few would be considered doubtful. To minimize this type of error, it was necessary to set strict limits on what would be recorded as a victory or defeat in a contest, as follows: if one animal showed an aggressive pattern, with lowered head or just a toss of the head while looking at the second animal, and the second animal reacted to the threat by the characteristic alarm and retreat, then the first was considered the victor in a *threat* contest between the two animals. Had the second animal merely walked away without the lurching alarm and/or retreat, then the contest would have been doubtful and not tabulated. Again, if one animal used its forehead to direct a blow at the second, and the second reacted by alarm and retreat, then the first was considered victorious in a *butt* contest between the two animals. The third and last type of clearly defined contest was the actual physical combat (described above) when one animal finally turned and fled. The rule of retreat was strictly adhered to, and in this manner the degree of subjectivity was minimized.

The next largest source of error was in mistaking the identity of a cow. It is possible by diligent study to distinguish between and "know" each animal of the herd, but even so mistakes are easily made when observing from a distance of 100 feet or more. In an effort to reduce this type of error, practically all observations were made with the aid of a trained assistant who knew the herd well, so that some cross-checking was possible. However, when a group was highly excited and unusually active, one observer was so busy recording what the other called out that he barely had time to look up from his pad; in effect, during periods of intense activity, there was no possible check on the veracity of identity, nor is it possible even to estimate the amount of error introduced.

The third source of error, equally as grave as the above two, was in the recording itself. In the press of trying to record events as quickly as they were happening when 30 or 40 animals were stirring about, it was very easy to write 211 instead of 21 or 311, or the like. During the periods of lesser activity or just after an obser-

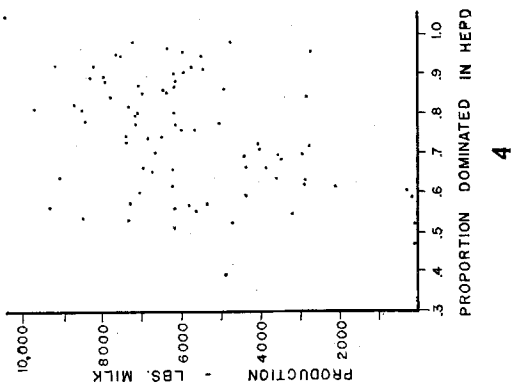
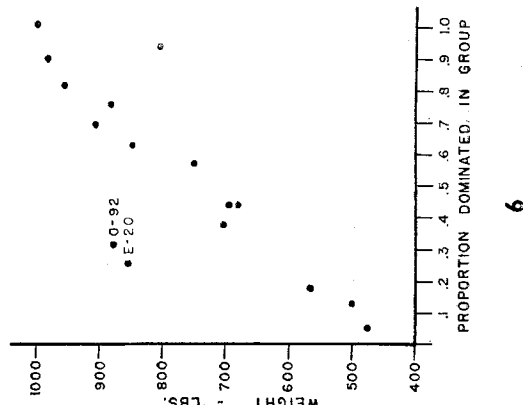
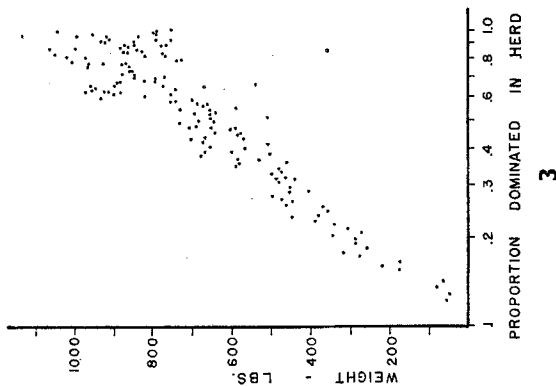
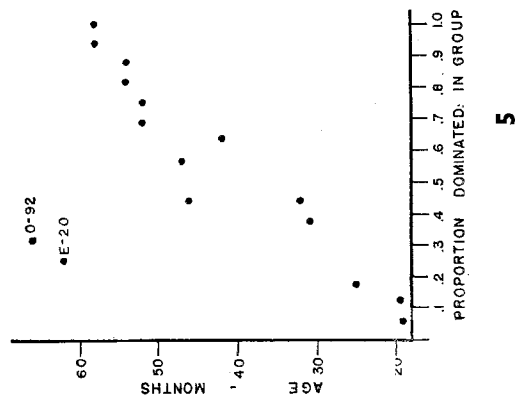
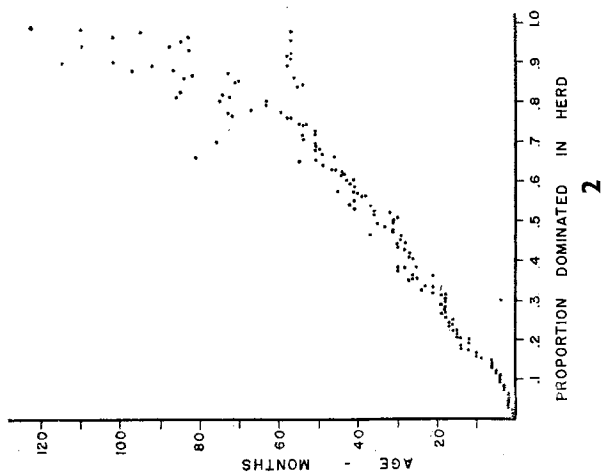


Fig. 2. The relationship between rank order and age.

Fig. 3. The relationship between rank order and weight.

Fig. 4. The relationship between rank order and milk production.

Fig. 5. Shipping group. The relationship between rank order and age.

Fig. 6. Shipping group. The relationship between rank order and weight.

vational period, the observer made an effort to check over the field notes to make sure there were no obvious errors, but still it would be impossible to estimate the amount of error from this source.

### Factors Determining Rank

In an effort to get a clearer understanding of the complex of factors which determine an individual's social ranking, the herd order was compared with the ages (Fig. 2), weights (Fig. 3) and first lactation milk production records (Fig. 4) of the animals. (In these and subsequent figures, the "rank order" of an individual refers to the proportion of the herd which she dominates). To calculate correlation coefficients it was necessary to first "normalize" the dominance rank order in the herd; this was accomplished by calculating the area under the normal curve at each rank point and then utilizing a standard table of Cumulative Normal Frequency Distributions (Snedecor, 1945).

Correlation coefficients for rank x age ( $r_a$ ) find rank x weight ( $r_w$ ) were highly significant, while that for rank x production ( $r_p$ ) was of a lower order of significance:  $r_a=0.93$ ,  $P<0.01$ ;  $r_w=0.87$ ,  $P<0.01$ ;  $r_p=0.25$ ,  $P<0.05$ . On the other hand, there seemed to be little, if any, correlation between social position and the failure to complete the full (305-day) lactation period.

The relationship between age, weight and social rank in this herd can be expressed by the following formula (determined by the method of multiple regression):

$$R=0.026 A + 1.532 \log. W - 5.422.$$

where  $R$ ="normalized" social rank,  $A$ =age in months, and  $W$ =weight in pounds.

It is impossible to determine from these data whether age and weight are causally or coincidentally related to rank. Age is a good index of "seniority" (length of time in the herd), but it does not necessarily include "aggressiveness" which is probably one of the more important factors in the delineation of social rank. By the same token, weight is used as an index of "strength", but it fails to take into account "agility", which may be equally important.

### Strange Cow Experiments

Some additional data on the relationship of age and weight to rank order were obtained by introducing two completely strange cows to various groups of cows from this station's herd. The two strange cows (O-92 and E-20)

were borrowed from the dairy herd at Louisiana State University; prior to this experiment, these cows had never had any contact with animals out of their "home" herd.

After an initial period of isolation during which they could neither see, hear nor smell any other animals, the two strange cows were introduced first to a group of 14 crossbred culls ("shipping group") and later to a group of two Jersey culls from this station's herd. The introduction of the strange cows to the shipping group was not accompanied by any violent fighting, although there was the usual amount of sniffing and threat activity; after eight days of observation the group's dominance order was determined, and the order was plotted against the ages (Fig. 5) and weights (Fig. 6) of the individuals. An examination of these figures indicates that the two introduced Jerseys are very much "out of line" with respect to age and weight, perhaps more so with age. Three weeks afterward the strange cows were introduced to two Jerseys culls from this station's herd. This time, the introduction was marked by violent and prolonged fighting. Observations made one week later indicated that a rather complex dominance order had been established within the newly formed group, as is shown in Fig. 7.

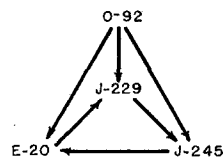


Fig. 7. Dominance relationships between 4 cows. Two cows are from the "home" herd and the other two are "strangers".

The significant lesson learned from this experiment was that the *previously established* dominance relationship between any pair of cows was not disturbed by the presence of the strangers. For example, each of the 14 cull animals in the shipping group was in relatively the same rank position with respect to the others of the "home" herd, despite the introduction of the strange cows. Similarly, J229 had always dominated J245 in the herd, and this relationship continued unchanged (Fig. 7) despite the rather complex order resulting from the introduction of the strange cows. It is interesting to note that O-92 and E-20 ranked fairly low in the shipping group, and yet *all* the animals



in the shipping group ranked below J229 and J245 in the herd dominance order.

These results indicate that although age and weight are closely correlated in this herd, they are not necessarily causally related to rank. Certainly, the data are suggestive that in normal herd management, "seniority" as depicted by age or weight, is highly associated with rank position, and that other physical and behavioural factors may play a major role at the same time.

### **The Individual as a Member of the Group**

Oestrus cycles do not materially affect the established social order, since the rank order has already been described (see above) as a relatively stable type of organization. A cow in heat is usually at a somewhat higher level of general excitement than the others of the group and is usually labelled "nervous." Instead of a normal placidity, she will spend a considerable amount of time approaching and sniffing the others (particularly in the vaginal region) without respect to their position in the social order. It is interesting to note that the sex drive of the individual supersedes organizational characteristics. Whereas under normal conditions the subordinate animal will avoid the dominants under penalty of being butted or otherwise punished, this same animal, when in heat, readily approaches her superiors in the order; even after being repeatedly threatened or chased, she will often continue her efforts to mount the aggressor. Consequently, observations made during the heat period of a cow tend to show considerably more contests involving this cow than is usually the case.

It is pertinent to mention that the maternal drive in a cow immediately post-partum seems to supersede the organizational or herd drive. Immediately post-partum, the mother rests and spends a great deal of time licking the calf, and is apparently oblivious to the rest of the group. When, in the course of normal wanderings, the group moves away, the mother stays behind with her calf and *no longer functions* as a member of the group.

Three days post-partum, the mother and calf are separated. The mother is returned to the wet group, but still manifests *maternal* rather than *organizational* drive patterns although she can no longer see nor hear her calf. She will largely ignore the group, preferring to spend her time near the milking parlour and calf barn; she is restless and bellows continually; she becomes visibly excited at the sight of any of

the human handlers. However, two or three days after the separation the maternal drive lessens and the cow returns to the group and normal organizational herd patterns.

The effect of the group on feeding behaviour, particularly grazing, has already been noted by other investigators. Hancock (1950) noted that the cows in a group grazed in unison and that the inclination to ruminate was suppressed if most of the other individuals continued to graze. He also noted that if two groups are separated by as little as a single-wire fence, they maintain separate group grazing patterns; that is, one group may be in the midst of a grazing cycle while the other group would be loafing or lying about.

It would be interesting to try to measure the strength of the grazing drive manifested by the group. Normally, grazing can be easily interrupted by the observer simply by caressing one or more of the pets; others will show curiosity and approach in an investigatory attitude. On other occasions, one cow will stop grazing and wander off toward water, and generally all the others follow, indicating that unless the cow is unusually hungry, the grazing drive is not very strong. It has already been noted above that patterns of behaviour strikingly similar to grazing are manifested between encounters in a particularly violent fight, and it was suggested that the grazing as such might well be a displacement activity. If this labelling is correct, then, according to Tinbergen's hypothesis (1951), grazing would be considered a low threshold activity; this particular point is worthy of a considerable amount of further investigation.

Barn feeding behaviour is also affected by organizational patterns, to the extent that under free group feeding conditions the higher order animals apparently get more to eat. For example, when a group of hungry cows is brought into the barn and offered hay, they will line up at the trough with much shuffling and eat as rapidly as possible. The higher order animals will not hesitate to butt or chase their subordinates away from what apparently looks like a desirable pile of hay, while the very lowest order animals spend a good deal of the feeding time searching for an opening whereby they can get to the hay. Although a quantitative measure of the amount of hay consumed in relation to the order of the animal has not as yet been undertaken, there is little doubt that the lower order animal would suffer markedly if she were

wholly dependant on trough feeding. (Calhoun, 1950, has indicated a direct relationship between the rank order in wild rats and the amount of food consumed). Apparently, "space" is the environmental factor in short supply (thereby stimulating competition) in barn hay feeding, since no spatial competition is evident in open pasture grazing. (For a more complete discussion on minimum environmental factors, see Orgain & Schein, 1953).

It is interesting to speculate as to when and how the order is established in the normal herd routine. The implication from the above discussion is that seniority plays an important role in the rank order. Therefore, barring sickness, injury or an unusual occurrence detrimental to normal calf development, it would seem that the place of each individual in the herd order is determined by the moment of birth. Furthermore, she will advance in the social scale as the older cows are removed from the group, maintaining largely the same relative position with respect to the others in the group.

Normally, intergroup shiftings are accompanied by a considerable amount of excitement and fighting as the introduced animal apparently strives to reassert her place in the overall social scale. The sole exception to this rule is an introduction into the young group, since the three months old heifer has not had any previous contact with the group, and therefore "is not aware of her place." It is interesting to note that the middle group already has a well defined order readily delineated by the observer, whereas numerous observational periods of the young group have yielded little results. In the three to six month old group, *threats* are rare and contests all seem to be of the play-fight type and therefore inconclusive, while in the middle group, *threats* and decisive contests are as common as play-fighting. Until further evidence is available, the hypothesis is proposed that the mechanism of the order is established somewhere between the late young and early middle group ages, with perhaps more emphasis on the latter.

### Summary

The object of this study has been to describe a type of social organization existing within a herd of dairy cattle, and to explore the effects of this organization on the behaviour of the individuals. Some of the ramifications of the organizational patterns are explored in an effort to trace the development of the organization.

A rather detailed description of the physical plant and management routines at the station where these studies were conducted is presented in the first section of the dissertation, so that the reader who is unfamiliar with dairy herd practices may better understand the ensuing discussion.

Aggressive behaviour patterns of the individual are also described in detail so as to afford the reader a clearer understanding of the role of the individual in the group. Such behaviour apparently follows a definite sequence, each phase of which is discussed in detail. The various links in the chain of aggression are termed: the *approach*, the *threat*, the *physical contact*, and the ensuing victory or defeat. The *approach* may be active or passive; while passive approach merely describes the chance meeting of two cows engaged in random wandering, active approach implies purposeful behaviour on the part of one or both of the animals.

Direct physical contact between two animals involves either butting or actual fighting. Butting is defined as when one animal uses its forehead to direct a blow at another without any retaliatory action on the part of the struck animal. On the other hand, fights occur when the struck cow strikes back. Commonly, a *fight* consists of a series of encounters; the actual encounters do not last for more than about a minute at a time and invariably end with one animal taking flight. The interval between encounters may vary from a few seconds to five minutes, with "displacement grazing" being the major activity between encounters. Actually, most contesting actions observed did not progress further than the *threat* stage, although these contests are considered just as decisive as if they had progressed through the *fight* phase.

Each group in the herd was observed for at least one hour a week during the course of this study. During the observational period, careful notes were kept of each animal involved in a contest, and the outcome of the contest was recorded. Close to 5,000 individual contests were recorded and were plotted on a large master chart. The pattern of wins and losses clearly indicated that the herd was organized in a straight-line peck-order very much like that previously described by workers in the field of domestic fowl.

The dominance order was compared to the ages, weight and production records of the

animals. A highly significant relationship obtained between rank and age and also between rank and weight, but the relationship between rank and milk production was inconclusive. The correlation between rank and the failure to complete a full lactation period was of a low order of significance and therefore not considered further.

In an effort to separate age and weight from seniority, two completely strange cows were introduced into a group of fourteen animals from the experimental herd. After the new group had stabilized, the dominance order was again plotted and it was found that the two introduced cows were very much "out of line" with respect to age and weight. Later, when the two strange cows were introduced to two high ranking animals from the experimental herd, the group of four set up a rather elaborate circular type of dominance order. This particular order did not show any relationship to age or weight, although it was markedly affected by the previously established relationships within the pairs of animals. Hence, it is concluded from these results that although age and weight are closely allied to the social scale pattern in the herd, they are probably not causally related. The data are suggestive that in normal herd management, seniority, as depicted by age or weight, is of primary importance in the determination of rank position. The social position of each animal is probably determined at three to six months of age, when she first encounters large group living conditions.

#### Acknowledgments

This work would not have been possible without the assistance and full co-operation of a number of people from entirely different walks of life. The author is particularly indebted to Mr. J. J. Vizinat, Dairy Husbandman, for assistance in many of the field phases of the study, and also to Dr. D. E. Davis, Johns Hopkins University, for overall direction and advice. In addition, the staff of the Iberia Livestock Dairy Station offered many helpful suggestions and criticisms, as did the staff of the Dairy Husbandry Research Branch, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.

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