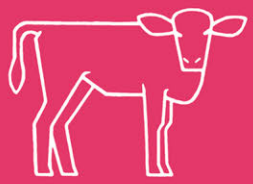
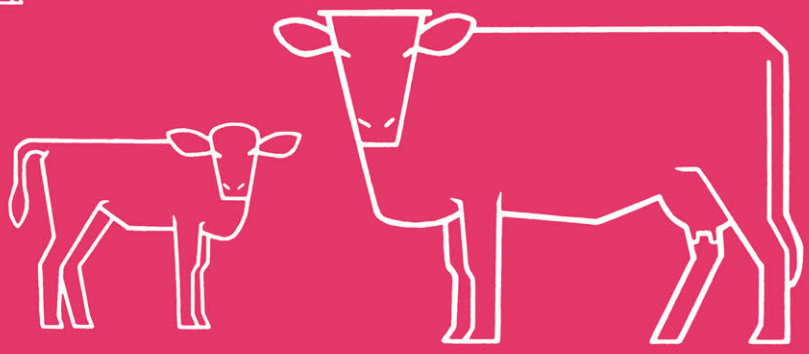
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TH 14



Marthe Kiley-Worthington
Susan de la Plain

The Behaviour of Beef Suckler Cattle

(Bos Taurus)

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Bereich und Zielsetzung

Jede Tierart, auch die der Haustiere, befindet sich in ihrer Entstehungsgeschichte in einer sie formenden Wechselbeziehung zu ihrer näheren und weiteren, belebten und unbelebten Umgebung. Dieser Prozess der Anpassung verläuft so langsam, dass er uns in der Zeitspanne unseres Lebens als statisch vorkommen muss. Die einzelnen Tiere haben vielfältige Verhaltensformen zu ihren Artgenossen und zu den tierischen und pflanzlichen Lebewesen der Umgebung ausgebildet. Diese ständige, mit den natürlichen Umgebungsbedingungen wechselnde Bereitschaft und Fähigkeit des Organismus, sich auf die fliessenden Veränderungen der Biosphäre einzustellen, also die engeren und weiteren Grenzen des physiologischen und ethologischen Anpassungsbereiches, lassen Haltungsformen zu, die ökologisch sinnvoll und tiergerecht sind. Diese weit über die ausschliesslichen Nutzungs- und Produktionseigenschaften hinausgehenden Aspekte wollen wir umfassender und vertieft kennenlernen.
Auch die vom Menschen in Abhängigkeit stehenden Tiere sind eigenständige Lebewesen. Die Verantwortung des Menschen begründet sich aus der Tatsache, mit dem Tier in derselben Biosphäre zu leben und wie das Tier von ihr abhängig zu sein. Aus diesem lebendigen, veränderlichen Verhältnis des Menschen zum Tier ergibt sich notwendig eine Basis der Respektierung und Achtung unserer tierischen Partner.
Es besteht ein Bedürfnis für Forschungsergebnisse auf dem ökologisch-ethologischen und gesundheitlichen Gebiet. Diese sollen gesammelt als breite Informationsbasis dienen und die Voraussetzung zum Aufbau und zur Realisierung von ökologisch sinnvollen und tierentsprechenden Haltungsformen bilden.
Diese Reihe hat als Informationsquelle Brückenfunktion zwischen den verschiedenen, an der gesunden Tierhaltung beteiligten Disziplinen und Berufsgruppen.
Die Reihe bietet Raum für fundierte Versuchs- und Untersuchungsergebnisse und darauf fussende kritisch diskutierte Überlegungen.

Aims and scope

Each animal species, including domestic animals, develops in the course of its evolution a reciprocal relationship to every aspect of the environment. This adaption is so slow that compared with a human lifetime it seems to be static. As a result of this action single animals show manifold behaviour pattern towards their companions and towards the creatures and plants of their environment. This constant readiness and capability to adapt to ever changing surroundings, the various limits of physiological and ethological adaption, allows forms of animal management which are ecologically balanced and adequate to animal requirements. These aspects, which are of far wider interest than those of production and revenue, are to be investigated extensively.
Animals are autonomous creatures, even if they depend on human beings. We share and depend on the biosphere with the animals and this compels us to responsibility. This ever changing, living relationship of humans and animals is the basis for our respect of our animal cohabitants.
There is a need for test conclusions in the field of ecology, ethology and health. This collected information is intended to serve as a reference and basis for the realization of ecologically sound animal management based on the animals' requirements.
This series and it's sources of information are intended to be a symposium for the many different disciplines and professions dealing with animal management.
The series offers space for well-founded test conclusions and critical discussions.

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Tierhaltung, Band 14
Animal Management, Vol. 14

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The Behaviour of Beef Suckler Cattle

(Bos Taurus)

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All men have their eyes on you
All women have their eyes on you
All children have their eyes on you
You have beautiful flesh
You have beautiful legs
You have beautiful arms
All of you is beautiful
My dark-skinned girl is as beautiful as a cow
Angolan Folk-Song

We dedicate this book to cows, and their calves



The cattle on the chalk downs during winter.



The cattle on the alluvial river meadows during summer. Bonds between pairs are reinforced by affiliative behaviour, such as licking.

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PREFACE

Oddly enough, although cattle have been domesticated for as long as six thousand years, little detail of their behaviour has been written down until recently. The behaviour of sticklebacks and gulls has been studied and documented in much greater detail than the behaviour of any domestic animal. This is surprising when one considers the economic importance of cattle and the vast amounts of money which have been and are being spent on improving milk or beef production. It is evident that farmers and research workers believed, until recently at least, that they knew all about the behaviour of cows - and of course, although they may never write it down, farmers who live and work with the animals often do know a lot about their charges. However, farmers like anyone else, can be opinionated about the behaviour of their stock and this can lead to the perpetration of legends about behaviour which may contain only a very slim element of truth; and of course cattlemen and farmers, often, like scientists, differ in their opinions!

In order to find out how cattle actually behave it is necessary to study them thoroughly in as natural a situation as possible. The results of such a study are the main subject of this book.

There are reasons for such a study besides dispelling or confirming folklore. Firstly, the knowledge so gained could be used to design environments and management systems most appropriate for cattle from a psychological as well as a physical point of view. Secondly, with the continual intensification of livestock management people are asking questions concerning welfare: 'Is it cruel'. Rather than relying on anthropomorphic judgement on these issues, an idea of the natural behaviour of the animal puts us in a better position to judge non-adaptive behaviour which is one indication of possible cruelty. Thirdly, the results of such a study make it possible to theorize and to attempt, at least, to answer questions about the social organization of these animals. Such questions are the current concern of many ethologists and evolutionary theorists and to our knowledge this is one of the first times such ideas have been applied to cattle, albeit in a semi-domestic situation (see also Rheinhardt 1980).

In the last two decades there have been many studies of wild species, particularly primates and ungulates (hoofed mammals), which have resulted in fairly refined and sophisticated techniques of studying animals in their natural habitat. In this study, we attempt to use some of these quantitative techniques to record the behaviour of single-suckler cattle in the field, and thereby we hope to have arrived at an accurate description of their behaviour, or at least some parts of it.

This book is <u>not</u> intended to be a review of everything known about cattle, but is rather the result of one series of

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studies which we hope tells us a bit more about the common cow. A brief bibliography is given at the end, but if important references have been omitted, let us apologize in advance.

Finally, I (M. K-W) would like to thank all those who have in one way or another helped me with the work or the running of my farm to allow me to do this work. Firstly, I must thank the Royal Society for the Prevention of Cruelty to Animals who financed most of the field work by awarding me a post-doctoral fellowship, and in particularly Mr. Philip Brown who has pushed so hard within the RSPCA towards a more scientifically-based assessment of animal welfare. Professor R.J. Andrew allowed me to be based in the Ethology and Neurophysiology Group at Sussex University and gave me much support and aid throughout. I would also like to thank all my colleagues for entertainment and discussion.

Mr. Ellis and his two sons, Raymond and Peter, of Church Farm, Lillington who allowed me to work on their suckler cattle both out and inside and Mr. Burgess of Wooten Farm, Folkington, are also thanked for allowing me access to their suckler herds.

We are indebted to many people for critically reading parts or all of the manuscript, in particular Richard Andrew, Peter Clifton, Juliet Clutton-Brock, Mike Kavanagh, Mike Land, Dr. V. Rheinhardt, Ian Russell, Dr. Selman of Glasgow Veterinary School, Dr. Sambraus (Munich Veterinary School), Peter Slater and Mr J.R. Spratling (Cambridge Veterinary School). Many people have also helped us with the typing, in particular we would like to thank Kathy Sound, Carolyn de la Plain and Ruth Elliot-Smith.

Beryl Blackburn, Olwen Silvers, Sarah Sheppard, Dolores Voster and Peggy Van Royen showed enormous enthusiasm and reliability in helping me (M. K-W) with the field work in the face of often bitter opposition from the weather, as well as helping on the farm. Others who have helped in so many ways and without whom I could never have completed this work are Ruth Frame, Chris Rendle and Tony Carter.

Last but by no means least, I would like to thank my co-author, Susan de la Plain, who despite all her other commitments had time and patience skilfully to convert my atrocious English and spelling into readable prose.

To all of you people, much love and many thanks, I hope it is worth it.

It is a sad thought that as land pressure increases and the misguided encouragement in specialization and intensive animal husbandry continues, there will be fewer and fewer cattle raising their own calves without interference. Indeed, even

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before the end of this study the spring-calving herd was slaughtered and the downland they used to graze is now under barley.

This is perhaps then a 'nearly last will and testament' of the downland suckler cow and we should like to dedicate this book, for what it is worth, to the widely abused cow and in particular to those who provided me (M.K-W.) with two fascinating years by tolerantly allowing me to eavesdrop on their lives, and almost made me an honorary cow!

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Table 1. A comparison of the social organisation in several species of Bovidae

SPECIES	HABITAT	GROUP STRUCTURE			TERRITORIALITY		GROUP MOVEMENTS		DOMINANCE			AFFILIATIVE BEHAVIOUR		CALF			TENDENCY TO FOLLOW	TENDENCY TO GROUP	COMMUNICATION USED				FOOD PREFERENCES		SOURCES
		Pair living	Family groups	Several family groups	Large herds	Defence of specific areas	Defence of proximity to individual	Home range	Migratory	Rigid Hierarchy	Less rigid	Not very important	Much	Little	Follower	Intermediate	Hidden			Tactile	Visual	Olfactory	Auditory	Grazers	Browsers	
Syncerus caffer (African buffalo)	savannah and edge of forest		?	*	*	?	**	*		?	?	?	?	?		*		**	**	?	*	?	*	**	*	Sinclair 1971 personal observations
Bison	prairies & forest		?	*	*		**	*	*	*	?	?	?	?		*		**	**	?		*	*	**	*	McHugh 1958 personal observations.
Bos indicus	savannah/ bush		*	*	*		**	*		*	?	?	?	?		*		**	*	*	*	*	*	*	*	Reinhardt 1980
Auroch (Bos taurus)	Edge of forest & plain		?	*	*		?	?	?	?	?	?	?	?	?	?	?	*		*	*	*	*	*	*	Cole 1961
Bos taurus																										
Feral	grassland		?	*	*	*	**	*	*	?*	?	?	?	?		*		**	**	*	*	*	*	*	*	Schloeth 1961
Domestic raising own calves at pasture all year	grassland		*	*	*		**	*	*	-		*	*			*		**	**	*	*	*	*	**	*	Kiley-Worthington & de la Plain (this study)
Domestic not raising calves, often inside	grassland & housed in groups		?	*	*	*	**	*		*	?		?	?	-	-	-	**	**	*	*	*	*	**	*	Koch 1968 Zimmermann-Müller 1978 personal observation

* - common
** - more common

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CHAPTER 1

The Origin and Evolution of Cattle. The Cattle Studied and Methods Used.

If one idly watches a large-uddered dairy cow rubbing itself on a fence post, it is difficult to imagine that cattle were once wild-eyed, quick-acting creatures. The ancestors of domestic cattle were the large Aurochs which roamed around on the edges of the post-glacial forests. These long-legged beasts (Bos primigenius) stood up to 2 metres at the withers and were fleet of foot. James Wilson (quoted by Zeuner (1963) described them as 'mighty untamable monsters of unconquerable ferocity'.

The first of the hoofed animals to be tamed, bred and used by man were sheep and goats in about 7000 BC. These animals were small, easy to feed (they have very catholic tastes) and easy to manipulate, especially when one considers the weak grass ropes and lack of sophisticated tools of early man. However, the increase in the human population rapidly necessitated the expansion of food growing areas and animals were needed as beasts of burden to carry supplies and to work the land. Sheep and goats were inadequate for this task, so in about 6000 BC the first cattle were 'domesticated' - they were tamed, and their movements, mating and life span were controlled by man, with whom they began to live in close association. The symbiotic relationship benefitted both man and beast. The domestication of cattle was one of the most important and fundamental steps taken by man and enabled large-scale exploitation of the western world, but it also required massive re-organization of agricultural practices.

Large animals, such as cattle, require relatively large amounts of food (about 15 to 20 kilograms of bulk food per day) which must have been a problem for the early sedentary Neolithic agriculturalists. The result was that the early domestic cattle and other livestock were malnourished and there is a very noticeable decrease in size from the wild to early domestic types. The latter have been described, again by James Wilson, as 'small, thin fleshed, narrow backed, sickel hocked, light dun beasties'. This change in size is so dramatic that many archaeologists thought they had discovered a new species, which they called Bos longifrons. Most of today's archaeologists maintain however that this was not a new species, but just a malnourished version of the Aurochs, Bos primigenius (Clutton-Brock, 1976). Living examples of these cattle can be seen today in the southern mediterranean peasants' cattle and also the small Kerrys of Ireland.

The importance of cattle to early man is emphasized by their frequent occurrence in ancient paintings, myths and religions.

While some cattle were becoming domesticated, the Aurochs continued to live wild in the forests being hunted

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occasionally until the beginning of the fourteenth century. The last survivor is reputed to have died in a Polish park in 1627. There have been attempts to re-breed this magnificent long-horned animal by crossing Hungarian Steppe cattle with Highland and Alpine breeds in Münich Zoo. At Berlin Zoo they tried independently to breed animals that must have resembled Aurochs by crossing Spanish fighting cattle with Camargue and Corsican cattle and introducing a smattering of English park cattle's blood. Both these efforts at 'reconstruction' have been relatively successful in establishing the colour marking and the offspring are still in Munich Zoo at least. However, they are very much smaller than the Aurochs are reputed to have been and therefore probably resemble the first domesticated cattle more than the Aurochs. As well as the changes in size and body form of the animals,a change in temperament is reported. The reconstructed Aurochs that have been allowed to run wild in the German forests have been called 'fierce, temperamental and extremely agile'. How much of this is the result of lack of contact with man, and how much genetic we don't know (Zeuner 1963).

Lately in Britain there have also been efforts to breed a reconstructed small domestic cow such as Neolithic man might have had by crossing the small Kerry, Dexter, Sussex and North Devon cattle. The Sussex cattle in particular, some of which are included in our experimental herds (see page 9) are considered to have 'purity of blood in a long and unbroken stream'.

How the first wild Aurochs were tamed remains something of a mystery. Juliet Clutton-Brock (1976) suggests that in the first place man selected animals that were non-territorial, such as sheep, goats and cattle, rather than the territorial antelope and deer which would be unlikely to breed in large numbers if restrained. She suggests rather than those which were selected for domestication had hierarchical social structures. We think this is probably an over-simplification although behaviour was, and is, one of the fundamental factors controlling both domestication and subsequently animal breeding.

The most likely way in which these enormous animals were domesticated would have been the capture of the young within twelve hours of birth when they are still unable to run fast. These were probably captured before they recognized their mother and then suckled by goats or sheep - or even women - who would then be recognized as the mother. Thereafter it would have been only a matter of training to teach them to lead, pull, stand to be milked, let down their milk and so on - 'only a matter of training' though which even with today's animals is a highly skilled affair.

As soon as the captured animals became mature, the first efforts at selective breeding were practised and unwanted bulls castrated. In this way there was rapid selection for particular characteristics both of physique and of behaviour. The selection of appropriate behavioural traits has tended not to be conscious

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in the same way as for other characteristics but nevertheless it has occurred. For example, a dangerous bull would have been killed rather than kept for breeding, while during the period of domestication, easily managed cattle would have been bred.

One of the most interesting changes in cattle behaviour as the result of man's selection is that of milk let-down (Amoroso and Jewell 1963). A captive wild animal, or even an animal bred for beef production today, will not let down her milk when milked by man. Milk let-down is controlled by oxytocin, produced by the pituitary with clear connections with the rest of the brain, including the cerebral cortex, thus if circumstances are not appropriate, then no milk will be let down. The suckling stimulus from the calf constitutes 'appropriate circumstances', but simply the presence of the calf can often do the trick. Over the years, man has selected for ease of milk let-down in the dairy breeds. Today all that is necessary with these breeds is the normal circumstances of milking, such as noise of buckets or the milking parlour. Even the herdsman's voice can act as the triggering conditioned stimulus (personal observations).

In the western world we now have two types of cattle which have been selected mainly according to characteristics of body form but also for behavioural characteristics. They are divisible into the 'beef' and 'dairy' breeds. The thickset beef breeds such as the Sussex, Hereford and Devon, which are the subject of most of this book, do not readily let down their milk. They produce less milk, as well as showing more rigid maternal behaviour than the dairy breeds, which are more lightly built, and let down their milk with greater ease.

We in Europe were blessed with a host of different cattle breeds adapted to the different environmental characteristics of the various areas. Many of these breeds were dual-purpose animals: large-framed quick-growing animals that produced plenty of milk for a calf or two and also let down their milk readily to feed the human family as well - breeds such as the Simmenthaler, South Devon, Shorthorn, Gloucester, Welshblack, Lincoln Red, Red Poll and so on. Today many of these breeds have almost disappeared, or the breed societies which are preserving them have succumbed to the current agricultural idea that animals must be bred for extremely specialized functions, and have opted to call their breed either beef (e.g. South Devon) or dairy (e.g. Dairy Shorthorn). One should remember before destroying previous selection programmes of many hundreds of years standing, firstly, that the local breeds are primarily adapted to local environmental conditions although some breeds (e.g. the Simmenthaler, Friesian and Hereford) may be able to adapt to very different environments. Secondly, that where animals have been carefully selected to fulfill a number of purposes, successful breeding takes very much longer to achieve. If specialization replaces it, it takes only a very short time before the previously selected multi-purpose characteristics are obscured by the emphasis on the selected characteristics. This is the case with many South Devon

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herds which have been selected purely for beef production for only three to four generations. They already produce very much less milk than their ancestors, and what they have will not be let down. The ultimate farce of this type of specialized breeding is perhaps the Hereford, where the animal has been so specifically bred for large buttocks to produce the expensive cuts of meat that it is more or less incapable of surviving without the intervention of man. Many of the top class show heifers which sell for several thousand guineas as one of the British livestock exports cannot produce enough milk to feed their own calves! (Hereford breeder's communication.)

We might expect, then, that the behaviour and social organization of today's cattle would have little resemblance to that of the original Aurochs. Since these latter are extinct, unfortunately we cannot know for sure if this is so, but such evidence as there is points to the lack of change in the social organization, communication systems and other social behaviour between the wild ancestral and modern domestic animals (e.g. Kiley-Worthington 1977). The social structure and organization of bison, African buffalo and Bos indicus and feral Bos taurus have many similarities although they come from rather different habitats and different genera of bovids (Table 1). It seems unlikely, therefore, that behaviour patterns relating to such basic things as social organization and the relationships between individuals have been radically altered by domestication. There has been little reason for change, since as long as 'normal' behaviour does not interfere with management, man has every reason to select for behaviour most fitted to the survival of the species. In the past man has often found it expedient to adapt management to the animals rather than to try to change their behaviour, an example being the boundaries of farms in the hills which have been drawn around the home ranges or 'hefts' of the sheep. One of the fundamental mistakes of modern intensive agriculture is that all too frequently the management and buildings are designed for man rather than the animals, often against the evolutionary potential for the survival of the animals.

In studying single-suckler beef cattle then, we are probably as near as is possible today to understanding how the society of the ancient Aurochs may have been organized. Perhaps more important from the practical point of view is that such a study, together with others already completed (e.g.: Koch 1968, Zimmer-Mann Muller 1978, Rheinhardt 1980) will give us a blueprint on which to build well-designed management practices.

The cattle and the methods of study

The first priority with this study was to look at the normal social organization of the groups in conditions which were as natural as possible, that is, where there was the least interference by man. The best cattle groups in Britain today to study from this point of view are probably the single-suckler cattle usually run out on marginal land such as moors and hills. We chose single-suckler herds on the Sussex Downs. Unlike other studies

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on grazing cattle to date, this study was in no way geared to production indices. The point was simply to discover what cattle did, how they lived and how they organized their society when left to themselves.

This work concentrated in particular on the relationship between mother and young and the ontogeny of behaviour in the calf. Sexual behaviour, other relationships between adults, and the behaviour of the whole herd in terms of the use of habitat were also studied. One particularly interesting thing from the theoretical as well as from the practical point of view was how and when cattle recognize their calves. This is considered in some detail, and some experiments were conducted to try to induce adoption in beef cattle.

The main study extended over a two year period during which two herds of single-suckler cattle were studied. One group was a spring-calving herd of between 32 and 38 cows with which a bull was run during the early summer. These animals were outside throughout the year. For the whole winter until between two and five months after calving (which was in February and March), they were kept in a large (60-acre) downland field. From December to May they were fed hay, straw and Rumevite blocks (a protein and mineral block made from urea). When the ground was dry enough and the grass had started growing (mid-May) they were moved to 50 acres of water meadows in the valley by the Cuckmere river, two miles from the south coast in Sussex.(see forepiece)

The autumn-calving herd, the second group, consisted of 120-150 individuals. During calving (October-November) they were kept out on the water meadows or downs in 15- to 40-acre fields. In December they were brought into covered yards with calf creeps where they were fed hay, straw and some concentrates. The calves had access to protein blocks, cake and a concentrate barley mixture. The bull was run with them after Christmas. At the end of April when the spring grass had begun to grow they were sent out for the summer on to the downland and meadow pastures.

Both herds consisted of mixed breeds with a preponderance of Hereford, Friesian and Sussex-cross cows. There were also several Blue-greys, Shorthorns and Charollais. The spring-calving cows were all known individually from their natural markings. Most of the autumn-calving cows had freeze-branded numbers stamped on their quarters.

The cows varied in age from first-calving heifers to cows up to twenty years old. The two herds were managed rather differently, the autumn-calvers being more intensively managed and kept at a higher plane of nutrition. They were moved around more and the group composition changed as animals calved. The spring-calvers were left much more to themselves, and they were therefore the ones we chose to study intensively.

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During the first day of life the calves of the autumn-calvers were caught, de-horned, ear-marked and, if male, castrated, but the spring calves were not touched until six to eight months old when the males were castrated.

In addition one of us, (M.K-W.) had a small herd of six Hereford, Friesian and Charollais-cross cows on her own farm, which were used for observation and for the adoption studies. These animals had a bull running with them throughout the first spring, but we used artificial insemination the following year. These cows were purposely kept on a low nutrition plane and each raised two calves. They were out all year in river meadows except for a few months during the winter (December - April) when the land was too wet and they had to be housed.

To date, most studies on wild and domestic animal behaviour have tended to concentrate on general differences between, for example, age or sex classes, but for various reasons, individual variations of behaviour have not been assessed. One of the advantages of studying a domestic species and using a rather laborious method of recording is that we were able to record individual differences in behaviour. To this end continuous half-hour observation periods on one cow and calf at a time were made. This was done two or three times per week for the first month when development of the calf was most rapid, then at approximately fortnightly intervals after that until the calf was four months old. A final set of recordings was made when they were six months old. Twenty two cows and 38 calves were recorded in this way for a total of 34 lactations. The detailed analysis on development of behaviour includes the data from 8 of these cows and their calves from the spring-calving herd.

The definition of the activities we recorded is as follows:

Licking. This involves the animal putting out its tongue and licking either an object, another animal (mutual grooming), or itself (self-licking or grooming).

Rubbing. The animal rubs any part of its body on an inanimate object or another animal. This rubbing is usually confined to the head and neck region, but the flanks and hind end may also be rubbed.

Scratching. The animal lifts a hind leg and scratches its forequarters, front legs, shoulders, neck or head.

Smelling and investigating. The animal approaches some object or other animal with its nose and speeds up the breathing rhythm, particularly by controlling the inspiratory phase (it sniffs). The resulting more controlled and repetitive flow of air over the receptors and olfactory mucosa increases the information that can be picked up (see page 25). Smelling and investigating is often done with the head extended forward and can be directed to inanimate objects or other animals. Watching - visual investigation - was not recorded separately.

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Calling. This category includes only noises made by the larynx, so that the snorts, puffs and burps that cattle often make were excluded. The calls are fully described in a later chapter.

Butting. This describes the action of the head being lowered and then brought up horn end first against any part of another animal.

Bunting. This term is given to the action made by the calf when it withdraws the head before thrusting it hard forwards again, nose first. It is an activity associated with suckling, and occurs only in the young.

Threatening. This involves head lowering, horn pointing and posturing. The full displays are described in Chapter 3 with figures.

Gaits. Cattle show three typical gaits:-

i) Walking. The animal had to change the position of all four legs before this was recorded. In the cow the sequence is normally a lateral walk, but at slow paces may be diagonal. The rhythm is in four-time.

ii) Trotting. Here the diagonal feet come to the ground together, giving a two-time rhythm.

iii) Gallop. The feet come to the ground in the sequence outside hind, inside hind and outside fore together, then inside fore. It is therefore a three-time rhythm. If the inside hind leg begins the sequence the animal will be 'leading' on the other fore leg - the last in the sequence.

Leaping. This consists of a bucking movement, with the hind legs leaving the ground, often with one being kicked out sideways. Occasionally the spine is bent in a convex curve, resulting in all four legs leaving the ground simultaneously in a leaping jump, as in the bucking steers or bulls in rodeos in America. These activities were brief in occurrence and therefore each performance was recorded as one event.

Play. The actions of butting or pushing another animal, circling and chasing (Figure 16) are classified as play. Cows can also play with objects - here the animal may rub it or lift it up with its head and then leap away before repeating the sequence. All these activities were included in this category.

Eating. During some observational periods in the spring and late summer, hay and straw were fed to the animals. Eating refers only to this.

Grazing. This term is used both for the process of breaking off the grass with the tongue and then chewing it. Browsing (eating bushes and trees) is included here.

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Eating and grazing are combined where both occurred.

Cudding or ruminating. This consists of regurgitating material from the rumen or first stomach and then chewing it before swallowing it again.

Sucking. This was scored only when the calf had its mouth around a teat and could be seen to be sucking by the movements of its mouth.

Making contact. This was scored when an animal moved for at least ten metres (without a break of more than ten seconds) towards another animal and thereafter either touched it or stood within one metre ot it.

Breaking contact. This was scored when an animal moved away from another from within a ten yard radius; within a 10-second period. Both making contact and breaking contact were probably underscored as cattle do not usually show such rapid clear cut patterns. The process of making contact can take an hour from the animal perceiving the other to actually touching it, with the perceiver persistently moving in the direction of the other, although stopping frequently to graze or stand and stare.

Lying. Cattle most commonly lie on their brisket (Figure 17), although they may lie flat on their sides for periods of up to twenty minutes (cows) or an hour (calves). Lying normally includes both of these positions in the analysis unless otherwise stated.

Resting. The time spent either lying or standing but not cudding (sometimes referred to as 'idling' or 'spare time' by other authors) was classed as resting.

Sleeping. A separate category for sleeping was not made throughout since it was often difficult to score, so lying includes time spent sleeping unless otherwise stated. For sleeping to be scored, the animal had to be lying with its eyes closed and not be cudding.

Dozing. No separate category was made here. It is rarer for cattle to stand while dozing than horses. Cattle can be dozing when cudding (Ruchebusch & Bell 1970).

Mounting. This term describes an animal jumping its forequarters on to another in any position.

Other activities associated with sex may also occur at such time (see Fig. and page 63).

A bout. This was defined as the time spent in one activity without a break of more than ten seconds. It is possible to compare numbers of bouts as well as changes in bout length.

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Statistics. The majority of the work described in this book is original research that has not been published elsewhere. It is necessary to give the figures that were recorded in the field. These are represented visually, mainly as histograms. Appropriate statistical tests have been applied to these figures to indicate any significant differences revealed by various comparisons. The names of the tests used are given in brackets after each statement, with the probability value (p).

In addition to these detailed observational periods, how the animals spent the day was studied, and how this varied with season, weather, and/or age of the calf. In order to do this eighteen cows and calves were watched throughout the day for six to eight hours. This was done once a week from when the calves were one week old to when they were six months. The recordings were taken every fifteen minutes for each animal, and we recorded how far (1) the cow and calf were from each other, (2) from their nearest neighbours and (3) what activities each was performing.

For the last four months of the study therefore, the position of the animals in the field was recorded once an hour for six to eight-hour periods approximately once a week. The autumn-calvers were brought into straw yards just before Christmas in 1974. We continued the observations for a couple of weeks into the new year and in that way assessed differences in their behaviour as a result of confinement. Tables 2 summarises the methods of recording and animals recorded.

The communication between individuals is particularly interesting. Although few quantitative measures were taken here (because many of the displays are very infrequent), a description of the various ways cattle communicate, and theories of their origin and evolution, are included.

Dominance hierarchies have been measured and discussed, probably more than any other aspect of cattle behaviour. The intention was to record sufficient encounters between individuals, (both activities related to dominance and affiliative behaviour) to analyse . Unfortunately the cows went to slaughter after 144 hours of these observations and there were insufficient data to analyse individual differences statistically. However, differences in the frequencies of affiliative (cohesive) behaviour and behaviour related to possible dominance hierarchies (dispersive) are discussed; together with preferences of association between individuals.

Today's agricultural developments give rise to so many problems, biological, social, political, aesthetic and ethical (Kiley-Worthington, 1980) it is possible that by the end of the century our children and grand-children will be desperately looking round for the unspecialized cow that evolved to live in marginal areas, converted cellulose to protein, raised it own calf and produced enough milk for others, as well as a good carcass, this is a study of such animals.

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TABLE 2. Summary of recording methods and the animals for the single suckler cattle.

a) The spring calving herd

38 cows and 39 calves with 1 bull. (May-July). Individuals recorded from calving (February - March) to 24 weeks post-partum. for 1974 and 1975.

Herd structure changed in 1975: 4 cows left.
5 cows added, and one 18 month old steer.

b) Autumn calving herd

100+ cows and calves with 1 bull (Dec. to Feb.). Herd subdivided and changing. Used for recordings on individual dam-calf dyads and recordings inside barn only.

Continuous recordings

These were made on individual dam-calf dyads for ½ hr periods 2 times/week from birth (or within 10 hrs of birth) to 24 weeks post-partum, between 8.00 hrs to 13.00 hrs. Simultaneously Periodic recordings (every 5 minutes) were made scoring:-

i) Dam to calf distance
ii) Dam to nearest neighbour and whether a cow or calf
iii) Calf to nearest neighbour and whether a cow or calf

Individual cows recorded:

Spring calves				Autumn calvers			
	1974	1975	Age	No:	1973	1974	Age
Fatty	✓		8+	17	✓	✓(twins)	3
Fraser	✓	✓	6+	20		✓	8+
Helen	✓	✓	3	26	✓	✓	8+
Lesley	✓	✓	6+	57	✓	✓(twins)	8+
Norah	✓		6+	65		✓	5
Olwen	✓	✓	10+	74		✓	3
Rebecca	✓	✓	8+	75		✓	4
Spot Eyes	✓	✓	6+	77	✓	✓	4
Spot Face	✓	✓	3	81		✓(twins)	8+
White lady	✓	✓	10+	100		✓(twins)	5+
				135	✓	✓	3
				25		✓	5+

Total: spring calvers: 10 cows & calves, 17 lactations; 22 cows, 26 calves, 34 lactations
autumn calvers: 12 cows & 16 calves, 17 lactations

Total number of hours continuously recorded: 1004

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TABLE 2 (continued).

Periodic recordings on spring calvers (every 15 minutes) for one 8 hr session/week. (weeks 1 - 24) scored:-

i) activity of dam and calf
ii) dam-calf distance
iii) dam's nearest neighbour distance and which individual
iv) calf's nearest neighbour distance and which individual.

Total number of cow or calf hours: 2668.

Cows & calves recorded:	1974	1975
Lesley	✓	✓
Fraser	✓	
Helen	✓	
Norah	✓	
Spot eye	✓	
Spot face	✓	
White lady	✓	
Short tail		✓
Roweena		✓
Dexter		✓
Bull		✓

Activity Scan of Whole Herd recorded every 15 minutes.

1/hour positions of key animals mapped.
During these periods all interactions seen between individuals recorded (i.e. mutual grooming, butting, threatening, withdrawing, head rubbing, flehmen) for last 150 hours.

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CHAPTER 2

The cow's world

A study of the behaviour of a species must be tied to an appreciation of the morphology, physiology and evolution that have given rise to it. In this chapter therefore, we examine the species specific characteristics of the sense organs of cattle, in order to understand their potential performance. To try to evaluate the extent to which this potential is realized, we also briefly outline the species specific characteristics of the brain.

Receptors

The eye

Prey species such as the large herbivores (cattle, sheep and goats) need a wide field of vision in order to be able to detect their predators, while the ability to judge distance is less important. These animals therefore have their eyes placed well to the side of the head, the results is a small field of binocular vision (10^{o} - 35^{o} in rabbits, 30^{o} - 70^{o} in horses and 25^{o} - 50^{o} in cattle) but a large overall field of vision - up to 360^{o} (Figure 1).

The position of the eye is also an indication of the relative importance of sight and smell in the different species. Animals with eyes at the side of the head frequently have big snouts and a well-developed sense of smell (e.g. the cow) whereas those with eyes at the front of the head often have smaller snouts and less well-developed olfactory mucosa, so they may rely more heavily on vision.

There is little doubt that all animals including man can suffer from long or short sight. In the case of domestic cows long or short sight is no great handicap, but for jumping horses or working sheep dogs it can be a disaster. It is thought that cattle are not able to accommodate to the same degree as primates and man, this is illustrated by the relatively poor development of the ciliary muscles which control the curvature of the lens.

One striking thing concerning the eye of the cow is that it is extremely large. The length of the whole eye is about 39mm the focal length is about 26mm, and the pupil is about 22mm wide. This means that much light can get in. For example, the image entering the eye is about three times brighter than in man.

It has been suggested that it is nocturnal animals that need these large eyes to be able to collect the maximum amount of available light (Walls 1967). This view is reinforced by the presence of the 'tapetum' in the cow's eye, which is a reflecting surface acting as a mirror to light rays which have passed through the retina. They are thus reflected back on to the retina where they activate more photo-receptors. In this way the sensitivity

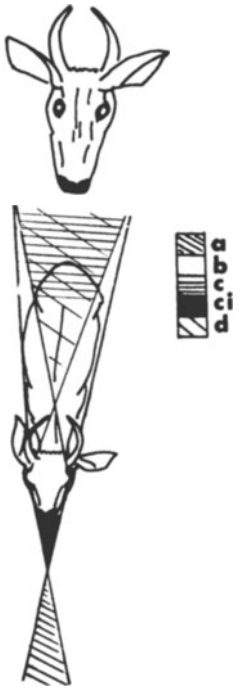
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is increased when there is little light. The tapetum of the cow covers the top threequarters of the retina so that it is most effective when the animal is looking down where the light is dimmer.It is probable that the cow was originally a nocturnal animal although today it is usually crepuscular.Its night vision is still very effective.

Figure 1

The visual field of the cow.

a - binocular front field
b - panoramic, monocular field of vision for left eye, (ears are above the eye and therefore do not interfere with visual field)
c - blind area, except when the head is up.
d - possible binocular field of vision at the rear when head is right up.
e - blind olfactory controlled area.



The presence of cone cells in the retina of cattle suggests that they can see the colours, but we do not know the extent of their visual spectrum. Recent evidence suggests that, most mammals do see colours, although perhaps not always with the same acuity as primates and man. Colour discrimination tests have been conducted with cattle (e.g. Graf & Sambraus 1978), horses and sheep in recent years, and all of them have been found

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to discriminate basic primary colours. In our work we found that coat colour was important in the recognition of the calf by the mother (page 152). Alexander and Shillito (1977) who experimented by dyeing lambs different colours also found that colour was important to the mother for recognizing her lamb.

The pupil of cattle changes size, to a limited degree. This response seems to be controlled by the parasympathetic or autonomic nervous system which acts at a subconscious or involuntary level. Some drugs and emotions (such as fear) can alter the size of the pupil.

Cows have more lacrimal glands than man, but they produce different substances. Tears are vital in lubricating the eye and keeping the cornea moist, but cattle do not cry in moments of emotional stress.

Our conclusions about the visual world of cattle then are (i) that they can see right round them monocularly although their binocular field of vision is small, (ii) that their sight is particularly efficient in poor light and (iii) that they can see colours. Also (iv) they have some difficulty with rapid focusing and (v) therefore their vision at a distance is probably more accurate than at close range.

Taste and smell

In cattle the taste buds are concentrated at the tip and back of the tongue and are relatively large (about 100μ by 20 - 45μ).

There are indications that taste is a particularly important sensory modality in cattle, in feeding and in collecting information about the environment (Kare and Beauchamp 1977). Cows respond more to taste stimuli than do birds, for example, and Russian workers have conditioned cows to discriminate different tastes. It has also been established that individual animals differ in their ability to discriminate between different tastes.

Although commercial feeds are often flavoured with aniseed or aromatic oils there is no evidence that cattle show a particular preference for such flavours. They do however like a sweet taste and can discriminate in favour of a 1% sugar solution. They will also take food containing sucrose octacetate (a complex sugar) which is repugnant to man in high concentrations.

Calves can also discriminate acid flavours, but show a wide tolerance of them, particularly mineral acids. They show even more taste tolerance of alkalis.(Kare & Beauchamp 1977).

The controversial question of nutritional wisdom ought to be mentioned here. This is the supposed ability of animals to avoid toxic substances and to pick food appropriate to their physiological requirements (if they lack calcium for example,

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they are supposed to pick out foods rich in this substance in order to fulfil their nutritional requirements). To some extent cattle do seem to show this so-called nutritional wisdom but it is very easy to interfere with this by altering the taste or texture of the food. The relative hunger of the animal may also affect its choice (see Kiley-Worthington 1977, for review).

Very closely connected to the sense of taste is the sense of smell and cattle have a somewhat unique nose in that it is very large with particularly wet nares. A point of interest is that when cows are alert and approaching to investigate something, the nose becomes, covered with secreted dew drops. They usually touch the object with the nose as they smell it. In this way possibly allowing better olfactory and gustatory testing. The elaborate and well-developed musculature of the nostrils (Figure 2) gives the nose great mobility, while inside the external nares lies the respiratory epithelium which warms and filters the incoming air. The recesses in the nose allow the accumulation of olfactory molecules, and there is a shelf at the back (a structure not found in primates and man) which forces the inspired air into these recesses so that the entire nasal cavity is filled with air when the cow is sniffing. Olfactory information in the air is picked up by the olfactory mucosa, a thin tissue supported by semi-cartilagenous scroll-shaped structures known as the turbinates, and the olfactory surface is therefore enormous. Its area is greater than that of the body surface and it is apparently highly efficient.

In the horse and the pig the nasal cavity is lined with hairs to clean the nasal passages, but these are not present in the cow and sheep. Instead, cattle from about the age of one month can lick out the inside of their nose with their tongue, a characteristic movement found only in the bovidae. The function of this movement may well be to transfer mucus containing dissolved olfactory 'cues' from the olfactory mucosa to the tongue so that the substance can also be tasted. In addition the tongue keeps the nares clean and removes old substances which might otherwise linger in the mucus, confusing more recent smells. Cattle also have a characteristic way of expiring forcefully after sniffing something and this presumably helps keep the olfactory tract clean.

The olfractory epithelium also lines the Organ of Jacobson, or vomeronasal gland. The function of this gland is still obscure, but it has been suggested that it is linked with the action of 'flehmen' in the detection of sex pheromones (page 48).

Since from the point of view of anatomy, physiology and behaviour the sense of smell seems to be very important in the life of cattle, this is further discussed on page 45.

Hearing

The external ears of cattle are relatively large and conspicuous. They can be moved independently of one another by eight pairs of muscles (Figure 2) which makes them capable of

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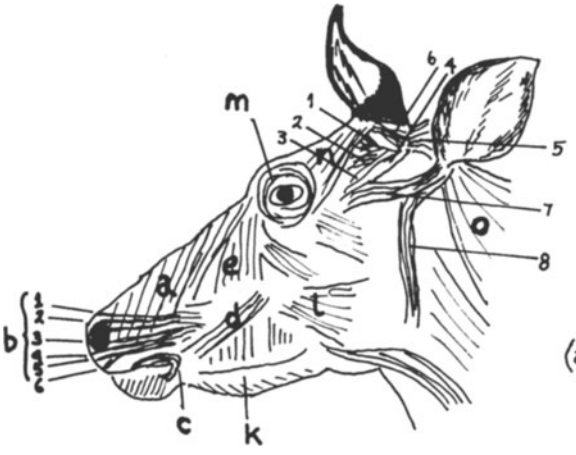
accurate orientation towards sound. Just as binocular vision is important for judging distance, so two ears allow the cow to locate the origin of a sound. This is important in most species, but particularly so in a social-living prey species, which must be able to locate the position of its friends as well as its foes. Messages picked up by the ear are relayed through the auditory nerve to the medulla then to the thalamus which has connections with the cortex where the messages are analysed.

Figure 2

Musculature of the face and area of the cow.

Note: there are 8 muscles to move one ear.

a - levator of nostril; b - extensor and levator muscles of nostril (1 to 6); c - mouth and lip constrictor; d - zygomaticus, lip corner lifter; e - malaris, a cheek muscle; f & fi - cheek muscles; m - eye constrictor; n - forehead muscle, and eye opener. 1 to 8 - muscles for moving ear forward and around; o - one of the major neck muscles, and attachment to ear for backward movement.



(adapted from Sisson 1953)

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We do not know much about the limits of hearing of cattle. The hearing of cattle is acute but we have no idea whether they hear noises above or below our normal hearing range. We do know, however, that they are capable of considerable analysis of sound. They learn rapidly to discern voice tone and possible individual emphases in human speech. A shouting milkman upsets the cows and reduces milk yield, while gentle milking and murmuring soothes them. Cows, like dogs, can be taught to respond to a limited vocabulary such as 'yes', 'no', 'come here', 'go away'. They are usually responding to intonation rather than individual phonemes, although with careful training, calves could probably be taught to recognise individual words.

Cattle use sound to a considerable degree for communication and transmitting information about the environment, but this is discussed further in the next chapter.

The larynx

Although the larynx is not a receptor we will consider it here because of its relevance to communication which will be dealt with in the next chapter.

The muscular and cartilagenous larynx by closing and opening can control the flow of air from the lungs to cause vibrations which are modified and magnified by the resonating cavities such as the back of the throat, the mouth and the nasal cavities. The cow is a good example of how the functional needs of the animal have changed the structure of the larynx. The first problem is that the cow, being a herbivore, spends a lot of time chewing and swallowing its food. During this time it is clearly important that it continues to be able to breathe and also, (because it must know what it is eating and be able to detect predators that might be around), that it continues to smell. The olfactory mucosa is in the nose, so during the eating and chewing time a flow of air must continue through the nose and over the olfactory mucosa, if the animal is to continue to smell. The cow (and other animals, including gazelles, horses and canids, felids and primates) solved this problem by the development of a flap called the epiglottis. This can cut off the mouth from the air stream which continues to flow through the nose, or it can move to allow breathing through the mouth and nose at the same time. In cattle the epiglottis is the 'wrong' side of the soft palate so that in its usual position it cuts the mouth off from the air stream, which is then forced over the olfactory mucosa. Under extreme conditions, however, (such as when giving a loud call) it is possible for the epiglottis to be pushed beyond the soft palate, to allow air to be exhaled through the mouth (Negus 1953).

Cattle and horses have also evolved lateral channels at the side of the larynx (not present in man and dogs) formed by folds between two of the cartilages, the arytenoid and epiglottis. Food can pass through them without interrupting the air stream,

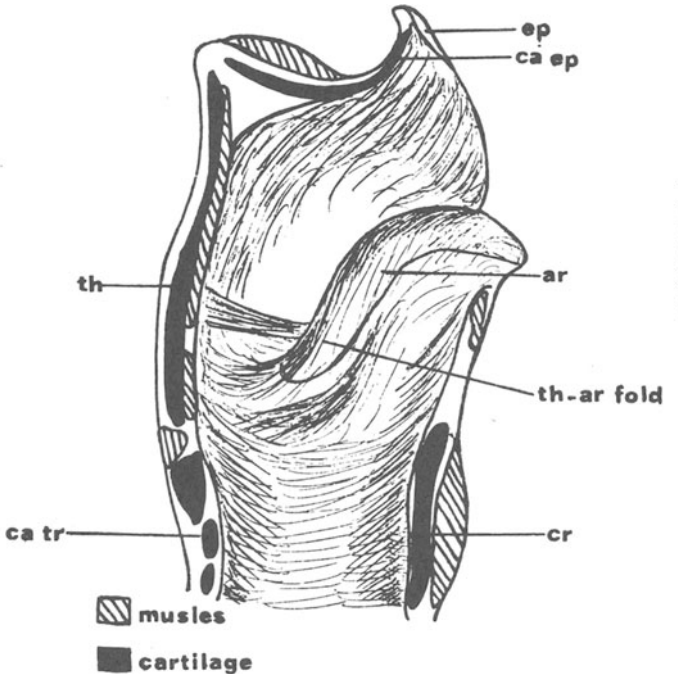
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and they also affect the type of sound produced, often producing pleasing melodic calls.

The middle part of the larynx also varies in different animals. The most primitive type is called a non-valvular larynx (Figure 3). This is the type of larynx that the cow has, together with amphibians and many other hoofed mammals.

Figure 3.

The larynx of the cow.



ep - epiglottis
ca ep - cartilage of epiglottis
ar - arytenoid cartilage
th-ar - thyro-arytenoid fold
cr - cricoid
th - thyroid
ca tr - tracheal cartilage

Most of the rodents, primates and man, however, have what is called a valvular larynx which can act as an inlet as well as an outlet valve. This type of larynx allows for greater possibilities in phonation by easily repeated interruption of the air stream, and greater variations in pitch, tonality and volume. This permits the development of more complex sounds and eventually human language. The flat-margined larynx of cattle and many other herbivores cannot function in this way. For this reason, we could never teach a cow to speak as humans do (Negus 1953).

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The sound is produced by the larynx, but it can then be greatly modified by a series of resonators. In cattle the first of these is the pharynx (passage-way up to the back of the mouth) which is smaller in cattle than, for example, in man. Herbivorous mammals such as the cow have large cheeks in which they ruminate their food, and these can act as resonators. The position of the tongue, and whether or not the mouth is open, also contribute to the quality of sound produced. Finally the nasal cavity also acts as a resonator. This cavity is large in cattle and allows for the sonorous quality of the 'mm' calls (see page 57).

As we have seen, the larynx varies from species to species, but there is little evidence that this modication has come about purely from the point of view of voice production. Rather, the structure of the larynx has evolved to suit the animal to its particular life-style. Voice and sound production are then affected by the development of the larynx, size and shape of the head, and the dispositions of the various facial and throat muscles. Natural selection influences the association of individual sounds with a particular meaning (see following chapter).

The brain

The size of the brain relative to the body size was considered for some time a measure of relative intelligence. Lately such ideas have become open to question.
Perhaps it is more relevant to look at the relative development of the different parts of the brain as a guide to the cattles' relative abilities. However we must emphasis that there has been very little physiological or anatomical work in any detail on the different species.

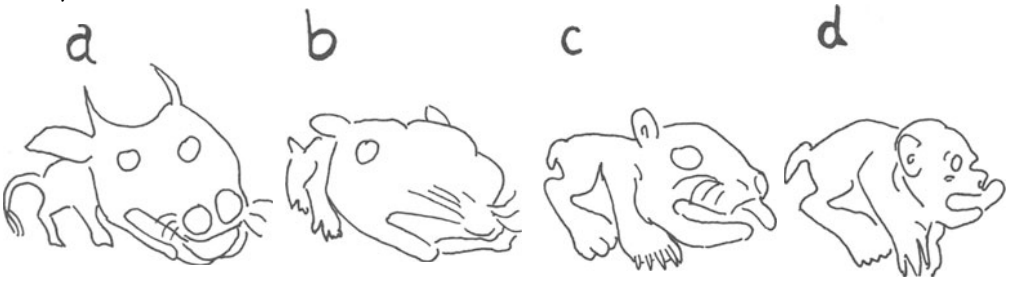
The cerebellum (which co-ordinates reflex and voluntary motor activities), is rather small and hidden beneath a hind part of the cerebral cortex in man . There are bound to be rather more of these motor activities with a large body, four legs and a tail, so a well-developed cerebellum in cattle is only to be expected, and is well shown in Figure 6. Apart from this there is nothing particularly unusual about the hind brain of cattle, as far as we know.

The mid-brain contains the reticular formation and hypothalamus which control consciousness, arousal and sleep. We know that cows have REM sleep, but we don't know whether they dream. When cudding, cows can also be in a very drowsy state, characterised by the synchronized brain waves although this is not the case always when they are ruminating (Ruckebusch & Bell 1970). The pituitary body can be considered the controlling power house of hormone production. The exact behavioural effects of these hormones are not thoroughly understood, but we do know that sex hormones can affect behaviour other than sexual behaviours (e.g. Andrew 1972). The pituitary stalk produces oxytocin which controls milk let down and its production is ellicited usually by conditioned stimuli.This is of importance particularly for dairying.

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Figure 4

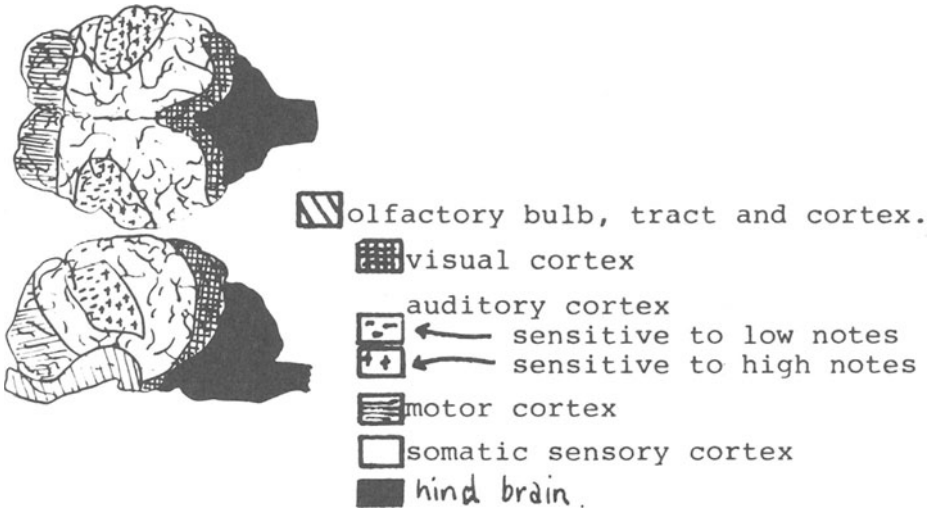
Diagram to illustrate the representation of the body surface in the sensory cortex. (A similar diagram could be constructed for the motor area) (adapted from Rose and Mountcastle 1959).



a = cow; b = rabbit; c = cat; d = monkey.

Figure 5.

The functional areas of the forebrains of the cow. (exact extent of areas hypothetical).



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The pineal gland is also a feature of the mid-brain. This is a small lobe-like body above and behind the hypothalamus whose function was for a long time obscure. However, it is now clear that it controls the reflex effects of light on the retina and through a feed-back system relays messages to other parts of the brain to control such things as daily rhythms of activity, for example, the relationship between sunrise and time of first grazing (Hughes and Reid 1951), although these are also affected by outside influences (Chapter 7).

In the forebrain the olfactory lobes in the cow are quite well developed. They are slightly larger than those in the horse but rather smaller than those in the dog, relative to the size of the brain, which may indicate that greater analysis of smell is possible in the dog than in the cow, and more in the cow than the horse (see Figure 6).

Particular parts of the neocortex deal with the analysis of sensory information: the back with visual analysis, the front with auditory analysis, and the other parts with somatic perception or feeling (Figure 4). There are also areas which appear to deal in particular with 'conscious thought'.

We do not know the exact extent of these various areas in the cow. If we did this could suggest how elaborate the analysis of particular sensory information is likely to be. But Figure 5 gives a rough idea of the various areas. In general, the greater the area, the more analysis, and the more important that sense system must be to the animal. We can see that the cow has quite large areas which deal with 'higher' brain activity, (white area). The representation of the trunk and limbs is relatively small since they do not use their limbs for manipulating objects, while the representation of the nostrils and lips is large, although not so great as it would be in the pig (Figure 5).

The disparity in the representation of different parts of the body may account for the apparent insensitivity of some animals to severe trunk wounds. Tubes fitted into the belly of sheep or cattle seem to distress them relatively little, something quite unthinkable in a horse which presumably has greater trunk representation in the cortex. Figure 4 gives a somewhat hypothetical relative representation of the different parts of the body in the cortex of several species. In cattle, sheep and goats there is no crossing over of sensory information from one side of the brain to another (common in more visually orientated species such as the horses and rabbit). Thus sensory and tactile information from other parts of the body have a close association with olfactory information, suggesting that smell is particularly important for these animals.

We can see a relative difference in the size and development of the cerebral hemispheres (figure 6). One of the important things in deciding the 'intelligence' of different species is not only the size of the cerebral cortex, but also the surface area,

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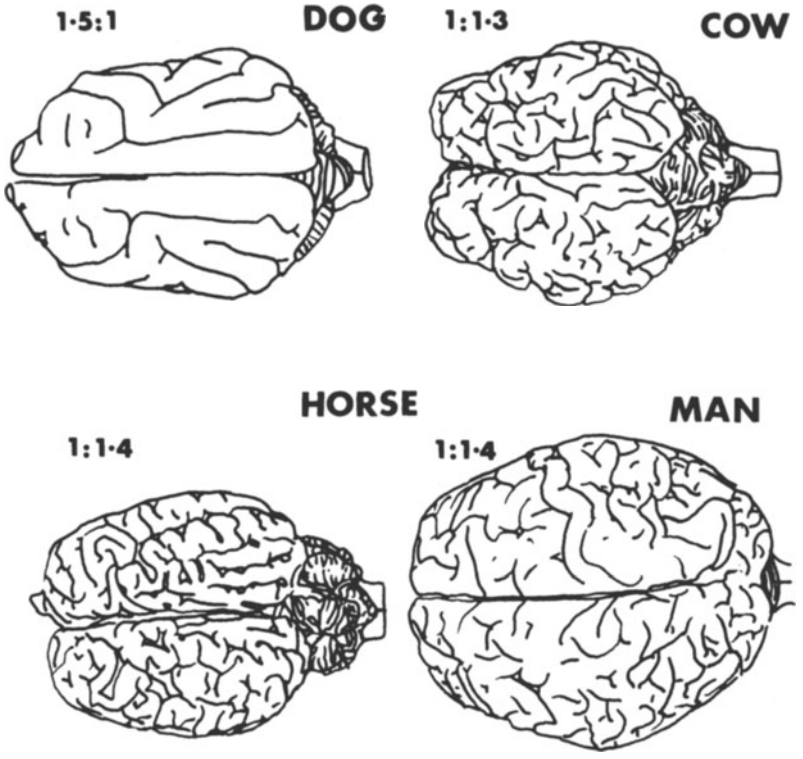
which is indicated by the number of convolutions. It can be seen very clearly from the diagrams that the convolutions of the hemispheres of a dog are very much less than those of the other species. Similarly those of the horse are rather better developed than those of the cow.

The significance of this is not at present understood, nore the relationship of intelligence to the body/brian ratio (e.g.Jerison I97).

Cattle can, of course, learn quite complex things fairly rapidly, but neither their potential for remembering and thinking, nor almost all aspects of their behaviour/neurophysiology have been studied in depth. Man has a 'speech' centre, called the Broca's area. As far as we know, cattle do not have this speech centre, but neither have we discovered what that area in the middle of the left hemisphere does instead.

Figure 6

Dorsal view of the brains of several mammals. Ratios give scale.



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CHAPTER 3

Communication

As far as we know, the ancestors of cattle lived on the plains at the edge of forest (Chapter 1), and there is little doubt that they were social, herd-living mammals. In order to retain their social cohesion they, like other species, had to communicate, that is, convey information about themselves and the environment to each other. Forms of communcation differ, and the particular method (or methods) adopted by a species depends to a large extent on its habitat. There would be little point in nocturnal animals, or animals who live in dark forests, for example, having elaborate visual signals for communcation. Such species (for example, pigs) therefore, tend to communicate vocally rather than visually while plains-dwelling species often have a very sophisticated system of visual communication, a good example being the horse, whose repertoire includes a remarkable number of postural changes and facial expressions (Trumler 1959, Kiley-Worthington 1969 and 1976). Cattle fall somewhere between these two groups. They call fairly frequently, which enables individuals to maintain contact even when they cannot see each other, but they also have a series of different body positions and some facial expressions which they use for communication, the latter particularly at close range.

The types of visual signals likely to catch the eye are short bursts of movement and contrasting colours and shapes. Obviously very conspicuous signals may be detected by predators as well as animals of the same species, so in most species, hunters and hunted alike, there is a balance between conspicuousness for communication and camouflage for protection. Some animals show seasonal variation in their outward appearance. For many birds the importance of the male being conspicuous to attract a mate during the breeding season outweighs the disadvantages of being seen by other species, so they assume their conspicuous plumage in the spring. Some ungulates follow the same pattern in the mating season and black-buck males can be seen dandying around, resplendent in their conspicuous black and brown coats, while the red deer has great difficulty keeping its head up on account of its enormous antlers.

A different ploy for many camouflaged animals is to carry signalling devices, often entailing specialized structures, to be exposed when appropriate, for example during sexual or fighting displays (Walther 1974) gazelles and black-buck have white patches under their chins which become very conspicuous when the head is raised vertically. Rabbits and some ungulates (e.g. the waterbuck) have white rump patches, supposedly for telling others of their kind that they are running away, and therefore warning of danger. The disadvantage is that they also tell the predator, as anyone who has watched a dog chasing a rabbit across a field must have realised! Like many scientific explanations however, this can be taken to extremes, with every odd coloured

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patch or lump on an animal's coat, along with postures or movements that display them, being considered functional for communication.

In cattle, we find that we cannot explain postures and movements on the basis of coat markings since they, like other domestic animals show much individual (but little seasonal) colour variation. However, changing postures can make various parts of the body more or less conspicuous. The horns, tail, four legs, trunk, head and face - including the latter's component parts: eyes, nostrils, ears and so on - can be variously positioned to communicate a number of different messages. From the human point of view, it is the ability to read such signals that makes one a good stockman - or bullfighter!

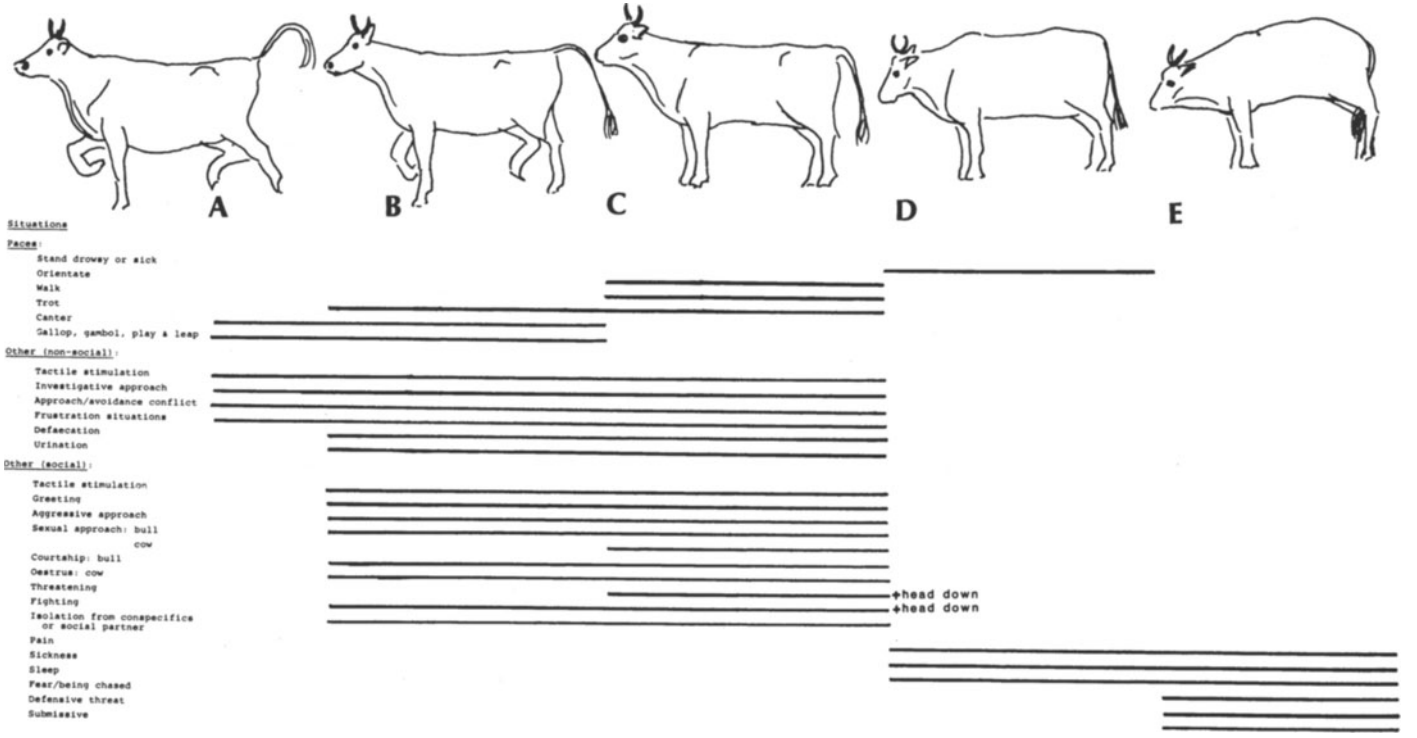
It is very difficult though to assess exactly how far an animal is consciously trying to communicate with others. The straightforward call and reply between cow and calf is fairly obvious, but postural and behavioural communication is not always so clear, especially as the recipient of a signal does not necessarily make any response. Often we are unable to tell what, if any, information has been conveyed. We can estimate to some extent what kinds of signals cattle are able to perceive and how these are interpreted by the brain (see Chapter 2), but until some clear method of judging is established we have to consider the hypothesis that everything an animal does which can be perceived by others has a possible communicative significance. Even if it is not making a conscious effort to communicate, an individual's attitude and behaviour can convey its state of mind to other animals, which can act, or not, on the information they accumulate, depending on how that information affects their own well-being. It is well known how little it takes for a whole herd to become alarmed once one of its members has become aware of something strange or frightening in its environment. This is not necessarily because the originally alarmed animal has consciously signalled to other herd-members, but is more likely to have resulted from neighbours noticing the change in attitude, sensing possible danger to themselves and consequently reacting in the same manner. This change in turn would be picked up by their neighbours, until the whole herd had been alerted.

Since we are taking the somewhat unorthodox view that all movements and noises made by cattle are of potential communicative significance we have to present the material in a slightly unusual way. The conventional way of describing animals' communication patterns is to label them according to the situation in which they seem to occur most frequently - 'aggressive', 'fearful', 'sexual' displays, for example (a 'display' is an exaggerated or stylized behavioural pattern which has acquired a specific meaning for communicative purposes in a species). Many of the everyday movements which are important for communication, do not fit conveniently into these categories, while others occur in more than one. For this reason, we prefer to treat them according to the reflex for which they

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Figure 7.

The postures of cattle and the situations giving rise to them.



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are most obviously associated. These are:

1. Movements related to postural reflexes.
2. Movements related to cutaneous irritation and skin care.
3. Scanning, orientation and investigative movements.
4. Protective movements, including movements related to the presence of horns.

Much of this behaviour has been previously described (e.g. Schloeth 1961, Koch 1968, Reinhardt 1980, Zimmermann-Müller, 1978).

The analysis here is causal and functional rather than simply descriptive.

1. Movements related to postural reflexes

The two main results of postural reflexes are positions of high or low postural tonus. The former involves the contraction of the anti-gravity muscles (those muscles that, when contracted, raise the body higher from the ground), and is characterised by the raising of the head and tail and a generally alert posture. A high postural tonus is usually associated with fast movement, preparation for activity, or an 'excited' state.

Low postural tonus is the result of relaxing the anti-gravity muscles, and the animal lies or stands with lowered head and tail. The position indicates tiredness, preparation for sleep, or possibly that the animal is ill or has been frightened. Low postural tonus can also indicate a lack of confidence or, when accompanied by an extension of the nose forward, investigation.

These postures are summarised in Figure 7 with the type of situations that give rise to them. These responses are common to many species (Kiley-Worthington 1976).

As a particular posture comes to be associated with a particular situation, so it gradually comes to acquire meaning and convey a message. Thus a cow seeing another standing alert and ready to move off is made aware of something interesting, or possibly frightening, in the environment. In cattle and some other animals this simple relationship between posture and excitement is complicated by horns or antlers. Aggressive postures adopted by an excited animal with high tonus (the aggressive, confident dog, for example) are not used in the same way by animals with horns where the head is lowered as a threat and for fighting. These animals, however, do have postures of high tension at such times. The threatening freeze of cattle is of such a type (Fig. 11a and page 50).

2. Movements related to cutaneous irritation and skin care

Warm-blooded animals whose skin is their main insulator against fluctuating external temperatures have to pay much attention to their hair, fur or feathers to keep them in a

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healthy condition. Birds preen and in some cases (for example, water fowl) add oil to their feathers, while animals with fur or hair have to eliminate parasites and other foreign bodies. Cattle are no exception, and many of the activities performed by cattle are related to skin irritation and care, for example, licking, scratching, rubbing, tail wagging, shaking or tossing the head and kicking.

In many birds and mammals activities relating to skin irritation occur in courtship or during territorial encounters. They have been called 'displacement activities' because they appear to be irrelevant to the main activity (Tinbergen 1952). Recent work on birds, however, has shown that such activities are in fact relevant to what is going on, and external factors do have a bearing on what activity takes place - for example, the state of terns' plumage affects their behaviour when they are unsure whether to approach a strange and possibly frightening situation or avoid it and they 'displacement preen' more when they have wet feathers than if the feathers are dry (van Iersel and Bol 1958).

'Attention shifting' often occurs in situations of conflict or 'stress' when both approach and withdrawal are inhibited. It involves the animal under stress apparently losing interest in the situation and either falling asleep or turning its attention to something else - frequently skin irritation, since the body is often itching somewhere, although not enough to interrupt other behaviour under normal circumstances (MacFarland 1965). This kind of behaviour has also been recorded in rats and birds and it is not unknown in humans: diverting the attention of a hurt or irritated child is a ploy frequently used by mothers. The probable explanation is that the animal is able to resolve its conflict by ignoring it and, in fact, when the conflict or frustration is being caused by another animal, the latter is often disconcerted by the apparent loss of interest and stops whatever it was doing so that the situation actually is resolved.

Since 'nervous' scratching and rubbing occur frequently in situations of stress or conflict, they can to some extent acquire a communicative value. A conflict between approach and advoidance is a situation which is very common in courtship, and 'displacement preening' has become a stylised part of some birds' courtship rituals. To some extent self-grooming seems to be part of the courtship pattern in cattle too (see page 60 et seq.) although most movements related to skin irritations have no particular message apart from communicating to others that the performer is 'nervous' or 'excited'.

Rubbing. The most common way cattle rid themselves of skin irritation, mainly caused by parasites, injury or objects touching them, is to rub themselves. Cattle will rub on any convenient protruding object - hay racks, water troughs, partitions and so on. Rubbing is more common in confined

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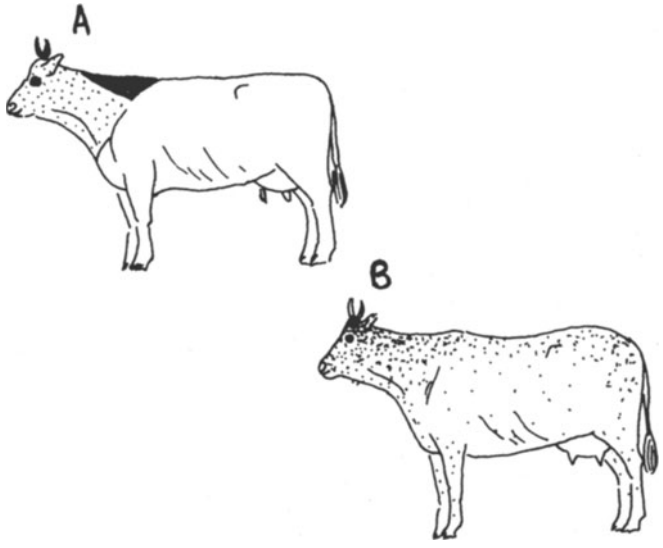
cattle, firstly because there is often less to occupy their attention so that they rub out of boredom (see Chapter 10), and secondly because there is usually an abundance of things to rub against. In the field, cows may have to queue up to rub against a particularly favoured fence post or bush. The amount of rubbing changes not only with the environment, but also with the time of year. Cattle rub very much more in spring when they are losing their winter coat than at other times (see Chapter 5 & 6).

The sight of an animal rubbing probably has very slight communicative value although cattle may find good spots for rubbing by noticing where others seem to be getting most satisfaction. Cows and calves also rub against one another, particularly calves against their mothers and this, with other forms of mutual grooming, probably increases the strength of the bond between pairs of animals within the herd. Pheromones can also be left where others have rubbed, thus adding to the communicative significance (Figure 11b, page 50).

Scratching. If cattle balance on two front and one hind leg they can lift the other hind leg to scratch their head, neck and shoulders (Figure 8A). However, scratching in this way is relatively rare (it occurred on average 0.01 times per cow per hour), and is unlikely to have any particular communicative value.

Figure 8

A. Areas scratched with the hind leg (dotted), and licked (white). Black area : neither.
B. Areas licked by conspecifics (density of dots relate to frequency).



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Licking or 'grooming'. Cattle can lick most areas of the body, as shown in Figure 8. Since they have very rough tongues, this is a particularly effective and frequently employed way of getting rid of irritating itches, but has no obvious communicative function. However, cattle also lick one another and objects they are investigating. The taste of the object provides them with more information about it and since it is also accompanied by a forward head extension this has become a visual signal signifying investigation.

The licking of the newborn calf by the mother may help her to recognise her calf, and mutual licking (demonstrating the bond between mother and calf) does continue into adulthood (Rheinhardt 1980). From the point of view of communication, however, the most interesting licking is that between two cows. The adult cattle we watched spent an average of 0.02 minutes per cow per hour licking one another which is more than, for example, threatening and butting (0.01/cow/hour $p<0.05$). Mutual licking probably helps maintain bonds between individuals and cohesion within the herd, (see page 105.) Licking obviously also helps remove itches and keeps the coat healthy and in good condition. Cows usually lick others in places which the individual cannot reach unaided, such as the head and neck (Figure 8B and 8C). The bull also licks an oestral cow, particularly at the rear end, and prior to mounting. She may also lick him.

Grooming of one individual by another is not, of course, unique in cattle, and in other animals it frequently takes forms other than licking. In studies of dominance hierarchies the most dominant animals in the herd were not found to be groomed by those at the bottom of the hierarchy as is frequently found in primates. Bouissou (1965), in her work with confined heifers, found that those animals which were butted most also received most grooming. Grooming relationships are obviously more complex than they appear at first sight, and are not fully understood (see Chapter 6).

Ear flicking. Cattle flick their ears when they are irritated by flies, but the communicative value is probably slight. In some species, however, (e.g. Thompson's and Grant's gazelles) ear-flicking, together with stamping and often head-shaking, has developed some importance as a signal since it tends to occur at specific moments (for example, as a 'transitional activity' after the animal had been staring at something and before it moves away: (Kiley-Worthington 1976)).

Tail wagging. Few people consider the tail of cattle or horses to have any use other than that of ridding the animal of flies, and this is certainly its primary function. We looked at tail wagging (lateral movements of the tail) in some detail, and Table 3 shows the situations in which it occurred during the winter when there were few flies about. The interesting

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thing to notice is that tail wagging occurred more in a social context than in non-social situations. It occurred especially in situations of conflict when an animal was uncertain whether to approach or retreat, or if it was frustrated in its efforts to attain some goal (the food dish, for example). There is no reason to believe that at such times the animal is suddenly attacked by swarms of flies, so apparently the 'attention shifting' mechanism (see page 39) comes into play; the animal becomes more conscious of irritants and it wags its tail to remove them. In other words the threshold for activation of tail wagging drops and the action is 'disinhibited', (MacFarland 1965). Since whenever the animal is in a 'stressful' or conflict situation it wags its tail, the movement becomes associated with stress and thereby acquires a signal value. However, in cattle such tail wagging is usually accompanied by other movements such as shaking or tossing the head, and therefore it appears to be only a component of the display.

Table 3.

Situations in which tail wagging occurs.

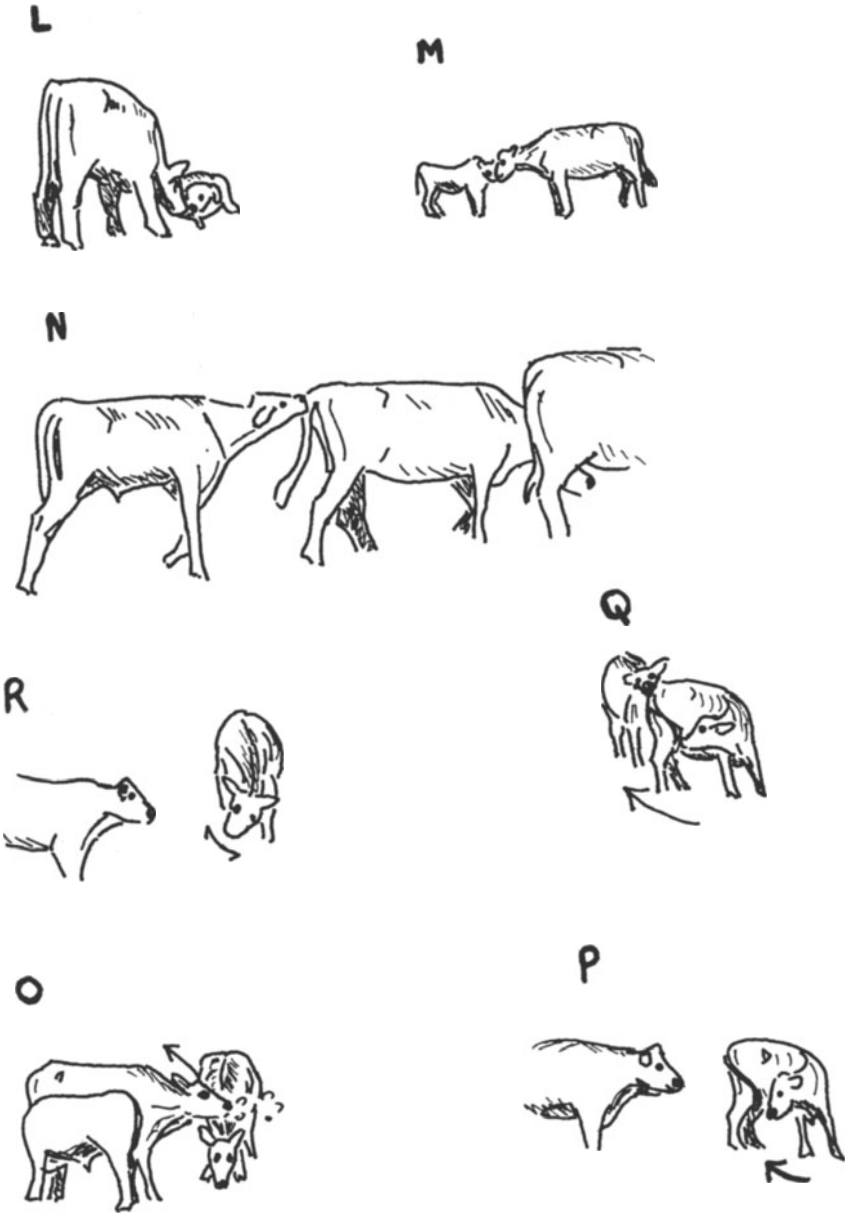
Non-Social situations	Cattle
Thwarting obstacle preventing obtaining goal	++
Forced change of direction or pace	++
Restricted movement or pace	+
Something sought after	
Food searching	+
Tactile stimulation (relief from irritation sought after)	+
Auditory or visual cue of food presence (reminder of something sought after)	+
Waiting for something	
Food	++
To be let out	+
To be milked	+
Transitional types of situations	
After alarm	+
After scratch	+
Between investigative bouts	+
Between movement bouts	+
COnflict between approach and avoid	+
Cutaneous irritation	++

Social situations	Cattle
Greeting	
Equal	+
Inferior wags	++
Superior wags	+
Individual distance violation	++
Aggressive types of situations	
Threat	++
Between fighting bouts	++
Intention to kick	+
WIthdrawal of superior	+
During attacking bouts	
Sexual frustration types of situations	
Pre-copulation, non-receptive female: female	++
Pre-copulation, non-reactive male	+
Pre-copulation, female non-receptive: male	+
Mounting male unable to obtain intromission	
Situations in which contact with conspecifics is sought or retained	
Isolation from young, mother or conspecific	++
Suckling young (mother) particularly during weaning	++
YOung suckling (insufficient milk flow)	++
Between play bouts	

++ = occurs almost always and with more frequent wagging; + = occurs usually.

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Figure 9.
L: Head extended as calf investigates dog.M: Head extend as calf smells another. N: Head extend to smell vulva of another calf. O: cow head tossing on approach of another cow (mild threat). P: head throw to cow to side. Q: Head throw to cow behind. R: Head shake from cow as mild threat to approach cow.

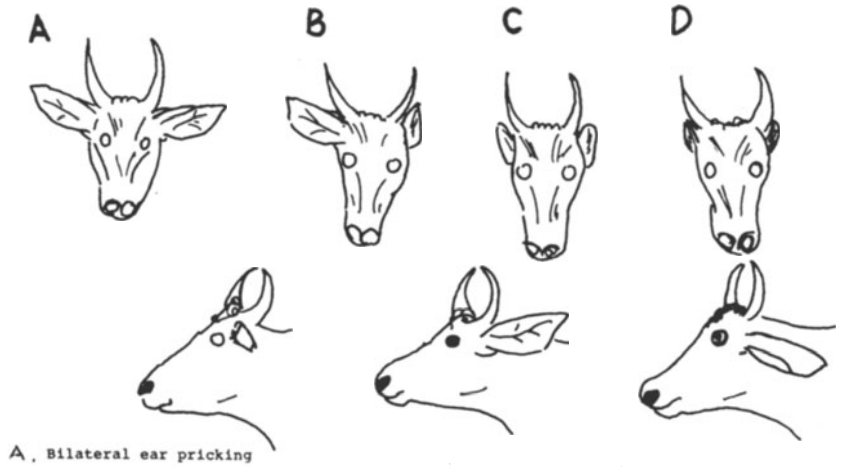


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Apart from the activities mentioned so far which have obvious connections with skin irritation, there are a series of head postures and movements related to itches, which are particularly relevant to communication. These were studied in detail in the eland, where, in an attempt to construe the meaning of messages, we measured the performance of the movement, the situations that give rise to it and the recipient response. Cattle are very similar in this respect to the eland, a brief description follows.

Figure 10

The main ear positions of cattle. Many intermediate positions are used.



A. Bilateral ear pricking

B. Uni-lateral ear withdrawal

C. Bi-lateral ear withdrawal

D. Bi-lateral ear withdrawal and rotation toward the head.

Head-tossing. (sudden dorsal movement of the head). In this movement the animal extends its head forward and then tosses it backwards and upwards (Figure 9), frequently with a noisy expiration. The movement occurs particularly when an animal is not completely confident or alternatively when it is irritated. We observed it frequently (a) in oestral or pre-oestral cows which were finding the attentions of the bull irritating, (b) during mild fighrs, (c) when a new animal was introduced to a herd, and (d) before flight, particularly in the case of calves, when an object which had been under investigation proved frightening.

Head-throwing. The primary motive in performing this action in which the animal throws its head round to hit its flank, is to rid itself of flies and other irritants.

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The same movement is also used as a threat and is further discussed in the section on protective movements (page 48 et seq.).

Head-shaking (lateral movement of the head). This is another movement to rid the animal of flies and irritants around the head and face, but it is also common in frustration and approach/avoidance situations. In eland it was often interpreted as a mild threat (Kiley-Worthington 1978), commonly occurring in aggressive situations where the aggressor usually shook its head more than the less confident individual. Cattle shake their heads in similar situations, and also commonly when a new animal is introduced to an established group (Koch 1968 and personal observation).

3. Scanning and orientation movements

Cattle have a number of behavioural characteristics for maintaining a constant surveillance of their immediate surroundings in order to detect potentially important stimuli. These non-directional scanning movements can lead to interesting cues being picked up and investigated.

(a) Scanning movements

Unilateral movements of the pinnae (external ears). The cow, like most hoofed mammals, has very mobile ears, whose movement is controlled by as many as eight pairs of muscles (Figure 2). The ears can therefore be moved independently to point in the best direction for picking up any interesting sound. Such movements of one or other ears occur mainly when the animal is wide awake, although they do occur to a lesser extent when the animal is dozing or cudding. Their function is obviously to keep a check on what is going on in the vicinity, and they can occur simultaneously with other actions. Cattle can also point their ears backwards if their attention is attracted by a stimulus behind them. Figure 10 shows the ear movements in cattle, and the situations that give rise to them. Note that they do not have an exaggerated ear flattening response such as the equids, rhinos, and camels. The suggestion is that ear flattening in this way occurs only in animals without temporal horns. In such species the ears are much more conspicuous and therefore more useful for visual displays (Kiley-Worthington 1969).

Eye movements. Cattle move their eyes in an exploratory way just as they move their ears. Since the eyes are placed at the side of the head, a cow's field of vision is very much greater than ours, extending to 360° when the head is up (Figure 1).

The main function of eye movements is obviously to gather information about the environment, although it is possible that they have a communicative significance, as they do for instance in the angel fish which flicks its eyes to communicate the direction of its attention. However, it is difficult to detect the eye movements of cattle at a distance of more than a

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a few yards and it is doubtful whether cows use them for communication to any great degree.

Movements of the nose and nostrils. The nostrils of a cow can be moved by a series of muscles (Figure 2) but these movements are only obvious at short distances, so any communicative value they may have can only be effective at close range. In addition, however, when cattle are investigating an unknown object or animal or are emotionally aroused, the nose comes out in 'sweat spots' and at close range these may communicate the investigating animal's general state to other cattle.

(b) Orientation movements

When in the course of its scanning movements an animal comes across an interesting stimulus, it focuses all its sense organs, which are mostly situated in the head, in the direction of the stimulus. This response is an 'orientation' reflex. Apart from the obvious move of turning its head in the direction of the stimulus, there is also a general increase in postural tonus, the ears are pricked forward, and there is a widening of the eyes and nostrils. These movements convey the individual's general motivation state to other animals in the vicinity and alert them to the presence of the stimulus. We will consider the orientation reflexes in turn:

Bi-lateral ear movements. As the ears are pricked, the sensory orifices are rotated forward by the contraction of one set of muscles. Ear pricking is often most pronounced when associated with potential danger, but it is not confined to such situations. A cow may prick its ears as it advances to greet another, and a bull always has pricked ears when trying to persuade a cow to stand for mating. The attacker in a contest will usually advance with its ears pricked, while the less confident individual has its ears drawn back (see Figure 10).

Body orientation. The first move an animal makes to inspect a stimulus is to turn its head in that direction, but if this does not provide enough information the whole body may be rotated with a significant increase in postural tonus. Head and body turning are discussed at greater length in the section on reflexes connected with the presence of horns (see page 48).

Orientation away from the stimulus. This is an extension of the 'attention shifting' and involves the animal looking away from the stimulus. It frequently occurs during a fight, or some other form of direct contact. A bull will frequently turn away from a female rejecting his advances. The cow then stops threatening him, which allows him to get closer to press his suit further, so that the sequence often starts all over again, to the point where it has become a feature of courtship (Figure 11).

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Head extension. This posture is very common in all hoofed animals and members of the cat and dog family. It has often been considered particularly characteristic of courtship since at such times both the male and female smell each other, especially in the region of the genitals (Fig. 15). Before mounting, the bull often performs a rather stereotyped variation of this head extension posture. He holds his head extended and slightly up in order to clear the female's back, while 'lip-licking' and in many cases producing a grunty 'mm' call (page 59). Simultaneously he runs at the female with short strides. Usually she will move forward with a head toss and tail wag when she hears him coming. But if she stands, he will mount her and attempt to introduce his penis.

In non-sexual situations this head-extending posture (Figure 9) commonly expresses interest or enquiry often incorporating some degree of ambivalence or lack of confidence. It is characteristically adopted by strange animals advancing to greet herd members, or by young or small animals approaching a food source; similarly an animal advancing to lick another will have its head extended, as will one soliciting licking from another. In order words, an animal that is not entirely confident advances those parts of its body needed to investigate an object (that is, the mouth, nose, eyes and ears) but until it is sure the object is not dangerous it keeps its legs as far back as possible ready to run away if the need arises. Other animals learn that an animal adopting this posture is not a threat and so they do not react aggressively. The result is that submissive or non-confident animals tend to adopt this posture, especially in response to a threat, since it conveys a message of non-aggression. It has therefore acquired a communicative function although to emphasize its signal character the non-aggressive posture has become slightly more exaggerated than that expressing simple enquiry.

Smell and taste. A close inspection of an interesting stimulus (whether an object or another animal) involves smelling and tasting. The characteristic posture is with the head extended forwards since the nose and mouth must be close to the stimulus. The height of the head naturally depends on the position of the stimulus, and nose and mouth movements may accompany this.

Mouth movements. The withdrawal of the corners of the mouth, used as a threat in biting species, does not occur as such in cattle.

(a) Flehmen. Flehmen, or lip curl, involves lifting and partially turning back the upper lip and closing the external nares while the head is extended forward. The position is held for some seconds. Flehmen occurs widely in many species, and is thought to be connected with the detection of oestrus in the female by the male since it is most common in bulls with oestral females. However cows and calves also flehmen. Estes (1972) suggests that the raising of the head involved in flehmen allows the mucus from the mouth and nose containing the pheromones to

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trickle down onto the vomeronasal gland. The function of this gland had always been a mystery, and Estes' explanation still awaits experimental confirmation. Although no other suggestion has been made to explain this rather conspicuous movement. Like other displays, flehmen could have a somewhat exaggerated form which would alert other cattle to the possibility of mating.

Table 4.
Flehmen recorded in the bull, cows and calves, and the cues eliciting it (numbers per animal per 200 hours). *$p<0.05$ t test.

	To bull	To vulva of adult cow	To urine of cow	To urine of calf	To other Object	Total
Bull	0.50	* 8.00	5.50	1.00	0	* 15.00
Cows	0.46	1.56	1.15	0.31	0.03	3.50
Calves	0.50	0.89	0.50	0.71	0.06	2.70
Total	1.46	* 10.45	7.15	2.02	0.09	21.20

Table 4 illustrates that flehmen is performed by cows, bulls and calves and particularly to adult cows. It also occurs when strong or unfamiliar smells of any sort (but especially of urine) are presented. It may therefore be a way of investigating any substance more carefully by allowing it to get to the vomeronasal gland.

(b) Licking of the lips and nose. The bull lip-licks during courtship and in preparation for mounting (page 60 et seq.) but lip-licking also frequently occurs at other times. Calves lip-lick a lot before suckling or when they anticipate being fed, and cattle lick their lips when they have smelt something strange, or after licking themselves or another animal they have been grooming. We have already mentioned that cattle lick out their noses during investigation of unfamiliar objects.

If a cow licks or smells something distasteful she will attempt to remove the unpleasantness by nodding her head up and down with her mouth open. At such a time she may also wrinkle the sides of the nostrils, and mouth.

4. Protective movements, including movements associated with the presence of the horns.

The horns in cattle are primarily for protection, although they are also used for fighting where there is competition for a limited resource (e.g. food or females to mate). In many species, including cattle, there is considerable sexual dimorphism. The males need large well-muscled shoulders and neck, and short thick horns for the head-on contests in which they push and wrestle their heads sideways, competing with other males for females. The females on the other hand can be smaller

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with less muscular development which is more evenly distributed, they use their horns predominantly for the protection of themselves and their young. Their horns are longer and thinner than the bulls'. Where there is a great deal of competition for females to mate, such as in groups with several males (which is how the untamed members of the cattle family such as the African buffalo and bison live), one would expect greater sexual dimorphism since the larger and stronger the male, the more fights he will win, the more females he will mate with and the more offspring he will beget. In this way the male characteristics relevant to winning mates will be genetically selected and the differences between males and females exaggerated. However fights between males in multi-male herds are rare in Bos indicus (Reinhardt 1971).

An interesting sexual difference in behaviour due to the presence of horns is that bulls will rarely use their horns other than to challenge another bull, or for ground horning (Reinhardt 1980; Schloeth 1961). Bulls' apparently spontaneous aggression to man shown by confined dairy bulls and in the bull ring is very atypical. In bull rings the animal usually attacks only when it has been goaded to a frenzy both before and after entering the ring. Nore does it have the option of running away. From the beginning such a fight is a last defense, rather than a demonstration of overt voluntary aggression on the part of the bull, even though he may have been selected for his aggressive tendencies. The reasons for the extreme aggression in confined and chained dairy bulls are discussed later (Chapter 10).

Cows, on the other hand, have no inhibitions about spiking other cows, calves, or even bulls in the side or rear - although this occurs rarely under field conditions (see page 117 et seq.), like bulls, they have a series of threat postures which preceed spiking and which normally warn an opponent off. The commonly held idea that bulls protect the females and young against predators is unlikely and there are certainly no well substantiated accounts of this in related wild species, such as the African buffalo and bison (eg: Sinclair 1974 & McHugh 1958).

The current common practice of removing the horns from cattle has not generally affected their communicative behaviour, although it may have led to a difference in the frequency of threats and butts. The form of the threat, is of course, genetically determined, and will take many generations to change.

Fighting. Unlike many hornless species cattle never strike out with their front legs in a fight. They always fight one another head on, and in bulls this takes the form of a ponderous wrestling match. The opponents may spend 30sec to 1 hour pushing, shoving and attempting to turn the others head (Figure 11). Before and after the fight there are a number of typical threat postures (posturing, head lowering, head and body turning) which are discussed below.

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Figure 11a

Sequence from photographs of aggressive encounter between two cows 1-2 days post-parturiant. N: head lower threat. O: head lower threat and circle. P: posturing (enlarged in V). Q: smell ground. R: pawing. S: head rubbing. T: head butting

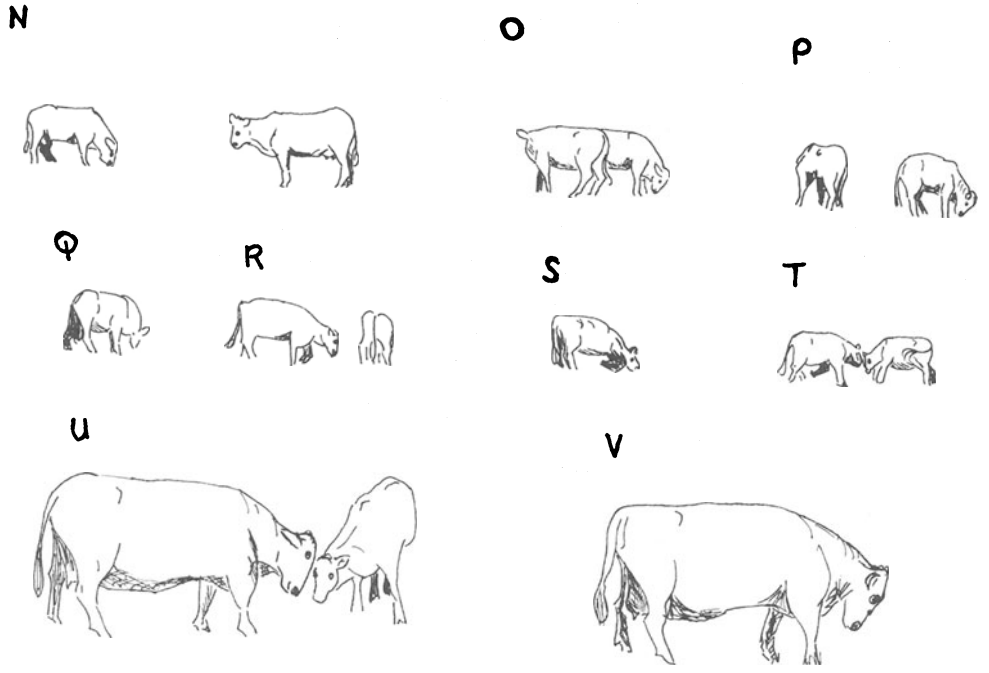
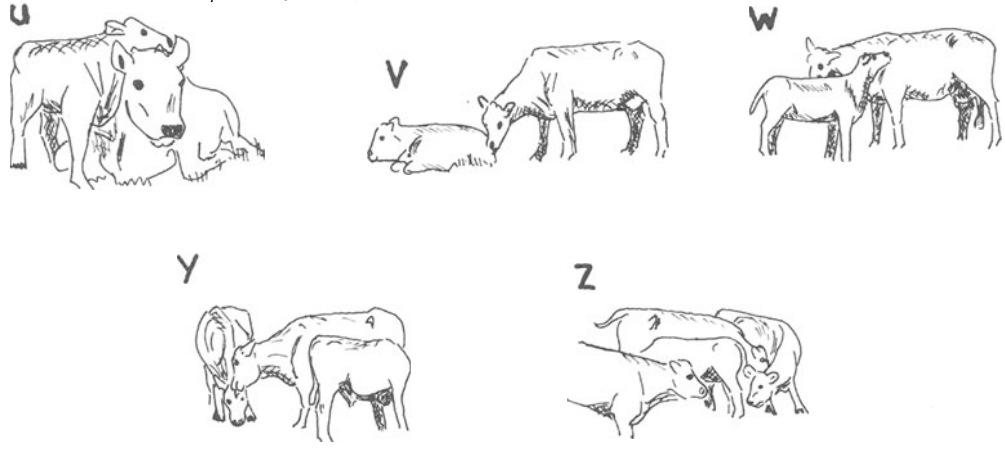


Figure 11b.

Affiliative Behaviour. U: calf rubs mother. V: mother licking calf. W: calf licking mother. Y: cow licking cow. Z: cow rubbing cow.



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Cows fight in the same way except that they do not twist the neck around in such a ponderous manner and usually their fights last for only a minute or so before one of the animals breaks off and either turns or runs away. Fighting is relatively rare between cows who know each other, and in groups of bulls in the absence of females. This is illustrated by the bulls kept in large herds by the Milk Marketing Board; these animals are rarely involved in serious fights, in spite of frequent threats. Fighting is more common, however, when more than one bull is confined in a group with females that are coming into season, but we do not know if this would be the case if cattle were allowed to associate in their natural groupings. Wild bison and buffalo often associate in herds with several adult males without the males fighting frequently (Sinclair 1974; McHugh 1958).

Posturing. This high intensity threat can be maintained for up to two minutes, during which time the animal occasionally blows loudly through the nose . The animal lowers its head and pulls in its chin, which has the effect of pointing the horns forward; the eyes are often rather protruberant and the ears are at right angles to the head. Posturing is not necessarily directed straight at the opponent. More usually in fact it is performed broadside on, and for this reason it has been called the 'broadside threat' (Geist 1966). Previously it has been observed only in bulls (e.g. Fraser 1966) but both the autumn and spring-calving cows that we observed performed this display, although it was confined to periods just before and after parturition (recorded 55 times from cows) or on the introduction of a strange animal into the herd (5 times from cows). Reinhardt (1980) also saw this in Bos indicus cows.

Posturing tends to be performed by cows and bulls as part of a series of threatening actions (Fig. 11) . Although on several occasions it was directed at the observer, it was normally directed at another animal, and I (M.K-W) observed three different responses to it: the recipient either (a) postured back, the most usual course, which was sometimes a preliminary to fighting; (b) withdrew; or (c) continued to approach, smell and lick the posturing animal, but with the head extended forward.

This posture, in common with associated displays (i.e. pawing and head rubbing) is more common in beef than in dairy cows. This may mean it is associated with the presence of the calves (which have of course been removed from dairy cows) or alternatively may vary with different breeds (see also Rheinhardt 1980).

Head lowering. The lowering of the head without withdrawing the chin (Figure II.N), is not maintained in the statuesque way which characterises posturing. It serves as a

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threat when it is followed by butting, or butting movements, if the animal at which it is directed does not withdraw. Alternatively it can be followed by a rapid head extension and toss if the animal is uncertain whether to threaten or avoid its opponent.

Of course the head is also lowered without having threatening implications for such activities as eating, dozing or being licked around the neck.

Head and body turning. The turning of the head towards an approaching animal can act as a threat, simply because of the presence of the horns. A fairly common and characteristic gesture is that of a cow tossing her head sideways and back to hit her flank (Figure 9), the same movement as that to get rid of an itch. It occurs most often when a bull approaches her from behind with the intention of mating. This frequently discourages the bull, but if it does not, and he continues to press his suit, either the gesture will be repeated, or the cow will turn her whole body about and either attack him or attempt to mount him in return. This sometimes leads to horn clashing and fighting, but more often the bull will try to remain behind the cow with the result that the two animals circle around each other (Figure 15.1.)This is a common courtship sequence, but it has also frequently been noted between females, when it is obviously merely a result of irritation.

Ear withdrawal. The pinnae or external ears can be withdrawn singly or together. Withdrawal is particularly common in aggressive encounters when withdrawing the ears renders them less liable to injury in head to head encounters (see Figure 10). It seems likely therefore that the origin of this movement was related to protection. It is usually the less confident individual which withdraws its ears, consequently ear withdrawal is often a sign of lack of confidence and/or submission.

Cattle also turn their ears backwards to investigate potential danger approaching from the rear but the posture is not distinguishable from the protective ear withdrawal. (Kiley 1969).

Tail withdrawal. Cattle, along with such species as dogs, cats and eland, can withdraw their tails right in under the belly (Figure 7). The movement serves, of course, to protect the rear end, hind parts and genitalia. It occurs commonly in sleeping or scared animals, or in animal which are being chased or attacked from behind. A cow will also withdraw her tail if a bull or another female attempts to mount her when she is not in oestrus.

Pawing and head rubbing. Apart from all the aforementioned movements, there is also a series of movements (illustrated in Figure 11) normally associated with attack in the bull, but which we found to be common in all beef cattle, particularly around parturition. It usually begins by posturing to an adversary, then pawing, head-rubbing and posturing again.

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Pawing is an activity performed by most ungulates at one time or another. It is usually associated with the search for food or water (mountain goats, sheep and ponies survive the winter by pawing for food; oryx survive in the Kalahari by pawing for water) but this is not the case in cattle which in cold climes would apparently starve rather than search for food by pawing away the snow. Although bison will search with their heads up to 1m. deep in snow (Sambraus, personal communication). Horses will paw as a sign of frustration, when restrained by a rider or when unable to eat their food fast enough, but cattle do not paw when frustrated and the origin of this movement in cattle is difficult to suggest. Its function in association with head-rubbing and this sequence of threatening behaviour is clearly to expose an area of mud or dust for the head to be rubbed in. The site chosen for head-rubbing is usually a small hillock, molehile or steep slope beside a track, where vegetation is sparse. We mapped the sites in the herd's summer pastures (see Chapter 8). In the cattle we observed, pawing would be repeated from two to fifteen times, either with one leg or both alternatively, sometimes interrupted by posturing and smelling the ground. Finally the animal would bend its front legs and rub its forehead and horns in the exposed soft ground. It would then usually stand and posture again or give a 'men(h)' call (page 59). The whole sequence could be repeated several times.

Table 5. The relative number of pawings, posturing and head rubbing per animal for bulls, cows and calves (per 200 hrs observations). * $p<0.05$ (T test).

	Paw	Posture	Head rub	Total
Bull (1 bull)	2.40 *	4.00 *	1.60 *	8.00 *
Cow (32 cows)	0.62	2.50	0.44	3.56
Calf (28 calves)	0.03	0.0	0.14	0.17
Total	3.05	6.50	2.18	11.71

Table 5 shows the number of occurrences of these sequences in cows and calves as well as bulls. Previously the sequence had been thought to be confined to bulls and possibly related to the male hormone testosterone (Fraser 1968) and Schloeth (1966) but see Reinhardt (1980).

We can conclude that cattle have a large range of visual signals which they use frequently, particularly at close range. The stance of the whole body and of the individual parts can all have a communicative function, but there are few easily distinguishable stereotyped movements to compare with the many ritual displays of such animals as birds and fishes. Rather, the meaning of a certain behaviour pattern can be judged by the degree of intensity or manner of its performance. (see Kiley-Worthington 1978 for discussion).

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Tactile communication

Although the communicative significance of touching may not be immediately apparent, a close study does show that calves frequently touch one another, particularly in winter when they keep close for warmth, but adult cows too spend a considerable amount of time near, and indeed touching, one another (7% of observations see Figure 30). Most people do not consider that touching is very important in communication among hoofed mammals other than during sexual encounters, yet this result illustrates that it occurs much more frequently than expected. Touch may, therefore, be more important in the development and maintenance of bonds between individual cattle than had been thought.

In cattle, touching can be with the nose or tongue during the mutual groomings, or simply standing close enough for parts of the body such as head, belly or flank to touch. Mothers and calves contact one another much more. Fig. 19, page 82 compares smell, rub and lick (a & B). Some of this time is taken up with sucking, but they also characterisically spend alot of time standing or lying so that contact is maintained. (Figure 24, page 93).

During courtship the bull constantly touches the cow by resting his chin on her back, frequently smelling and touching her vulva, or when attempt to mount. This prolonged process of courtship, which involves tactile as well as visual, auditory and olfactory communication, may be important in promoting the female's excitement, and thus facilitating conception (Fig. 40, page 116).

Olfactory communication

This, with gustatory communication, is one of the areas about which least is known, largely because our own olfactory receptors are so poor and our olfactory communication is consequently strictly limited.

We usually think of carnivores (dogs and cats, for example) as being the greatest users of smells for communication, but there are indications that it may be just as important to the prey species. For example, many antelope and deer have scent glands which produce substances relating to territorial, sexual and individual recognition (Ralls 1971). Although cattle have no obvious specialized skin glands producing such pheromones, it does not follow that pheromones do not exist in cattle. Bouissou (1971) tested to see whether cows could recognise one another by smell alone, and found that although they could, they found visual identification easier. Nevertheless, we found that cattle spend quite a lot of time smelling one another and since a cow will reject calves that do not smell like her own (see Chapter 8) it is probable that cattle do discriminate between individuals by smell (see also Fig. 19, page 82).

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There is much smelling of strange animals if they are mixed with a resident herd, and it is also possible that because the herd lives as a group in one place, eating similar food, it develops a 'herd smell' unlike any other.

Cattle also smell the urine and faeces (both rich sources of pheromones) of one another, and on several occasions I (M.K-W) have watched both cows and calves following a fresh scent when looking for each other, so presumably even footprints leave at least a short lived individual smell which is strong enough to be identified and followed. The best known pheromones in cattle are those related to sex. The bull will identify oestral cows by picking up the scent from the vulva or in the urine. Cows also react to the presence of the bulls, probably partly as a result of sexual pheromones.

Often in species that hide their young, the young are said to have practically no smell for the first few days of life to reduce the risk of attracting predators, but we have little information as to whether this is the case for calves. Initially cows recognize their calves by smell as well as by sight, but it must be the smell of the birth fluids that the cow first recognizes on the calf, and we do not know whether the calf's skin glands are producing their own individual smell (which the cow presumably comes to recognize through association with her own) at birth, or whether they take several days to start functioning.

We still have much to learn about olfactory communication in cattle, and indeed in other animals. Cattle may well have a complex network of olfactory communication, in which head rubbing, choosing places to lie down and other such activities play a part. The individual pheromones though await identification.

Gustatory communication

Tasting and smelling are closely related activities in all animals, but it is particularly difficult to distinguish between them in cattle.

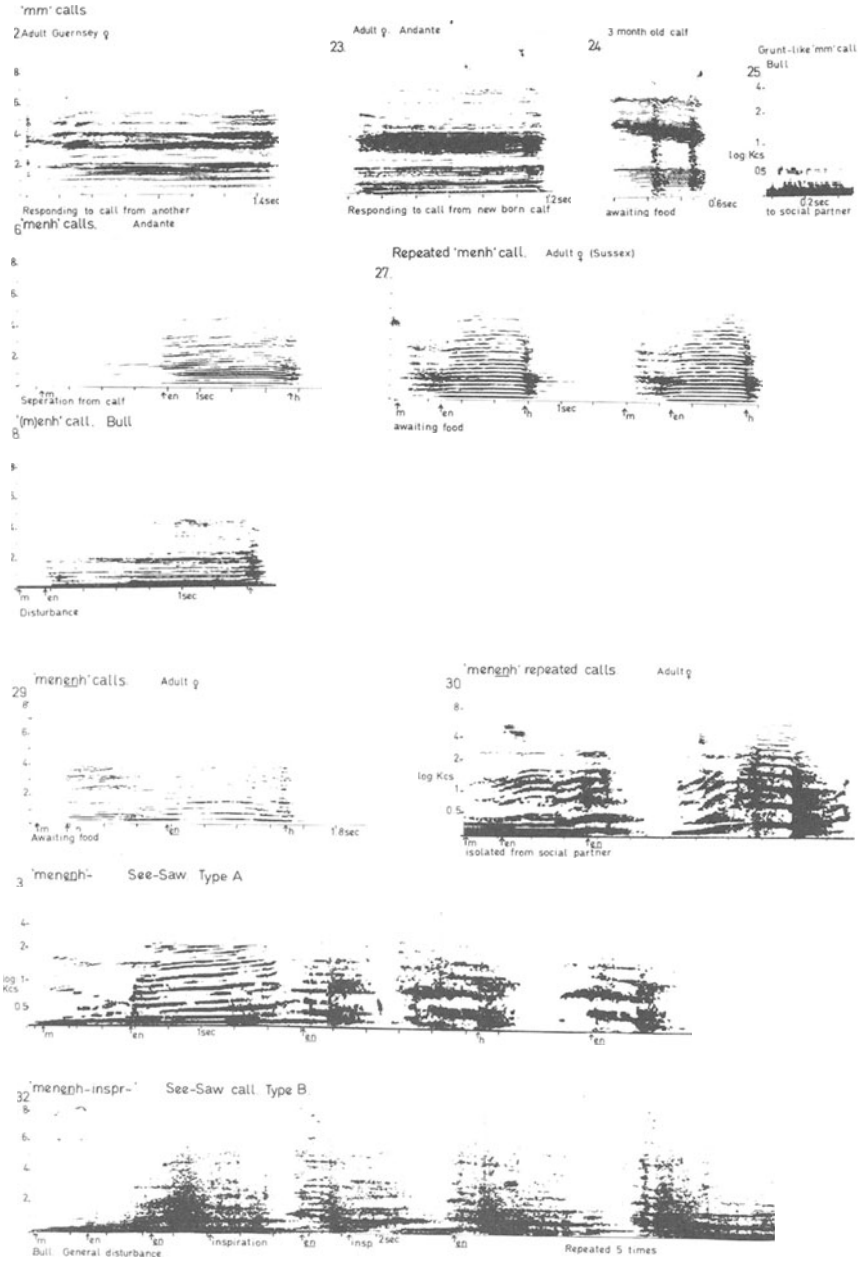
Cattle frequently lick objects they are investigating, because presumably this increases the efficiency of investigation by adding gustatory and olfactory cues. They always smell and lick something new before eating it.

Cattle may well taste as well as smell the difference between individuals during their grooming session, and even an individual cow's milk may be recognizable since a cow will more readily accept a foster calf if it has been fed or washed in her milk. Most of our ideas on gustatory communication are pure conjecture, however, and there is still a great deal to be learnt.

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Figure 12.

The calls of cattle (from Kiley 1972).



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Vocal communication

It is of course possible for cattle - or other animals - to make sounds that are not produced through the larynx. Cattle make chewing, burping, farting and blowing noises and they also make much noise just moving about - all of which can convey messages about the performing animal's general motivational state, although any communicatory significance is probably incidental. We shall not consider these noises here, but rather concentrate on the vocal calls.

The interesting thing about calls and the organs necessary to make them is that their primary and probably only function now is for communication. This is not the case for visual displays where, for example, the tail, legs, head and horns have other more obvious functions.

Different species use vocal communication to differing degrees depending on their lifestyles and habitats, and their vocal systems therefore vary in sophistication. Cattle are among those that use their vocal repertoire quite readily (more than horses, for example, but less than pigs).

Despite their common occurrence and familiarity, cow calls have not been studied scientifically in any detail to date (other than my own work, Kiley 1972). Schloeth (1961, 1966) describes two different calls in the wild Camargue cattle but he made no tape recordings. Darling (1946) considers that "the range of sounds all called "moo" such as the tiny, expectant moo of the cow who has finished her turnips and is ready for some hay, and ....the greedy moo of the cow who sees the skep of corn-lick coming along....are nuances of expression immediately comprehensible to other cattle and are capable of arousing similar emotions in them and consequently herd behaviour." It is however, open to debate whether a man, or even a cow, would be capable of interpreting all these various calls in isolation from other cues such as a knowledge of the calling animal's situation. The following account is an attempt to furnish a detailed description of the calls of cattle and to evaluate their meaning and importance.

Tape recordings were made from a herd of Guernsey dairy cows and a herd of Sussex single-suckler beef cattle. Crossbred Guernsey/Hereford/Charollais and Angus calves isolated from their mothers were also recorded. The bull vocalizations were recorded from herds of dairy bulls (Friesian, Ayrshire, Jersey, Guernsey and Dairy Shorthorn) as well as from isolated bulls. Table 6 defines the various parameters that were measured and we have included sonograms of the different calls (Figure 12). A total of 250 calls were analysed.

The parts of the calls can be divided up into syllables.

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Table 6

The parameters in the calls of cattle.

Syllables:-		mm	men(h)	(m)enh		See - Saw Type A (m)(en)EN	See - Saw Type B men EN-Insp
Length in seconds of syllables	mm	0.5-2.8	0.1-1.1		0.1-1.7	0.1-0.7	0.7-0.3
	en	-	0.3-2.8	0.9-2.4	0.1-0.3	(0.1-0.2)	0.1-1.2
	EN	-	-	-	0.5-1.1	0.3-0.6	0.2-0.4
	h	-	0.1-0.2	0.1-0.4	0.1-0.4	0.1-0.4	0 -0.1
Total time of call (in secs)		1-3	0.5-4.1	1.0-2.8	0.8-3.5	0.7-2.3	T 1.0-2.5 Insp 0.3-0.5
Repetition		-	up to 10x	-	normally before seesaw 10x	1 - 20x	1-13x
Amplitude:	mm	1-m	1-m		m	(m)	(m)
	en	-	m-h	h	m-h		h
	EN					h	h
	h		1-m	h	m	m	h
Pitch: in cps	mm	50-125	50-123	-	75-100	75-125	75-125
	en		125-300	125-250	100-250	rise	rise
	EN				500-800	175-500	250-750
	h		-	-	100 drop	drop	drop Insp: 1000-1250
Mouth Open (+) or closed(-)	m	-	-	-	-	(-)	(-)
	en		+	+	+	(-)	+
	EN				+	+	+
	h		+	+	+	+	+
Tonality	m	h	m-h	-	m-h	(h)	m
	en		m-h	m-h	m-h	(m)	l-h
	EN			m-h	m-h	m-h	l-h
	h		l	l	l	l	l
Insp:							l-h
Inspiration		-	-	-	-	-	+

Key:

Length in seconds.
Repetition: scored if call repeated within 2 seconds.

Amplitude: l = lo , m = medium, h = high, scored by ear.

Tonality: This is the degree of sine waves, in the call: Low(l), medium(m) or high(h). Where it is high, the musical characteristics predominate. Where it is low, square sound waves predominate and the call is "noisy" rather than musical and has no pitch.

Pitch: This is the pitch of the fundamental - the tone actually heard. It is expressed in cycles per second.

Mouth open or closed: This is important because it changes the characteristics of the sound by changing the resonating character of the mouth.

Inspiration: Whether or not there is a vocalized inspiratory phase.

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The calls, the situations in which they occur and the 'accompanying behaviour'

Table 6 gives a summarized quantitative description of the calls formed by the grouping of the syllables.

The 'mm' call. This call is of the lowest amplitude, usually only audible up to twenty feet from the calling animal.

The 'mm' call has many of the characteristics of a call for easy localization and retaining contact within the herd (see page 62). It presumably serves mainly to aid individual recognition at close distances, particularly between mother and young, and so helps to maintain herd cohesion. Even people can readily tell individual cows apart by this call. Common examples of its use are (a) cows calling their young calves, (b) when a member of the herd which associates frequently with the caller approaches, or calls (c) on the approach of a familiar handler, (d) while waiting to be milked or waiting for food, and (e) by a bull with an oestral female and vice versa. It is also given during sexual behaviour between males, male and female or two females and between bouts of play in juveniles.

The 'mm' call is also the call used by the cow to her newborn calf. She calls if she has a visual or auditory cue. This is a common call, used in a great variety of situations (see Table 7).

Table 7.

The situations evoking the various calls in cattle (+ indicates occurrence).

Situation	mm	men(h)	(m)enh	menenh	SS'A' (m)enh	menenh
Greeting						
Confident greeting	+	+				
Greeting of equals	+		+	+		
Defensive threat		+	+	+		
Aggressive threat		+	+	+		
Fear		+	+			
Close contact retaining	+					
Tactile stimulation	+					
Isolation		+	+	+	+	+
Startle						
Pain/Fear		+	+	+		
Frustration situation	+	+	+	+	+	+
Anticipation pleasant	+	+	+	+	+	+
Anticipation unpleasant	+	+	+	+	+	+
Disturbance	+	+	+	+	+	+

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The 'men(h)' call. This is the most common call, used in a great variety of situations (see Table 7).

The '(m)enh'call. This call is the stockman's holler or roar. It is very similar to the 'mm' call, except that it is louder, the mouth is open, and it may be repeated a number of times. It is given primarily in situations of threat and conflict, often accompanied by pawing and head lowering in a threatening bull.

The 'menENh' call. This is a loud call with the 'EN' syllable of a higher pitch than the 'en' syllable. The call is given where the stimulus eliciting calling however continues or increases in intensity.

The see-saw calls. These calls are usually made by bulls although the cows around parturition may also make the see-saw call with no vocalized inspiratory phase. Both calls are constructed from repeated variations of the 'menENh' call with short intervals between each repeat. The number of repeats in each call varied between two and fifteen (B type call with vocalized inspiration) and from two to twenty in the A type call with no vocalized inspiration. The overall length varying from two seconds to two minutes.

These calls seem to be elicited by any disturbance. In a herd of bulls, if two animals fight or threaten one another, others will give see-saw calls. In effect, they occur in excited animals in which the calling threshold has dropped. Having given a see-saw call, the threshold is apparently raised again as the same animal is less likely to call for some time.

For ease of classification we have summarized the six most easily identified calls, although the range of each call overlaps into the next, thus the difference tends to be one of degree. Each call can also vary considerably between and within individuals (Table 6).

Vocalizations, particularly in bulls but also in cows, occurred in bouts. These are followed by a relatively quiet period before another bout of calling begins. Thus it appears that the system controlling calls can be specifically depressed by performance.

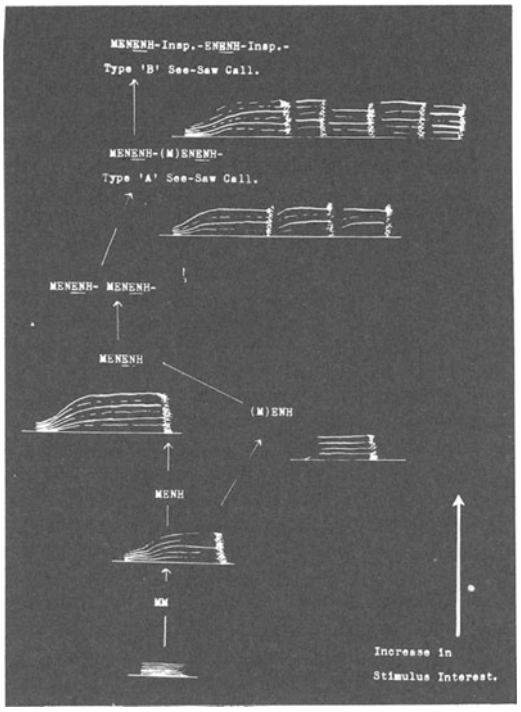
Figure 13 summarizes the vocalization and their interrelationships. It can be seen that increased excitement (frequently caused by frustration) affects the amplitude, frequency, length and/or repetition of the calls. At the highest level of excitement a call is given with a vocalized inspiratory phase.

The emulative nature of calls. The stimulus most likely to evoke a vocalization of any type is a call from another animal, and it appears that this 'emulative' characteristic may also have some effect on the motivational state of the animals involved. If,

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Figure 13.

The inter-relationships of the calls of cattle (from Kiley 1972).



for example, a bull hears a call characteristic of a higher excitement level than his own, he will probably reply with a call appropriate to his own present state. However, if the other animal continues to call, then after a while, the animal hearing the call may well reply with a call showing a higher excitement level. In this way a whole group may be aroused until they are all giving see-saw calls, accompanied by pawing, threatening postures, a general restlessness and often by bouts of aggression. This kind of effect is illustrated in Figure I4. There are, of course, many variations on the basic pattern which depend on the general level of excitement of the individuals involved, the size of the group, and so on.

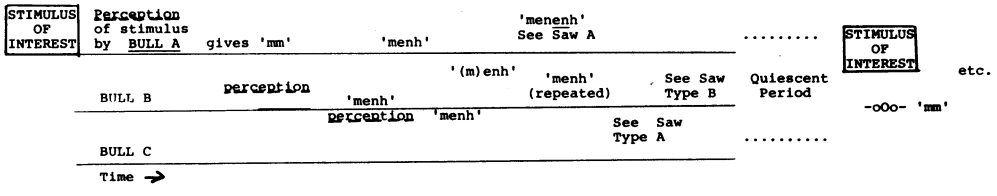
Individual recognition of calls. There is a certain amount of variation in length, pitch, tonality and amplitude each time an individual cow gives a call, but there is a greater amount of variation in these characteristics between cows.

The most individual characteristic of the call is found in the formats or structure of the overtones.

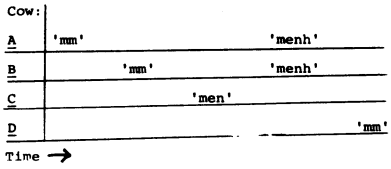
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Figure 14

Diagram of vocalization bout in a group of three bulls, illustrating the emulative effect and change in the vocalizations.



Similar diagram in a group of four cows



Other calls

There are other calls intermediate to those already described.

Location of calls. One factors that has been found to be very important in the evolution and function of calls in birds and mammals, is the ease with which a call can be located. Obviously there are times when an animal is calling when it wants to be located, for example a calf which is lost or separated from its mother. Mating calls and territorial calls are often of this type. There are other times when it would be a definite disadvantage to the animal if it were located when giving a call, for example in giving warning calls. There are other times, such as in calls which function to cement bonds between individuals that are already close to each other, when the ease of location makes little difference.

It is possible to see how Marler's (1955) rules for location of sound are used by cattle when they produce various calls. For example, the most common 'menh)' call is meant to be easily located since it is a call produced when the animal is lost, cold, hungry or separated from the group. Thus it has a reasonably sudden onset and stop, it varies in pitch and amplitude and is often repeated. The 'see-saw' calls are also easy to locate as one would expect from advertising calls.

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On the other hand the 'mm' call and the low purrs of the recently calved cow do not need to be easily located, they are only given when the animals are already close to each other, and are apparently used largely to cement bonds between individuals. Thus they do not have a sudden start and stop; they tend not to have a very varying pitch and they are often quite long, although they may be repeated.

Cattle do not have a specific warning call, but they do give short snorts when suddenly alerted or surprised, like their cousins the buffalo and bison. These noises have all the characteristics of being difficult to locate, they are short with a sudden start and finish and are usually not repeated.

What we can conclude then concerning the vocal communication of cattle? It seems that cattle have a series of calls which they use with facility, particularly around the time of calving (see page 76), or when lost, disturbed or isolated, but these calls are not language in the sense that one call has a specific meaning or only occurs in a specific situation. Rather their function seems to be to inform other cattle about the general motivational state of the calling animal, and the calls must be heard in context to get any specific idea of their meaning. It is possible that cattle calls convey more precise information than we can at present understand, limited as we are by our concept of human language. Cattle calls may well be on a different communicative level that we have yet to appreciate.

Sexual behaviour

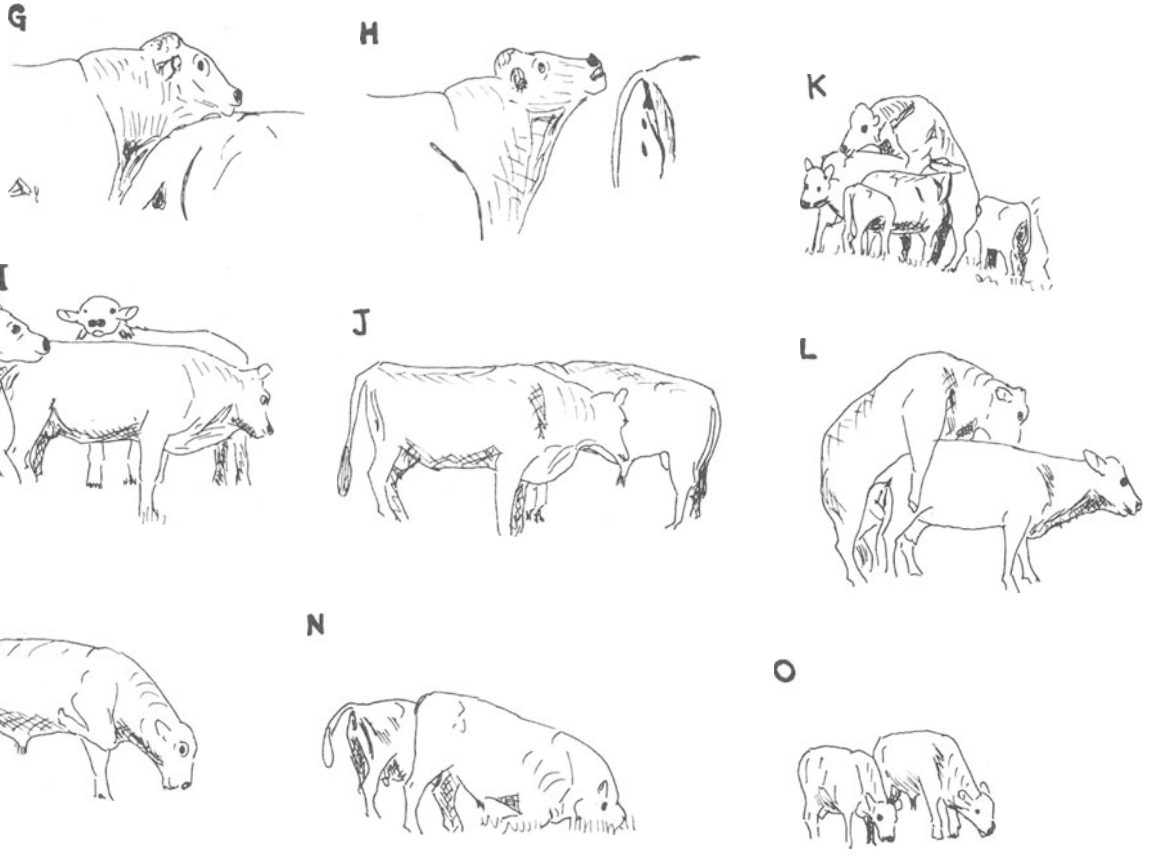
One aspect of behaviour that has received more attention than any other is sexual behaviour, probably because sexual behaviour is more obvious and spectacular than many other activities.

The following description is from our own observations and data complimented by those of Sambraus et al 1974; Zimmermann-Müller 1978; Schloeth 1961). It is an aspect of behaviour in which we can see how all these various communication modalities come together and are complementary in a functional way. Figure 15 presents the display visually.

Usually the first sign of approaching oestrus in the cow, and the one which attracts the bulls' attention, is the cow urinating. The bull sees her and then walks over to the place, smells the ground and flehmens. He may then smell the ground again, and flehmen several more times. After this, he will wander around and by checking the vulva of several cows, smelling with his head extended, he eventually finds the oestral female. Oestrus is detected largely through a pheromone which has not to date been isolated but which is excreted in the urine or from the vagina.

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Figure 15. G: Chin resting by bull on oestral cow. H: Bull flehmen. I: cow-bull circling as bull attempts to get behind cow. J: cow smelling penis. K: mounting. L: mounting and intromission. M: bull pawing after copulation and N: head rubbing. O:"tending" cow and bull after copulation.



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For the next twelve to twenty-four hours the bull will then remain fairly close to this cow, often not moving more than fifteen yards from her side until oestrus is over. She will appear to be setting the pace if they move off, the bull following and yet when one examines this closely, it is evident that she is keeping close to him, just as much as he to her. Thus when a bull is confined near several oestral cows, they do not leave him to wander off and eat even though they may be quite hungry. This close association is called 'tending' and Fig 40 shows how close the pair remain during the oestral period.

As the cow comes into full oestrus, the bull spends more time smelling her vulva, licking her and resting his chin on her rump, side or other parts of her back. He is not always orientated directly in line behind her. Before she is fully receptive, she circles around and prevents him retaining his balance when he tries to mount her. It is in this way that the activity of 'circling' so characteristic of many courting ungulates arises (Figure 15). As the female moves around, so the male moves around to keep behind her. Sometimes she may even lower her head and threaten the bull, and cows occasionally attack a particularly persistent bull with a head lowered run. There is no chase in cattle as there is in many deer and antelope species where the female eventually apparently becomes irritated by the male's constant attention and takes off at a gallop in and out and about the other herd members with the male in close pursuit. In cattle she gives a more sedate occasional leap around to face the persistent bull or they trot rapidly around each other.

The courtship sequence is interrupted from time to time at this stage by bouts of eating, flehmen, or the cow smelling the male's prepuce.

There is considerable amount of licking and smelling of each other which is particularly confined to the head and neck area, although the external genitalia also receive a certain amount of attention from both bull and cow.

For the next few hours, the bull will frequently attempt to mount the cow, usually preceeded by chin resting, erection and a short grunting call. The circling, licking, touching and other forms of contact behaviour appear to excite both the bull and cow.

The bull may mount the cow as many as fifty times before intromission is achieved, and ejaculation occurs within a few seconds of intromission, sometimes while the cow is walking forwards. The bulls then slides off the cow, who may immediately start grazing. The bull meanwhile stands resting for a while, or sometimes the pair lie down close together, often touching. After a break of anything from a few minutes to an hour, the mating sequence is repeated.

After about eight to twelve hours, the cow is no longer receptive and ovulation and probably conception have taken place. The cow gradually drifts back to the company of companions in the

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herd, often followed slowly by the bull who may drift off and begin to accompany another cow. Sometimes the bonds between cow and bull remain strong for some days after mating, even for a lifetime if the bull and cow have been raised together or isolated for long periods together. During the mating sequence there is no tacit recognition of privacy; other cow, calves and steers may congregate around and, in fact, interrupt mounting and mating. The cows often mount the oestral female, or she mounts them. The calves appear to be particularly interested. They mount or try to mount the bull or the cow, although they may mount each other, flehmen and moving around, smelling the bull's penis, and the female's vulva, licking each other and the active pair and generally getting in their way.

If the cow is running out with a bull when no other cows are in oestrus at the same time, she may mate as many as fifteen times during one oestrus. This, together with the mutual excitement of the two animals bought on by their courtship and tactile, gustatory, olfactory and visual cues, ensures that the conception rate is high in normal breeding animals (around 95%) compared with the single insemination administered by artificial insemination after the cow has been isolated from her fellows and confined often for much of the day. It is hardly surprising that the conception rate by AI (artificial insemination) is so very much lower (Esslemont 1980).

Homosexual activity is not uncommon in cattle, although the incidence in domestic cattle may be higher because of the practice of keeping animals of one sex together. The normal way of detecting oestrus, as any cattle man or farmer knows, is to watch for cows mounting each other. It is usually the mounted animal that is in oestrus, although she may also mount others at this time. The cows go through all the same courtship movements with each other, even to the development of a strong tending bond of one cow with another following the full courtship patterns of behaviour. The only difference is that the cows obviously cannot achieve intromission and ejaculation, and they also only rarely make the grunting call before mounting. In some herds there are certain cows that always take over the role of the bull when others are in oestrus. In other herds there are different cows, frequently close companions of the cow in oestrus who take on this role.

Bulls in groups which I (M.K-W.) observed at the Milk Marketing Board Bull Testing Station, will also behave homosexually from time to time, performing all the same activities and adding head lowering and horn wrestling. Sometimes such an incident can turn into a quite serious fight. At other times what started off as a wrestling fight can end with one opponent mounting and riding the other, interrupted by circling, licking and mutual smelling of the penis. We have never witnessed intromission between males but it is said to have occurred. Steers may also go through most or all of the sexual movements with one another, although usually without intromission (Sambraus 1976).

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Many farmers find that keeping a steer with their cows in the absence of a bull is a good investment as he detects oestrus and is easy to spot in the cow herd. This is particularly useful in a group of suckler cows as they often have rather quiet oestrus periods when suckling calves and consequently do not conceive easily with A.I.

The Russians and others (Petropavlovski and Rykova 1958) have shown that the actual presence of the bull affects oestrus and indeed can bring cows into oestrus. Others (van Demark and Hays 1972) have shown that vulval manipulation which causes similar muscular contractions as courtship and sexual excitement can influence the passage of the sperm up the vagina and thus conception. All in all, if one wants easy conception in cows, it is really very much easier and more efficient to keep a bull with them, despite the enormous changes in the widespread use AI has wrought.

We can see from this brief description of sexual behaviour how the various displays we have talked about earlier in this chapter come together and complement each other in complex sequences of messages. Similarly emotional states such as 'aggression' and 'fear' initiate behaviour patterns which incorporate the displays already mentioned.

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CHAPTER 4

The birth of a calf and the behaviour after birth.

It was, of course, necessary to study the mother and calf from the moment of birth. This proved surprisingly difficult since calving time was often on freezing nights in October to November, or between February and March. In our own interests, therefore, we became quite skilled at predicting approaching parturition. These observations may be of use to others and there fore are described.

If the date when the animal was artificially inseminated or covered by the bull is known, then the approximate date of birth can be ascertained. However, cows' gestation can vary from 278 to 290 days (Parkes 1966), so the average length (280 days) is not necessarily accurate. If, on the other hand, the cows have been mating with a bull in the field, not only is it unlikely that one can predict parturition within less than three weeks, but there is not certainty that any given cow is even in calf.

Signs of an approaching birth can be divided into physical and behavioural clues.

Physical changes associated with approaching parturition.

The first external sign of approaching parturtion in the cow is usually the slight swelling of the vulva, which begins at between three months to six weeks before the birth. In a heifer this will be accompanied by a rapid growth and swelling of the udder which will have begun shortly after conception. In the multiparus cow, however, there will not necessarily be any change in the udder until between a week and a few days before the birth. Then the bag expands and looks 'tighter' with the teats pointing outwards rather than their usual downwards or inwards direction. This swelling of the udder may occur suddenly over the last days; alternatively it may be a gradual change and not be obvious. Accompanying the swelling udder goes a further well-marked swelling of the vulva, which (usually about four to five hours before parturition) may begin to exude a clear mucus.

The third sign of approaching parturition as gauged by many stockmen is the softening of the sacrosciatic ligaments so that it is possible to place a fist in the crater created at the base of the tail.

These signs do not always occur in the same order. It is for this reason that the few who have attempted to study parturition in cattle have used internal vaginal examination (e.g. Selman et. al. 1970). However, these workers studied their cattle in specially designed maternity boxes while we concentrated on studying beef animals in the field. These animals are not used to any form of handling and certainly would not allow internal examination without considerable restraint.

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Behavioural signs of approaching parturition.

One of the usual signs before giving birth was that the cow would become "restless". This was apparent by the frequent interruption of what she was doing; the cow would graze in short bouts, interrupted by short periods of walking or standing and staring around, lying, getting up and circling.

Many social mammals approaching parturition will leave the herd (e.g. red deer, fallow deer or sheep - Lent 1974), but a purposeful separation from the herd was rare among cows. Rather, during the course of this "restless" behaviour, pre-parturient cows would tend not to synchronize their activities with the herd to the same degree as usual and this often resulted in their being left behind as the herd grazed on. Of the twelve parturitions that we recorded in detail. the greatest distance of the cow from another was two hundred yards and the least five yards. More than half (55%) of the cows were between fifteen and fifty yards from their neighbours - which is only slightly above the 'typical' distance between cattle in a herd (see page 106 and Figure 30).

Another behavioural clue which proved useful in determining approaching parturition was calling. The characteristic call of a cow to her calf is usually described as a 'purr', although Selman (1970) calls it a grunt. This is the low 'mm' call (Fig 12). This call is frequently directed at the calf during the first two to three days of its life. However, it was also made by six of the twenty-four cows three to four hours before birth and in these cases proved a valuable aid to predicting the time of birth.

The cow cuds and eats less at this time; and usually she stops both activities about thirty minutes before the birth. Here again there are exceptions: some cows may apparently continue cudding between contractions, or even take an occasional mouthful of hay or grass.

As parturition approaches, many cows turn the head around to stare at the flanks. As the contractions begin, a cow may also rotate her ears backwards indicating that her attention is directed towards the contractions.

A particularly interesting set of movements that was frequently recorded in cows during the three weeks before giving birth was the posturing, threatening, circling, pawing and head rubbing (Figure 11); this sequence was performed before parturition by fifty cows in the two herds (a total of 126 animals). The incidence of these activities after birth was even greater (158 occurrences of all or part of the sequence were recorded, with twenty cows performing them more than twice). The occurrence of these activities at this time is probably related to changes in the balance of progesterone and oestrogen which occur around birth.

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The birth

This is no place to discuss the physical problems and complications of bovine births, but we will briefly describe a typical birth. Visible muscular contractions may continue between about thirty minutes and four hours after the breaking of the amniotic sac. This is the first thing to appear out of the vulva followed by the front legs of the calf. The cow during this time will continue restlessly walking about, lying, standing and circling. As soon as the amniotic fluid is released she will turn about, smell it and eat the grass and even the earth on which it has fallen. Thereafter she will not normally move far from the place until the calf is walking. Most cattle (80% of those watched) lie down for at least part of labour, particularly when they have severe contractions - sometimes lying out flat, at other times lying on the sternum but stretching the upper hind leg out and back when the contractions are particularly strong. 41% of the cows grunted with the contractions. Between contractions, apart from the frequent 'mm' calls, many cows would walk about and pull at grass, giving no indication that they were in labour. Other calls such as the 'menh' call (Figure 12 and page 56) were sometimes given between contractions, apparently directed at other herd members. The higher amplitude, 'menENh', call was occasionally given during particularly severe contractions.

Selman (1970) observed that cattle giving birth in enclosed boxes lie down until the calf's head and forequarters appear. The suckler cows in the field showed the same behaviour: lying for the very severe contractions as the head passed through the pelvis and vagina, and then standing. The calf might have dangled half out of its mother for as much as three or four minutes before a further contraction ensured the passing of the hips. It is a curious sight to watch a dangling calf begin to blink and breathe, apparently taking notice of its environment, before even totally out of its mother, a real example of the precocity of the young of this species.

As soon as the calf drops to the ground, provided the mother has not had a particularly traumatic birth, she will turn round to smell and lick it, although she may clear up any amniotic fluid first. The sight of the calf is instrumental in eliciting the purring 'mm' call from the mother, even if she has not called previously. We studied three heifers giving birth and they were all slower to turn round and pay attention to the calf than the more experienced cows. They took between ten and thirty-five minutes to touch it, whereas the multi-parous cows took between five seconds and two minutes.

During birth, contacts with other cows were rare, but where they did occur, it was always the non-parturient cow who approached the other, usually with a head extended in the 'inquisitive' posture (page 43, Figure 9). She would frequently smell the vulva of the parturient cow, and thereafter she might flehmen (page 47).

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Table 8. Generalized outline of behaviour of dam and calf for the first three hours post partum.

Time from birth of calf	Dam	Calf
5 - 10 mins	lick calf/eat contaminated bedding/call repeatedly	lie with occasional leg movements and head shakes.
30 mins	lick calf in short bouts/pass and eat afterbirth/calling	First attempts to rise, collapsing and rising.
40 mins	standing/calling	
1 hour	lick calf/calling	standing unsteadily.
1 hr 20-30 mins	standing/calling	attempts to walk/dam sniffing.
1½ - 2 hours	standing/smell and lick calf	teat searching/sucking teat in short bouts.
2 hours - 2 hours 30 mins	grazing/eating/lying	investigating/walking.
2½ hrs - 3 hrs	lying and cudding/standing and cudding	lying.

Post-parturient behaviour

For a period of three hours after birth all the activities of the cow and the calf were scored on check sheets so that an accurate quantitative record was made of those first very important hours in a calf's life. Quantitative observations were made continuously (see page 15 et seq.). Definition of activities (Table 2, pages 22-23). By using this method it was possible to score accurately activities that were short in duration and relatively rare. In the following analysis, therefore, the total time for the performance of any behaviour that occurred for periods of over a minute is given (such as lying, standing, licking, rubbing, eating, sucking and cudding), whereas the number of times short activities are performed is given (these are: calling, smelling other individuals, leaping, head shaking, attempting to get up and falling).

Table 8 gives a summarized outline of the behavioural sequence of the cow and calf for a three hour period after birth.

How the cow and calf divide their time between these activities is represented for maintenance activities in Figure 18, page 81 and for social activities Fig. 19, page 82 where it is also compared with

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that for the rest of the lactation. It can be seen that there is a marked difference in behaviour during these first three hours.

Table 9.

Recordings of several behaviours of dam and calf for first 3 hours post-partum for 11 cows and 12 births.

Cow	Age of cow (years)	Amount of licking (mins in 3 hrs)	No. of licking bouts in 3 hrs	No. of calls per hour	Time to 1st stand calf (hrs)	Total time teat searching (mins)	Time to 1st suckle (hrs)	Total time suckling in 3 hrs (mins)	Size of calf	No. of falls and rises of calf
Helen	3	5.17	24	99	0.98	5.00	1.33	23.00	Small	38
17	3	13.27	51	31	3.45	8.14	2.98	3.4	Small	3
Dolores	4	39.50	21	-	2.75	12.45	3.62	0	Large	22
CG1))	4	12.81	13	149	3.36	10.11	2.38	3.04	Small	31
CG2)	4	1.5	4	53	3.58	15.06	3.40	0	Small	-
Winifred	5	21.4	19	100	3.20	13.54	2.83	6.52	Medium	13
Peggy	4	39.24	42	163	0.50	15.44	2.42	2.0	Small	20
Sylvia	6	23.54	26	37	2.00	7.24	1.42	3.42	Medium	19
Pamela	12	37.49	27	64	0.98	18.68	4.04	0	Large	23
Spot face	12	23.5	19	133	0.33	20.19	2.61	2.59	Medium	19
Old lady	14	38.5	30	50	0.50	5.02	0.63	4.53	Medium	12
Rachel	18	12.58	8	34	0.33	24.01	3.61	0	Medium	9
Mean	7.72	22.2	26.2	83	1.83	12.90	2.45	4.04		

The following detailed account of the first 3 hours post-partum of dam and calf discusses the more important activities performed by the dam and then the calf using data from 12 parturitions.

The dam

Smelling and investigating the calf. Normally the cow's first activity after the birth is to turn round, often while calling, and smell the calf before beginning to lick it. However, two of the ten cows licked the calf without obviously smelling it first.

This initial smelling usually lasted from one to ten seconds. The cow also occasionally smelt the calf for up to five seconds at a time while licking it. The average number of smelling bouts by the cow of the calf for the first three hours after birth was 4 per hour, although this varied between 1 and 11 per hour. This is much higher than for later periods (between one week and six months the average number per hour was 1.16/hr Table 13).

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This suggests that smell is particularly important at this time. It may be that she is attracted to smell the calf in the first place by the similarity in smell to her own, since it has just emerged from her body; although it is also covered in amniotic fluids, which contain waste products from its own body. This early smelling probably aids olfactory recognition of the calf by the mother thereafter (see Chapter 8).

The first contact the mother has with the calf is normally to smell its back or shoulders, and after licking them dry she then smells other parts of the calf that remain wet, such as the face, nose, legs, perineum and umbilicus.

Investigating inanimate objects. Smelling and licking of the calf is often interrupted by the cow smelling or licking and eating the ground, soiled bedding or other objects such as coats, stones and tree stumps. Most attention is directed towards objects that have become contaminated with amniotic fluid. In this way more time is spent by the cow smelling and investigating objects in the environment than at any subsequent time (average of 0.36 min. per hour after birth compared with 0.13 minutes per hour from one day to six months old t test $p<0.01$).

Licking. Most mammalian mothers lick their newborn young, particularly if they are hairy. It appears to be important in stimulating blood flow in a warm-blooded animal born into a temperature lower than its own. One of the most important functions of licking, after the initial drying of the newborn calf, may be to strengthen the bonds between mother and offspring. Dams continue to lick the calf as it grows older and sometimes this continues throughout its life. Licking might be used as an indicator of a bond between individuals. The close relationship between the mother and her mature offspring shown by licking may be one of the fundamental relationships in the herd structure (see Chapter 6).

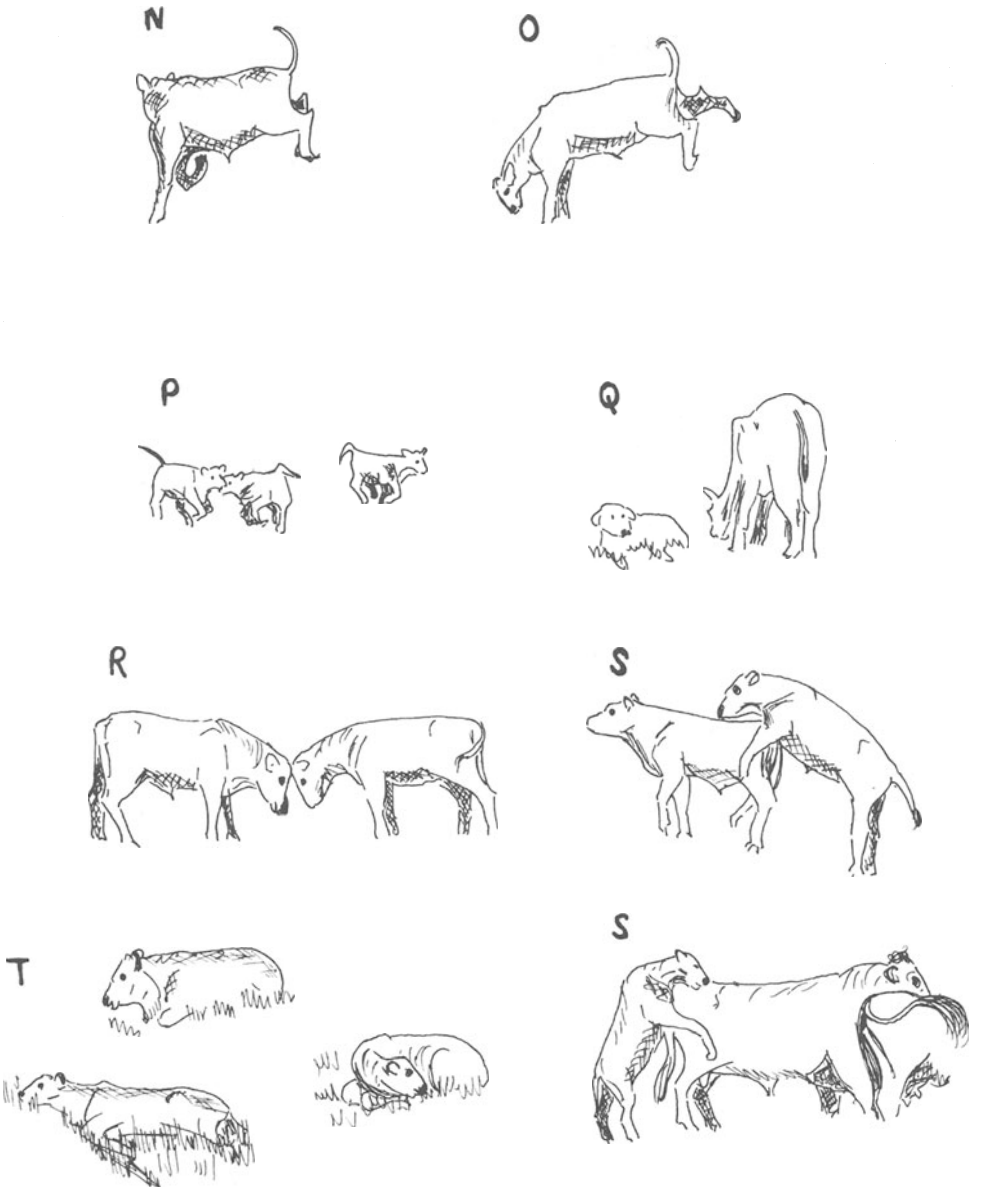
Cows lick their young for much of the first three hours after birth. For the twelve cows recorded after the birth this averaged 22.2 minutes in the first three hours, although there was much individual variation. One of a pair of twins was licked for only 1.5 minutes while another cow licked her calf for over thirty-nine minutes in the first three hours. The total time spent licking the calf was not correlated with the age or past experience of the cow. (Table 10, page 75).

The total time spent licking the young calf may not be as important in the later formation of the relationship as the number of times the calf is licked, and the length of the bouts. Table 9 column 3 shows the number of bouts for the different cows during the first three hours after birth. The majority of these licking bouts were very short, less than a minute (66%), but there is much variation between dams. Spearman rank order correlation indicates that there is a correlation between the amount of time spent licking, and the length or number of bouts (Table 10, column 2 , $p<0.01$). In other words, those cows that lick most do so in many bouts.

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Figure 16.

Calves playing. N and O: calves bucking and leaping. P: chasing. Q: investigating. R: head butting. S: mounting. T: calves lying positions, sternal flat and foetal.



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Figure 17.

The frequency of licking bouts of different lengths performed by the mother to the calf for the first 3 hours after birth (total 249 bouts).

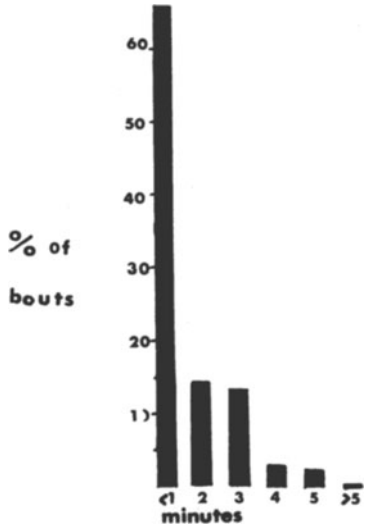


Table 10.

Spearman Rank Order Correlations for the performance of different activities of dams and calves for first 3 hours post-partum.

	No: licking bouts	No: calls of dam	time to 1st standing of calf	Time calf teat searching	Time to first suckle	Total time suckling	Age of cow	Size of calf	Total falls & rises of calf
Amount time licking	0.89 P<0.01	0.36	0.04	0.11	0.20	0.06	0.24	0.64	0.19
No. licking bouts		0.08	0.43	0.30	0.12	0.51	0.13	0.11	0.25
No. calls of dam			0.23	0.36	0.31	0.39	0.12	0.18	0.57 P<0.05
Time to 1st standing of calf				0.14	0.10	0.32	0.45	0.04	0.03
Time calf teat searching					0.54 P<0.05	-0.73 P<0.01	0.57 P<0.05	0.46	0.01
Time of first suckle						0.74 P<0.01	0.03	0.58 P<0.05	0.42
Total time suckling							-0.57 P<0.05	0.36	0.32
Age of cow								0.59 P<0.05	0.06
Size of calf									0.02

Figures are values of r_s Spearman Rank Order Correlation (Siegel 1956)

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It has been suggested that the more the calf is licked after birth, the more rapidly it will stand up. To investigate this, we measured the time to first standing and correlated it with the amount of licking that the calves received from their mothers. We found that there was no correlation (Spearman Rank Order Coefficient: $p<0.05$, Table 10, column 4). In other words, from our small sample we found that the amount of licking the calf receives does not seem to influence its time to first standing, nor any of the other variables we correlated with it (Table 10, line 1). Neither were there any correlations with the number of licking bouts (Table 10, line 2). Selman (1970) showed that calves that stand, find the teats and drink soon after birth have a distinct advantage since the mother produces more immunoglobulin (antibodies) at this time and the calf is more able to absorb them. Calves that are early to stand are therefore more likely to survive.

It is possible that calf size may influence how long the calf takes to stand; some people believe that large calves are more likely to survive, while others find that small calves are often more active. A rough estimate of size by eye was correlated with time to first standing and we found that there was no correlation in this sample (Table 10, column 9).

Rubbing. The two cows CG (2) and Helen which spent very little time licking their calves, instead rubbed their heads on the body of the calf. This was not a stereotyped rubbing associated with threatening (page 50), but rather a rub suggestive of an itch. The other cows did not rub the calves.

Calling. One of the most distinctive behavioural changes in the cow around parturition is that she calls very frequently with the low 'purr' or 'mm' call. As we have already mentioned, this often begins before birth, but in all cows the number of calls increased dramatically once the calf was present. The average number was eighty-three calls per hour. After the first three hours of the calf's life, the calls fell off again so by the end of the first week it was less than fifteen. The intriguing question is why the cow suddenly calls so frequently to the calf when she is standing right beside it during this period. The calf makes no overt response to the calls. We did some tests to determine the immediate stimuli that elicited calls and found that any slight environmental change, not simply movements or sounds made by the calf, seemed to be sufficient to elicit a call from the mother. She possibly calls frequently at this time so that the calf can learn to recognise her individual call which she will use when they are looking for each other later on. In other words it may be 'auditory imprinting' of the cow on the calf. This imprinting cannot be mutual at this stage since the calf rarely calls.

This may be supposition, but it is known from work in Sweden on reindeer, a fairly closely related species, that individual dams do recognize their calves' calls (Espmark 1971).

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We can see from Table 9 that there is a large difference between individuals in the amount that they call at this time. This might be related to other behaviour and associated with being a 'good' mother. However the amount of calling does not show any significant correlation with licking or any of the other behaviours scored (Table 10, line 3) except with the 'persistence' (i.e. the amount of getting up and falling) of the calf. This might suggest that the dams calling encouraged the calf to get up and suckle.

Eating the afterbirth (placenta). In all the cows studied (except the one that had twins) the afterbirth came away within three hours, usually preceded by two or three further contractions after about one and a half hours from the birth. There was much variation between individuals. The observed cows varied between eight minutes and two and half hours.

Immediately the afterbirth fell to the ground the cow turned round and began to eat it; sometimes, indeed, she would begin eating the end of it while the rest remained inside her! Consumption of the afterbirth took an average of over nine minutes, varying from three to twenty-five minutes, although the afterbirth was never completely devoured.

While eating the afterbirth, the dam might break off to lick the calf, or contaminated grass or bedding. Afterbirths presented to the cows when cold after three to four hours were sniffed and then ignored.

The function of eating the afterbirth is not entirely understood, and not all ungulates do it. Lent (1974) suggests that the consuming of the afterbirth is a predator defence. It is therefore well developed in 'hider types' (for example, many species of deer) in which the young do not move far from the place of birth. Afterbirth eating is hardly developed, if at all, in 'follower types' such as the horse, in which the young follow the mother from shortly after the birth. The calf falls somewhere between these two extremes, being neither a pure hider nor a follower (see Chapter 6). Consumption of the afterbirth may be partly to reduce signs of the birth but it may also be nutritionally advantageous as a source of minerals and other substances particularly required by the lactating dam.

Contact with other cows after the birth of a calf. Contact with other cows immediately after birth was confined to keeping them away from the calf by threatening and butting. At this time the dams were significantly more aggressive towards other herd members than usual (page 82 and Figure 19) (1.03 butts or threats per cow per hour, compared with 0.27 per hour per cow ($p<0.01$) for the rest of the time to six months post-partum). Other activities such as smelling, licking and rubbing other cows, (reasonably common later) did not occur at all at this time. The other cows were not

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easily rebuffed, and particularly those close to calving would approach and try to sniff and even lick the newborn calf, as well as the mother.

The reason for this increase in aggression towards other cows at this stage is clear. Probably already the mother recognises her calf using the cues of smell, vision, and possibly taste (see Chapter 8). The calf has not yet learnt to recognise the cow, visually at least, and will follow any large moving object unless the mother intervenes by driving away other animals and placing herself between them and the calf. It is clearly of evolutionary advantage to her to keep other animals away from the calf until mutual imprinting is established. This is a gradual process, taking a day or so, but once she has suckled the calf it seems to have some real recognition of her, although it will remain opportunist and try to steal milk from other cows unless they rebuff it.

In a dairy herd where the calves are taken away and where maternal recognition and tolerance is not so rigid (see page 139), a calf born out in the field can be trampled to death by cows competing to mother it. Welch and Kilgour (1970) found that 15% of the Romney sheep they were studying had been 'mismothered'. This was almost certainly partly a result of being confined in a small space so that the mother was unable to keep other ewes away until her lambs had become imprinted on her - such results obviously confuse selective breeding!

Head shaking and tossing. These activities are associated in particular with threatening or being threatened at this time (see page 42-43), and since the mother is keeping other cows away, they occur more frequently than later after the birth (0.26 times per hour, compared to 0.045 times per hour, t test $p<0.01$).

Contact with other calves. Because of her rapid recognition of her own calf, the cow immediately after birth will drive away strange calves. She will normally smell an invader, and if it is not her own, drive it away by butting and kicking it. This is important for the survival of her own calf, since if she allowed other calves to suck her, her own calf might not obtain enough milk to survive.

Distance between the mother and calf. One indication of the strength of the bond between the dam and her calf is the distance apart they habitually maintain. Changes in distance over a period of time tells us about the weakening or strengthening of the bond as the result of either the development of the calf, or changes in the mother's behaviour.

The distance between the cow and calf was noted every five minutes for the first three hours of the calves' lives. Table 11 shows the results for 8 cows. A higher percentage of the time was spent near the calf or touching it than later in its development (see page 107 and Figure 31).

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Table 11.

The distance between 5 cows and their calves for the 3-hour post-partum (numbers of observations 36/cow). Total 288 observations.

Cow	touching	0 - 1 metre	+1 - 5 metre	Over 5m
Pamela	22	14	0	0
Heifer	6	21	9	0
Winifred	5	21	10	0
Peggy	10	25	1	0
Sylvia	12	20	4	0
17	10	20	6	0
Old Lady	15	15	6	0
Rachel	10	11	15	0
Total:	90(31.25%)	147(51.04%)	51(17.7%)	0

During the first three hours of the calf's life the cows spent more time touching their calves than later in the lactation and they also spent more than half their time within one metre of their calf. Again this is significantly more than at any time afterwards (see page 82 and Figure 19).

Since the calves were lying immobile and their dams were standing over them for much of the first three hours, the cows can be said to have been responsible for the maintenance of this close bond. At this stage there were no individual differences between the cows as to how far from their calves they stayed.

Kicking the calf. The only cows which showed any resistance to the calf sucking were the two heifers, one of whom (Helen) kicked a total of eight times. The other (17) kicked twice during the three hours. It is quite usual for heifers to do this and the reason seems obvious. The teats are initially swollen and because they have not been used previously are very sensitive. Clumsy sucking, chewing and biting, characteristic of very young calves, quickly makes them sore. It is also possible of course (since the heifers also lick the calf rather less than the more experienced cows), that experience affects the early onset of maternal behaviour and the initial kicking may be a partial rejection of the calf. However, both these animals and five other heifers that we watched had accepted their calves by the end of the three hours, provided the calf had got to its feet and found the teats.

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Maintenance activities of the cow

Figure 18 shows these. The cows spend less time eating ruminating and walking than later after birth ($p<0.05$) but they spend more time standing ($p<0.05$) usually over the calf (Figure 24, page 93).

The behaviour of the calf

The first signs of life in the calf are often the blinking of the eyes as it dangles from its mother's vulva. After falling to the ground, the next sign is, of course, the beginning of regular breathing, often preceded by a coughing splutter. For the next few minutes, the calf lies in a prostrate position. Thereafter it moves its legs and pushes itself into a sternal lying position. Licking by the mother frequently stimulates this movement of the calf.

Lying. Young calves spend much of the time lying down, as we will see later, but during the first three hours of life, the calf spends a rather smaller proportion of time lying than later on. As soon as it is strong enough, and dry enough, it will begin to shake its head and get to its feet.

Head shaking. Another typical early movement of the calf is head shaking, often accompanied by a powerful and noisy expiration. The average number of head shakes during the first three hours post partum was 1.6 per hour. Only two other head shakes were recorded from calves during the remaining 268 hours of recording. Head shaking is therefore particularly characteristic of the very young calf, obviously to help clear out the nostrils and ears of birth fluids.

Attempting to rise and falling. After lying for between five minutes and one and a half hours, the calf attempts to rise in the typical bovine way - hind legs first. These attempts are clumsy and initially rather painful to watch as the calf raises itself onto its hind legs, and sometimes knees, only to tumble back onto its side. The tumbling is often helped along by the dam's continuous rough licking. Attempts to rise were more numerous than tumbles (rising attempts: average 14.7 per hour, tumbles: 1.63 per hour for the first three hours). Some calves tumbled only three or four times, while the highest number was thirty-one.

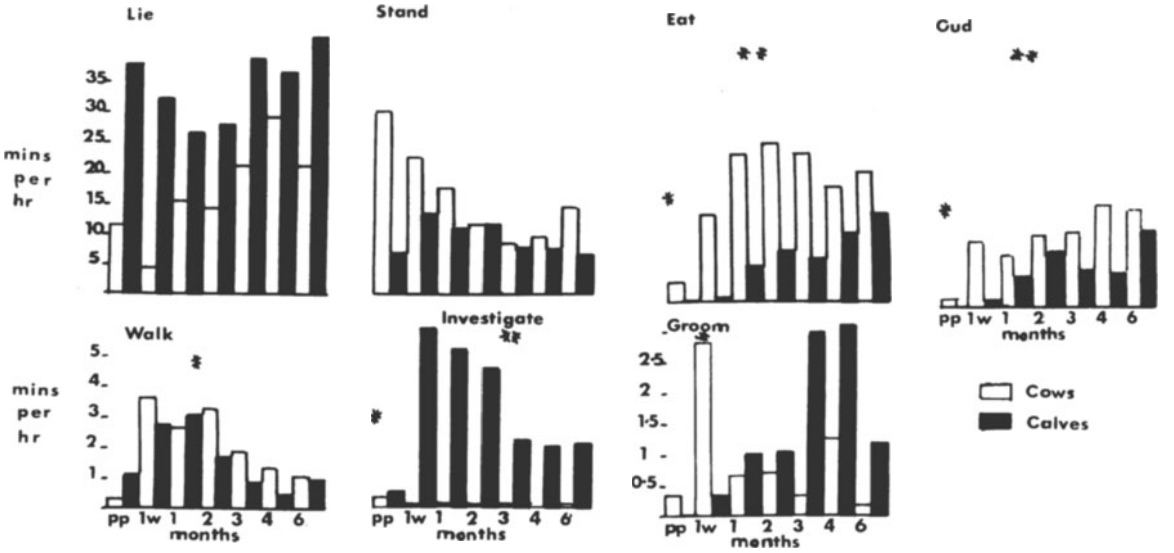
One particular point of interest is that the calves born inside fell more frequently than those born at grass (average twenty times for 5 compared with five times for 6). This is because in the stable, even if on a thick straw bed, the legs of the young calf slip from under it. The process of getting up and tumbling appears to be very exhausting for a young calf, and delays the time the calf takes to first suckling. It would probably be a good idea, therefore, to provide a non-slip surface (such as a deep litter straw bed, or earth) for the young calf if the cow has to calve inside.

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Figure 18. The changes in the amount of time spent in the various maintenance activities for cows and calves from birth to six months old.

White columns = cows
Black columns = calves
Total: 260 hrs observed.
Vertical axis: time (in minutes) per hour observed.
Horizontal axis: time from birth.
pp = first three hours post-partum.
lw = 1st week.
1,2,3,4 and 6 = months old.
* = significantly different from mean.
p<0.05 t test.

** significant trends for calves (Kolmogorov-Smirnov.2 sample test.) p<0.05.

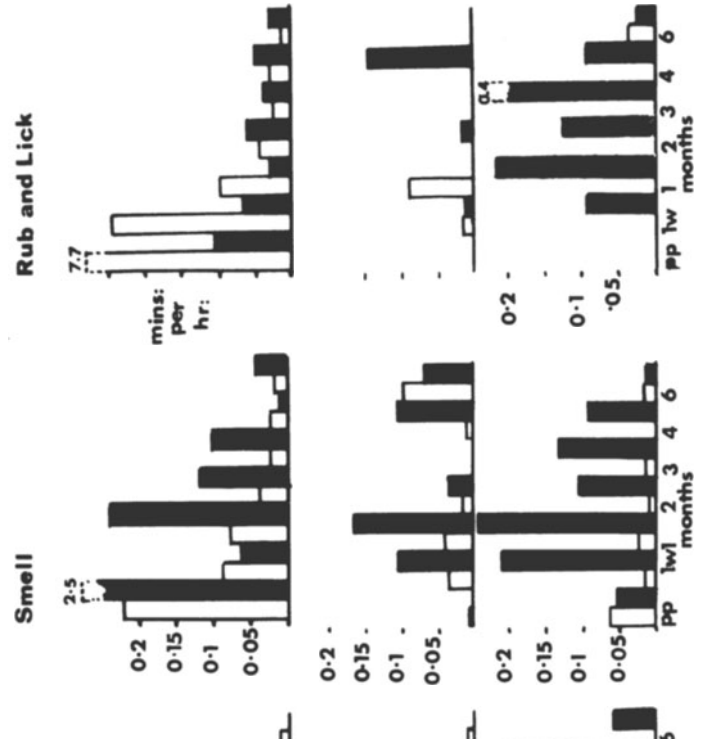


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Figure 19.

Social behaviour of cows and calves from birth to 6 months old.

A = Activites directed at her own calf for the dam, or at the mother by the calf.
B = Activities directed at cows by cows and calves.
C = Activities directed at calves by cows and calves.
White columns = dams/cows. Black columns = calves.



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Standing. Having got to its feet, the calf will then stand rather unsteadily for about thirty seconds to a minute, before taking its first steps. The average amount of time spent standing during the first three hours of the calf's life did not vary greatly from the average for the growing calf (6.3 minutes per hour compared to 6.7 minutes per hour average). The act of balancing on four legs is rapidly learnt. The time the calf takes initially to stand may be an important indicator of viability. We therefore correlated this for 11 calves with other variables (Table 10 column and line 4). We found, for this small sample, that the amount of time before first standing of the calf was not correlated with any maternal behaviour (such as licking and calling) nor with any other behaviour of the calf such as teat searching, time to suckle, or size of the calf.

Walking. As soon as the calf is more or less able to stand, it begins to try to walk, usually to its mother. At first this is a very uncoordinated movement, and may quickly end in a fall. Thereupon the calf will again struggle to its feet, more rapidly this time, and begin staggering over to its mother. Within a few steps, however, walking becomes more coordinated and four of the ten calves were leaping around by the end of the three hours. Walking, is thus a good example in the calf of rapid early learning.

The calves may lie for the entire three hour period after birth, however the amount of walking was not significantly less than for the older calves (to 6 months) (1.1 minutes compared with an average of 1.51 minutes per hour). This was because although the calves did not walk far, they spent some time learning coordination.

Leaping. This involves the rapid forward movement of the forequarters followed by a bucking of the hind, often accompanied by the sideways kick of one hind leg, so characteristic of bovids (Fig. 16,p. 74). It became less frequent as the calf grew older (0.9 times per hour, compared with an average of 0.33 per hour for calves between one week and six months old, T test - $p<0.05$). The calf is precocial at birth, but even so, the rapidity with which they learn to stand, walk and then leap about never ceases to amaze.

Smelling. As soon as the calf is able to stand, it wobbles over to the dam and begins smelling her. Although most of this smelling is related to searching for the udder and teats (see below) olfactory cues concerning the mother's identity must also be picked up.

Smelling of the mother is more frequent at this time than when the calf is older (Figure 19: 2.53 times compared to the average of six months of 0.44 times per hour; T test: $P<0.05$). Any other calves or cows in the vicinity will also be smelt.

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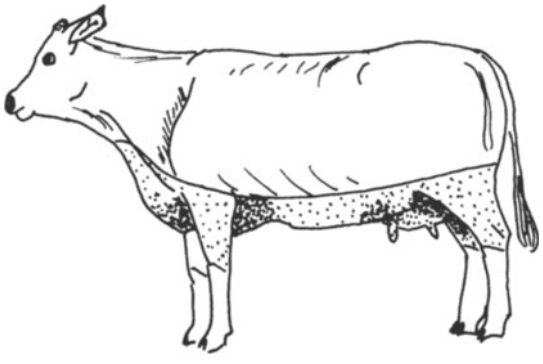
In addition, calves investigate by smelling and touching objects such as stones, grass or bedding, coats, a trough or hay within the first three hours of birth (0.53 minutes per hour), although far less time is spent doing this than in older calves (average to six months 3.18 minutes per hour). The calf, thus as soon as it is able, begins to investigate the environment, and it seems that it learns early and swiftly.

Teat searching. Much of the effort of the calf once it is on its feet and able to walk is geared to searching for the teats. Teat searching has been the subject of some study in lambs (e.g. Barham 1975) and calves (Selman 1971 and Reinhardt 1980). These authors concluded that the calf pushes its nose into any right-angled bend, such as between the brisket or belly, and udder and hind legs. Our observations confirm these findings. The calf is essentially an opportunist and having received no reward in one place, it tries another, until eventually it finds the teat. Some calves may spend a considerable time sucking the hair or skin in the angle between the udder and the belly before continuing down to the teats. The places searched by the calf are shown in Figure 20. If the teats are particularly large the calf may only grasp the edge in its mouth and then give up after obtaining no milk.

The average time spent teat searching was 12.9 minutes in the first three hours post-partum although there was much individual variation (Table 10, column 6). Helen's calf spent only 5 minutes teat searching before finding the teat whereas Rachel's calf spent 24.01 minutes in the first three hours post-partum. Selman (1978) showed that the time spent teat searching is related to the shape of the mother's udder. The calf finds a small, compact udder quicker than a large pendulous one. Most of the cattle were beef suckler cows which had characteristically small udders. Rachel, an old Shorthorn dual-purpose cow, had a large, low udder and in consequence her calf spent the most time searching. There is a significant correlation between the time spent teat searching by the calf and the age of the cow (Table 10 column 8).

Figure 20.

Teat searching areas (dotted). The greater density of dots indicates the greater frequency of search in that area.



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There is also a correlation between the time the calf takes to suckle and the time teat searching, that is the more time it takes searching for the teat, the less it suckles. This is not necessarily a truism since the amount of time teat searching varies greatly. Selman et al (1970b) also pointed out that prolonged teat searching can affect the calf's survival as the search not only uses energy, but can also reduce the calf's intake and absorption of immuno-globins during the first critical hours.

This is confirmed by the significant negative correlation with the total amount of time suckling. This indicates that long teat searching does tend to exhaust the calf (Table 10 line 5).

Once the calf has swallowed a few drops of milk, it will rapidly learn to return to the same place and it will subsequently take very much less time to find the teats. Of four calves that had two sucking bouts within the three hour period, the total teat searching time was reduced from 20.5 minutes the first time to 2.6 minutes for the second time.

Short bouts of teat searching (less than one minute) may continue for several days after birth. However, some of this may be related to learning the smell and general configuration of the mother, rather than searching for the teats.

Smell is another cue apparently used by calves to locate the teats and smearing the teat with colostrum frequently facilitates its localization. This smell may be used as a cue in later sucking bouts when the teats are wet.

Sucking. Within the first three hours after birth, the average time spent actually sucking is low (average 1.49 minutes per hour - average overall to six months, 3.63 minutes per hour), but of course the calf has to learn to stand, walk and find the teats before it can suck. (Figure 21).

The time to first suck correlated with the time spent teat searching but not with the time first standing, nor any of the maternal variables measured (column and line 6, Table 10). It did correlate with the total time suckling ($p<0.01$).

There was considerable variation between calves in the total time spent sucking (from 0 to 23 minutes). Within the first three hours, the suckling bout length is typically much shorter than when the calf is older. Thus 73% of the forty-nine bouts within the first three hours were one minute or less in duration, compared to 8% when calves were from one week to six months old (Figure 22). The very first suckling bout was only from two to twenty seconds.

The calf tends to stick to one or two teats the first few times it suckles, although the amount of teat swapping depends

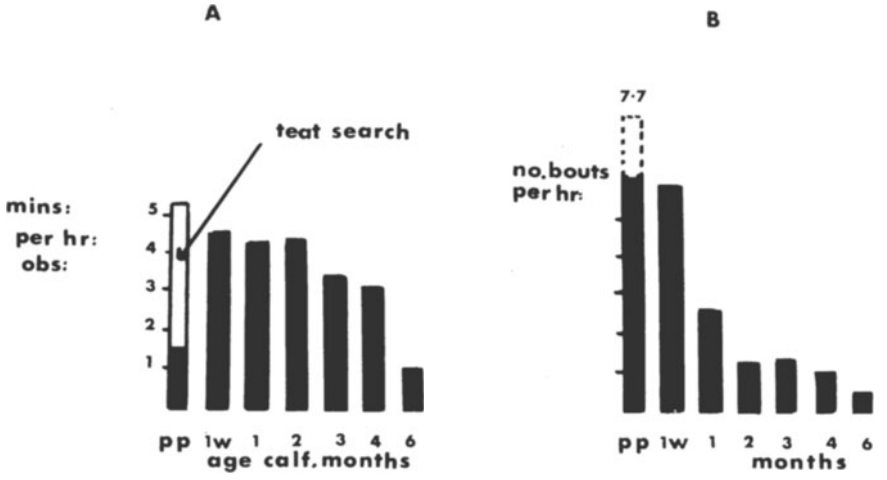
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Figure 21.

Suckling by the calf from birth to 6 months old.

A:vertical axis = minutes per hour observed (total hours 278.5).
B:vertical axis = number of bouts per hour observed.

Note: although there is little change in the time spent suckling (until the calf is 6 months old) there is a very obvious decline in number of bouts as the calf gets older;



initially on the shape of the bag. If the rear teats are lower than the front, as frequently happens in the older cows, then they may not be suckled for up to a week post-partum (eight examples were observed of this). This is of considerable concern for the stockman since the cow may either contract mastitis in these teats or reabsorb milk and have a reduced yield thereafter.

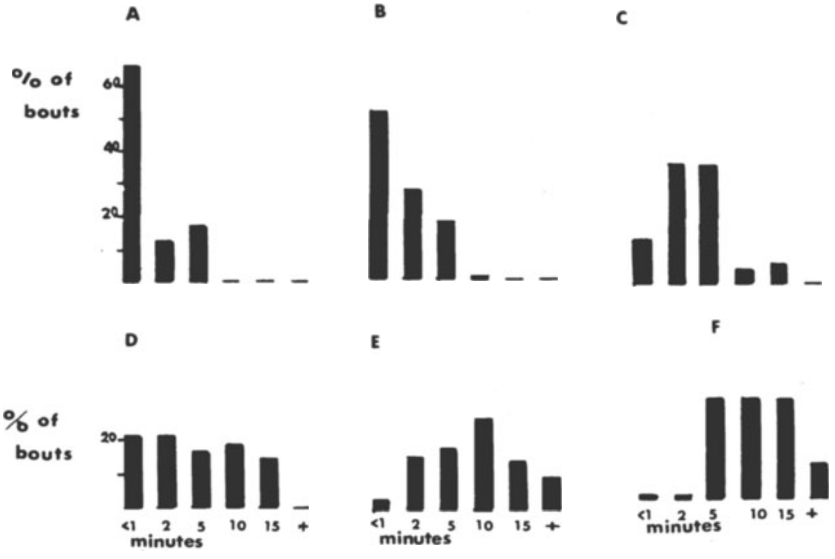
The age (and experience of the cow) and the size of the calf are shown to significantly affect suckling, but not the other behaviours measured here (column and line 8, Table 10). Thus the older the cow, the more time was spent teat searching by the calf, presumably because older cows often have more pendulous udders. The total time suckling, in turn, showed a significant negative correlation with the age of the cow, presumably for the same reason.

The size of the calf showed a negative correlation with the time to first suckling ($p<0.05$). That is the smaller the calf, the quicker it suckled, although it did not necessarily suckle more ($r = 0.36$ $p>0.05$)

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Figure 22.

The changes in the length of suckling bouts from birth to 6 months old. Total no. bouts = 269.



Vertical axis = % of bout of that length
Horizontal axis = length of bout.

A = at birth; B = end of first week; C = end of second week; D = end of second month; E = end of fourth month; F = end of sixth month.

1 = up to 1 minute; 2 = between 1 & 2 minutes; 5 = between 2 & 5 minutes; 10 = between 5 & 10 minutes; 15 = between 10 & 15 minutes; + = over 15 minutes.

The age of the cow also correlated with the size of the calf, that is older cows tended to have larger calves in this sample ($p<0.05$).

Contact with the mother. The calf rubs and licks the mother as well as smelling her, but less than she licks and rubs the calf. If all these interactions with the mother are added together, then we have a total score of 3.18 times per hour. This is significantly higher for the first three hours after birth than at any subsequent time ($p<0.05$) so the mother's high score for interaction with the calf at this time (7.95 times per hour) is reciprocated by the calf (Figure 25a, page 96).

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Calves' contact with others. Calves may smell and even follow other cows at this time. Rachel's calf, which spent three-quarters of an hour searching for a teat on his mother eventually sought and found a teat on another cow, whereupon he was instantly rebuffed with a kick. Interest in other calves is shown even at this age. The new calf (see Figure 19.C, page 82) given a chance, will smell other calves and if it is hungry, will even search for a teat and suck another calf. Later such a behaviour, known as inter-suckling, can become pathological in group-reared calves (Kiley-Worthington 1977 for review).

Calling. By contrast with the almost constant calling of the cow at this time, the newborn calf calls rarely. Calling occurred 1.16 times per hour which was little different from when the calf was older (average 0.93 times per hour).

The calls are of the 'men' type (page 57) with the mouth open, rather than of the 'mm' purring type.

It was difficult to assess what made the calf call. It appeared to be a response to an'uncomforatble' situation, thus it might call if it were cold, or not sufficiently licked; or if it were alone, or ignored by its mother. Occasionally it called apparently in response to its mother's calling - she would then issue a spate of calls while approaching or licking the calf.

Calves also occasionally called when they smelt the dam or another cow, calf or a strange object.

It has been suggested (Andrew 1963) that calling occurs when there is a mis-match in the environment between that which is expected or required and that which is observed. This description although not adequate for some calls, fits well the rather rare calling of the newborn calf.

Self-grooming and scratching. Within the first three hours of its life the calf may lick itself. This did not occur many times (average 0.017 minutes per hour), but nevertheless it is interesting that it occurs at all, since it involves the calf in a complex and elaborate series of movements. It may, for example, try licking its shoulders while on its feet - usually collapsing in the attempt - or it may lick itself while lying.

Variations in learning and persistence in very young calves. It is evident that young calves have a vast amount of learning to do in a relatively short time.

It is, of course, not easy to test differences in speed of learning or persistence under farm conditions, as there are so many variables that may affect this, for example, the size of the calf at birth and its potential for survival, as well as how quickly it forms the necessary proprioceptive connections. Other variables related to the dam and her behaviour, such as the shape

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of her udder or whether she kicks, make a measure of such things as time spent searching for a teat an inadequate assessment of individual learning speeds.

It may be possible however to have some measure of 'persistence' if we sum the number of attempts to get up with the number of falls sustained. This is what we have done in Table 10, column and line 10. The ease with which the calf learns to stand may be related to its size, but there is no significant correlation ($r_s = 0.02$ $p > 0.05$). This suggests that there may be a variation in persistence which is independent of size or viability of the calf, but the sample is too small for this to be conclusive. The only other variable that did correlate with persistance of the calf was the dams calling ($p < 0.01$). This is most interesting and suggests that another function of maternal calling just around parturition may be to motivate the calf to rise.

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CHAPTER 5

The development of behaviour in cows and their calves.

To obtain an accurate record of the changes in the behaviour of calves and their dams it was essential to note practically everything they did. We watched eighteeen cows and eighteen calves from the birth until the calves were six months old (see page 17 et seq. for deails of method) for a total of over 5000 hours. The observations were always made in the morning (between 9 am and noon) so that any effects of daily rhythm would be small.

Our aim was to establish how the animals spent their time and to record the differences in behaviour between cows and calves. We have divided the activities into maintenance activities - eating, grazing, cudding, lying, standing and self grooming - and social activities. The latter took up little time overall (for cows: just over 2 minutes per hour; for calves: 1.2 minutes per hour), but they may be very important for the survival of the calf and the preservation of the herd structure.

Maintenance behaviour

Figure 23 shows the average time per hour observed spent in the different activities by cows and their calves (see page 18 for definitions of the activities).

The cow divided their time almost equally between eating, standing and lying (18 minutes eating and grazing, 15 minutes lying, and 16 minutes standing). Of course the time spent grazing and eating varies according to such factors as the time of day, the weather, availability and digestibility of the grass, milk production and so on. The relative importance of some of these is discussed in Chapter 7.

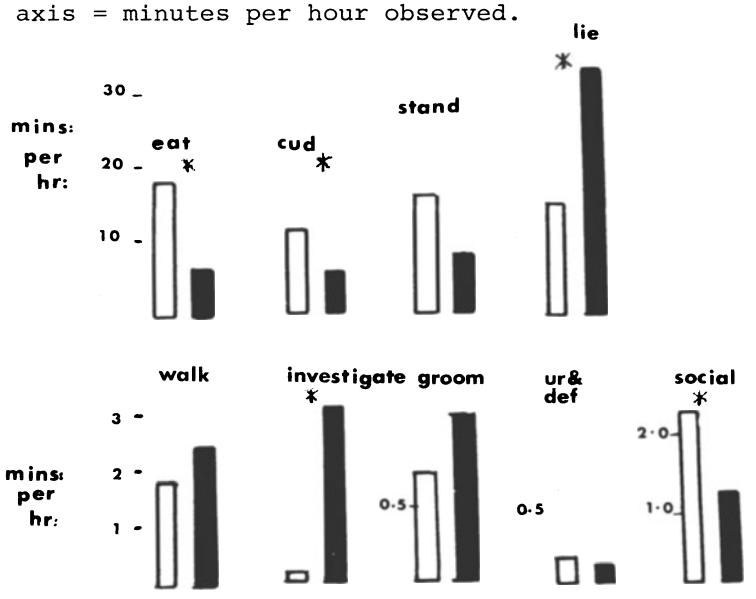
In contrast to the cows, the calves spent more than half every observed hour lying down, and for approximately half this time they were apparently asleep. In the field it is difficult to estimate accurately the amount of time actually spent sleeping. The calves consequently spent less time eating (only about 6 min/hr and standing:8.7 min/hr). The calves also ruminated less (cows: IO.7 mins/hr; calves 5.3 mins/hr). This is to be expected since the rumen is not fully developed in the first months. Calves continue to suck until around 9 months old, and consequently are not during this period totally dependant on grass. Hence eating and ruminating is less.

The cows and calves spent about the same amount of time moving about (cows 1.8 and calves 1.6 minutes per hour), although the calves spent a remarkable amount of time investigating the environment, smelling the ground and objects in it (3.18 minutes per hour, contrasted with O.13 minutes for cows). They also spend rather more time grooming themselves (O.34 minutes per hour for cows, 1.27 minutes per hour for calves).

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Figure 23.

The average amount of time spent per hour by cows (blank) and calves (black) in maintenance and social activities (15 cows, 18 calves). The total number of hours observed was 2600 from when the calves were born, to when they were 6 months old.
ur & def = urinate and defaecate. social = social contact.
vertical axis = minutes per hour observed.



* significant differences, t test
t test.p<0.05.

Fig 18 & 19 show the average amount of time spent by dam and calf in the various activities from the third hour after birth of the calf; at one week; one month; two months; three, four and six months post partum. Kolmogorov-Smirnov tests were then done to see if there were any significant trends as the animals grew older. We shall briefly consider each activity in turn.

Lying. Cows typically lie on their sternum, although when sleeping they may rest the head forward on the ground, or more typically take on the 'foetal position' (Figure 16) with the head tucked round and resting on the hind legs or the ground. Very occasionally, particularly on a hot summer day, they will lie flat on their sides, but it seems that they are unable to retain this position for long periods because of the accumulation of gas in the rumen.

Calves, on the other hand, very frequently lie flat on their sides, particularly if the weather is hot. With the less well-developed rumen, the accumulation of gas is presumably not

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such a problem. It is interesting that the calves were very particular where they lay. From the first day they became adept at seeking out sheltered spots, such as hedgerows or ditches and slight dips where they were sheltered from the wind. The sheltered places were not always the same, of course, as the wind changed direction. One factor that may have been instrumental in helping the calves find shelter was that they showed an obvious tendency (84% of total 623) to lie where another calf had recently lain, and before lying down a calf would sniff the ground and turn round, rather like a dog preparing to lie down. They were also faithful to location, and a calf very frequently returned to lie in the same spot it had vacated several hours before. This was an aid to finding specific calves and meant that calves were often found with the same companions - perhaps an important factor in the development of the group and of strong individual bonds (see Chapter 6).

Since the weather was cold for the calves' first month of life, the ability to seek shelter is probably vital for survival; the calf has small fat reserves and its coat at birth is never as long as a full winter coat. Stockmen talk about 'the mother taking the calf to sheltered spots' but the truth is that the calf goes off on its own to find sheltered spots and sometimes its mother follows.

We can see from Figure 18 that the amount of time spent lying down does not show any significant change for either the cows or the calves over this six month period. The cows would lie somewhat more towards the end of the period, but this may well have been because of weather changes (it got progressively hotter towards the end of the summer) rather than because the calf had matured.

It seems reasonable to expect that the calves would spend much more time lying down than the cows and this in fact was the case. Most young animals, even precocial ones like the calf, spend much of their early life sleeping.

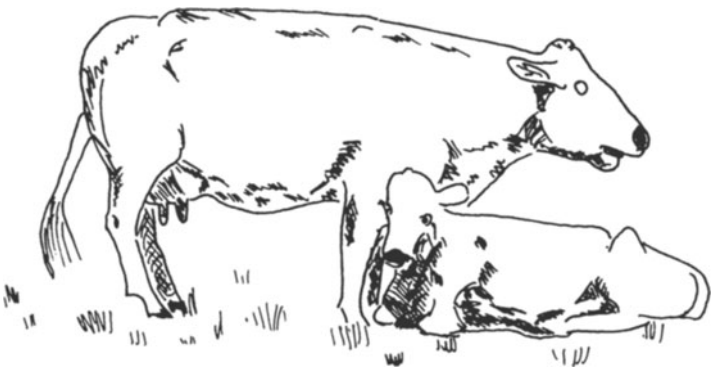
Standing. The amount of time the cows spent standing declined slightly, but not significantly, over the six months. The calf does not habitually follow the cow around, nor does it remain with her for long periods. When they do come together however, the cow often prolongs contact by adopting the 'stand over' position (Figure 24) for up to an hour. A cow may go and seek out her calf, which may be in a calf group at some distance, in order to 'stand over it' - not necessarily to suckle it, although suckling often precedes 'standing over'.

Eating and grazing. These were treated together as hay was fed to the cows for the first month after calving. We have already mentioned that the cows spent approximately one third of each hour eating, and this pattern did not change significantly over the six months, although they ate significantly less (Figure 18) during the first three hours after birth. It is interesting that

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Figure 24.

Dam standing over calf.



the time spent grazing remained fairly stable despite the decline in the availability of grass as the dry summer of 1975 progressed.

The calves spent markedly more time grazing and eating as they grew older (Kolmogorov-Smirnov $p < 0.05$). The rumen of the calf is, of course, undeveloped at birth, and over the first two weeks the calves can chew at length on odd whisps of grass or hay. By the end of the first month, however, they are already spending over five minutes in every hour grazing, although their intake at this time is probably low as they are still inefficient eaters, and much of this time is spent actually chewing each mouthful. By the end of the sixth month, the calves' grazing time has substantially increased but it is still not as great as the adult cows'. (14 minutes compared with over 18).

Cudding or ruminating. Ruminating is frequently done standing although they can cud lying down. It is generally considered that only an animal that is fairly relaxed and healthy will cud. Less ruminating might therefore reflect anxiety or physiological stress (see page 154) as well as sickness, although it also varies of course, according to the diet.

The cows showed no significant change in the amount of time they spent cudding over the six months, but the calves, as their rumens developed spent more time ruminating to match the increase in grazing time (Kolmogorov-Smirnov $p<0.01$).

Overall the cows spend on average 10 minutes cudding for 18 minutes eating or grazing. The calves, by comparison spent an average of 8 minutes cudding for 10 minutes eating. The ruminating to eating ratio thus varies : I/I.8 for cows compared to I/I.3 for calves. Why should this be? The amount of ruminating to some extent depends on the fibre content of the diet, although psychological factors are also important (Kiley-Worthington 1977).

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Perhaps some of this difference is due to the calves choosing a diet with a lower fibre content than the cows'. This is not unlikely since calves pick the tops and seed heads of the grasses. The difference might also reflect that calves, which are relatively inefficient grazers, may also be inefficient at cudding.

Walking. The cows and calves spent 1.8 - 1.6m/hr walking. This is only about half an hour in every twenty-four. The cattle walked mainly while grazing, but nevertheless this is something to bear in mind when confining cattle and reducing their options for exercise.

There was no significant trend in these results over the period for either cows or calves; if anything the animals walked slightly less as the summer advanced and the weather became hotter.

Investigating. The cows did occasionally smell the ground (for example, before head-rubbing - see Figure 11, page 50, on objects such as tree-stumps or bushes, but they spent much less time in this activity than calves, (only on average 0.13 minutes per hour, or just over 7 seconds compared to calves which spent an average of 3.18 minutes per hour). Calves do most of their investigating when they are between one week (when it reaches a peak) and two months old,(Fig. 18, page 81, black column). It has often been observed that young animals are more curious, perhaps because more is new to them. Investigating is clearly an important activity in the life of young calves, and it is presumably at this time that they learn the configuration of their environment (where for example, shelter is to be found) which may be vital to their survival, and they begin experimenting with what to eat (much of their investigating is directed at the ground or grass). In addition, olfactory information about other animals in the group may well be gathered.

Self-grooming. Self-grooming consists mostly of licking parts of the body with the rough tongue. Scratching and rubbing against objects and scratching with the hind feet are also included here, although they were less frequent (see Figure 8, page 40).

The variations in the amount of time the cows spent grooming are probably more closely related to seasonal changes than anything else. At the end of the first week, which corresponded with the period of annual 'moulting' in March, there was a grooming peak. There was another peak in June to July when the summer flies were around and there was a particularly bad outbreak of gadflies.

The calves showed a significant increase in the amount of self-grooming in the first six months of life (Kolmogorov-Smirnov $p < 0.01$), which is partly due, no doubt, to the maturing

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of the calf and partly to the increase in flies and skin irritation as the summer progressed.

Gadding. Gadding is a characteristic form of behaviour which occurs only when biting flies are nearby (warble or gadflies). The animal raises its head and tail to an exaggerated extent before galloping off (Figure 16). When the gadflies were around the herd would gradually make their way to shaded, dark places (Figure 45, page 128) and remain standing there, sometimes for hours. Both cows and calves 'gad', but the calves did it more readily. Social facilitation seemed to have an effect on gadding particularly among calves, so that the sight of one animal gadding would apparently cause others to begin gadding too, without being bitten or even hearing a fly. The same behaviour is noticeable when cattle are attacked by bees or horse flies. Gadding was recorded too few times for statistical treatment.

We tested for individual difference in maintenance behaviour, and there was no significant difference which was surprising when compared to the differences in social behaviour (Figure 25 & 28).

Social activities

This category includes aggressive activities such as butting, threatening, and kicking, sexual activities such as circling and mounting and most important, affiliative activities, such as calling and smelling, licking and rubbing another animal. We have also included sucking here, although it could be considered a 'maintenance activity' for the calves (see Fig. 11d and b, page 50).

Many of these activities are extremely brief so we recorded the number of occurrences of most of them. For those activities that could go on for a considerable period, (such as sucking, rubbing and licking) the total time was recorded. In order to have a comparative score, the brief activities have been converted into bouts (one bout = one minute or less).

Since it was the relationship between individuals which most interested us, we bore in mind contact behaviour between:

a) cows and their own calves, and vice versa
b) the dams' behaviour to other calves, and other cows
c) the calves' behaviour to other calves and other cows

Figure 25.1 shows the relative differences in the total numbers of contact occurrences per animal per hour observed for seven cows and seven calves. We can see that the amount of interaction with the calf initiation by the dam is much greater than that initiated by the calf (A).

Both cows and calves social contact activities were directed more to their peers (Figure 25 B&C). This peer preference is further discussed in the following chapter. Table 12 confirms

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the patterns shown in Figure 25. We can see that there was significantly more contact between dams and their own calves than between dams and other calves for this period. In addition dams contacted other cows more than other calves ($p<0.05$); calves contacted their mother more than the dam contacted other calves ($p<0.05$). Calves also contacted other calves more than their dam contacted other calves ($p<0.01$), or they contacted other cows ($p<0.05$).

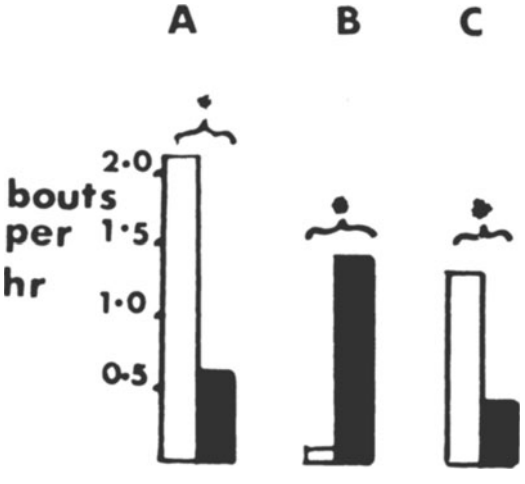
Thus dams and their calves contact each other more than other herd members; but both cows and calves contact their peers more than other herd members.

If we compare total contacts of cows with that of calves we find that the cows have a slightly higher average score (2.3 per hr, compared with I.2 / hr for calves), but this difference is not significant. This means that both age groups contact others about the same amount over the first 6 months of the calf's life.

Figure 25.

The average amount of contact between different groups in the herd in bouts per hour.

A (clear)= dams contact with her own calf.(black) = calf's contact with its dam. B = dams (clear) and calves (black) contact with other calves in the herd. C = dams (clear and calves: black) contact with other cows in the herd.
* significant difference between groups (t test, $p<0.05$).



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Table 12

Matched paired t tests of contact preferences between cows and their calves and others in the herd, and calves their mothers and others. * = significant value of t ($p < 0.05$).

	Dam and other cows	Dam and other cows	Calf and dam	Calf and other cows	Calf and other calves
Dam and own calf $\bar{x}$ =	0.27 2.01 2.8*	0.37 2.01 1.8*	0.89 2.01 1.6	0.08 2.01 1.6	0.27 2.01 1.1
Dam and other cows $\bar{x}$ =		0.03 2.2* 0.27	0.89 1.2 0.27	0.08 1.2 0.27	0.27 1.7 0.27
Dam and other calves $\bar{x}$ =			0.89 2.2* 0.03	0.08 1.2 0.03	0.27 2.7* 0.03
Calf and dam $\bar{x}$ =				0.08 2.0* 0.89	0.27 1.4 0.89
Calf and other cows $\bar{x}$ =					0.27 2.2* 0.08

Changes in the contact between mother and calf and others over six months.

Figure 26 divides the total scores (figure 25) into periods for the 6 months post partum. It shows the changes in the total contact between dams and their calves (A) with those for cows and calves (B and C).

Leaving aside the first three hours after birth which has its own specific behaviour patterns, we can see that the contact with the calf initiated by the dam declines substantially as the calf matures (Figure 26 , white columns). It is different for the calf which shows more or less the same amount of contact with its mother from the end of the first week to the end of the six months (Figure 26, black column). On the other hand, the calf does show slightly increased contact with other calves as it matures, up to the fourth month when it begins to behave slightly more like an adult in this respect, even contacting cows rather more (Figure 26, black column). The cows again show no significant or obvious change in the amount they associate with other

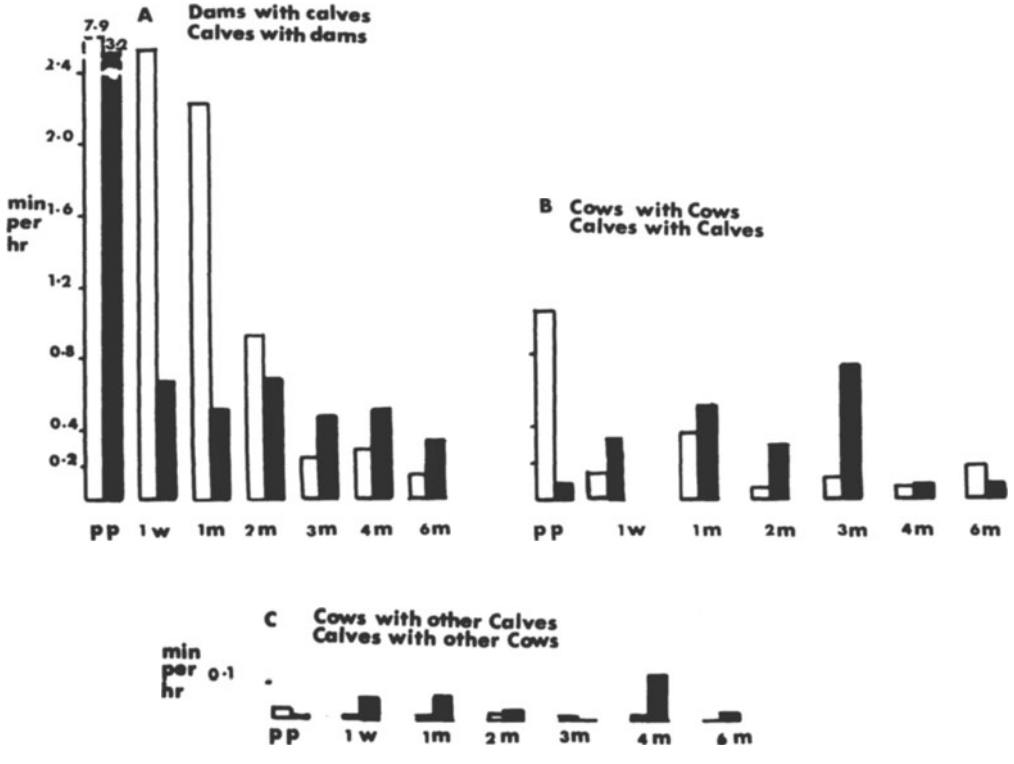
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cows or calves during this six month period, except again for the first three hours after birth when they usually attack or threaten any other cows that comes too near the calf (Figure 19b, white columns).

At three months the calves show a marked increase in social contacts with their dams and others. If we look at Figure 19 we find that this is mainly due to a sudden increase in the amount the calves rub and lick each other (page 82).

Figure 26

Total contact between dams (clear) and calves (black) and other cows and calves in the herd, from birth to six months post partum.



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There are, however, other contacts between individuals which we must consider here, such as butting, mounting and playing. The activities are defined on page 17 et seq.

Butting and Mounting. The cows butted and mounted each other occasionally, and since both scores were low we have added them together in Figure 19. The higher score after the birth of the calf was because the dam was butting other animals away from her new calf.

Among themselves the young calves did do a certain amount of butting and mounting, although the numerical scores are too low (0.06 times per hour per calf) to allow comparisons within age groups or individuals. Mounting was recorded from a calf of two weeks old but it became much more common by the third month. Both male and female calves mounted and were mounted. Cows mounted other animals only when they were in oestrus, and then it was very frequent. We were careful not to record animals in oestrus during these continuous observations, as this would have been misleading.

Playing. This consisted of leaping, bucking, cavorting and chasing one another (Figure 16). It occurred rarely in the adult cattle, although when the calves were playing, usually in the summer evenings, cows would occasionally take part. Other occasions on which cattle will leap and cavort about and often butt each other are when strange objects or noises intrude, for example, when drills and cranes were being used to mend the bridge outside the field one day, the cattle first came to look, crowding near the fence, then leapt and cavorted around for twenty minutes when the noises of drilling started. Dogs, hang-gliders, riders or walkers in funny hats could spark off the same reaction. The quantitative observations were made during the morning and since there were only three adult animals which played during 193 hours of observation (0.01 times per cow per hour), it was a fairly rare phenomenon at that time of day. Even among the calves, the data on playing was insufficient for individual differences to be discussed.

Playing in the calves consisted of galloping, leaping and kicking, usually with several calves together. This did not often take the form of a chase as is common in many young mammals (horses for example), but usually three to five calves would leap and gallop off abreast or in different directions, circle and come back together. (Figure 16)

Another form of play is head butting, when calves press their heads together and push and shove, in much the same way as adults. Butting and pushing is frequently directed at the mother which is often the recipient of much of the calves' playing.

Calves do not play much when very young, although within three hours of birth a calf may take an occasional leap around

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its mother. The amount of playing remains about the same as the calf grows up, with the exception of a sudden peak at four months, which is possibly related to maximum milk intake.

Playing, like gadding (see page 133) is apparently affected by 'social facilitation', so that one calf leaping about or two butting will attract others to join in, and a group of up to twenty playing calves may quickly form. In July when the gadflies were about, one or two animals might 'gad' which often initiated leaping and galloping about, although not always with the typical gadding posture. The gadflies help to explain the peak in playing at around four months, and it is possible that at this time the calves are at a stage when using and developing muscles and exploring the environment are particularly important.

Further analysis of contact between dam and calf

Cow to calf contact can be divided into auditory (calling), tactile (suckling, rubbing and licking), olfactory (smelling) and gustatory (tasting and licking).

Calling. Most of the calling in the grazing single-suckler herd was between mother and calf. Sudden disturbance might cause the herd to start calling (see page 51 et seq.), but the total number of outbreaks of that kind was very small. Figure 19 shows the total amount of calling and other forms of contact for the mothers and the calves. We can see that after the first week post partum, the amount of calling by the dam suddenly dropped, mainly because from that time she rarely gave the low 'mm' contact call characteristic of the first week. The calf called very little to the mother, or anyone else, unless it was very cold, hungry or lonely, an unusual state in these mother-reared calves. The average number of calls for a calf per hour of observation was 0.021, and for the cows, 0.392. ($p<0.05$).

As we have mentioned there is more licking, rubbing and smelling of the calf by the dam in the first tree hours after birth than later in the calf's life (Figure 19, page 82). In the case of the mother there is then a significant drop in the bouts of contact with the calf as it grows older, although licking does continue into adulthood. After the first three hours from birth the amount of contact with the mother initiated by the calf stays more or less constant at about one contact every two hours, occurring either before or after suckling.

Smelling. Smelling of the calf by the mother was measured separately since it is often suggested that the recognition of the calf (or other young mammal) by the mother is achieved initially by smell. We see from Table 13 that the cow smells her own calf more than any other during the first six months of its life.

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Typically during the first few weeks, a cow would walk up to a group of calves lying in a hedgerow and smell one and then another before smelling and licking her own. One would think after watching this behaviour on several occasions that at this stage the calf was recognized by smell. However, closer study of the animals suggests that visual recognition is established very rapidly and that the cow may have visually recognized her own calf before approaching the group (see Chapter 8).

Table 13. Average number of times smelling by one cow per hour. (Total observation hours 193 for 8 cows)

Smelling own calf	Smelling other cows	Smelling other calves
1.16*	0.1*	0.16*

* T test $p<0.01$ for each comparison.

Suckling. The amount of suckling and the length of the bouts depended on many factors, such as how much milk the cow had. The average amount of time spent suckling for the single-sucklers was 3.6 minutes per hour, with the exception of the post partum period when it was only 1.49 minutes per hour (Figure 21). At six months the calves were almost weaned and suckling occupied less than a minute per hour (0.914 minutes per hour - Figure 21A). A substantial change was in the number of bouts per hour (Figure 21B) which declined as the calf grew up. (Figure 22, page 87).

If we look in more detail at the changes in bout length (Figure 22) for the six month period, we find that at first, when the calf was still learning to suck effectively, the majority of the bouts were under one minute long (65% at birth, 50% at one week). By the end of the second week the majority were between one and five minutes long. By the end of the fourth month, the bouts vary greatly with 20% being between five and ten minutes long, and by the end of the sixth month, although the calves were suckling less by then, the bouts of suckling were very much longer: more than 22% were longer than fifteen minutes. This is probably because the cows' milk was beginning to decline and the calves had to work longer to obtain a reasonable meal.

Contact making and breaking between cows and their calves

A stockman's requirement of a good mother is a cow which "leaves her calf in a sheltered spot," implying that it is the dam which controls the relationship with the calf. To determine which animal controlled the bond, we looked at the number of times each animal made and broke contact with its partner (see page 11 for definition of making and breaking contact). The results are in Figure 27.

We can see that initially it was the mother who made the contacts somewhat more than the calf (compare week 1 and month 1),

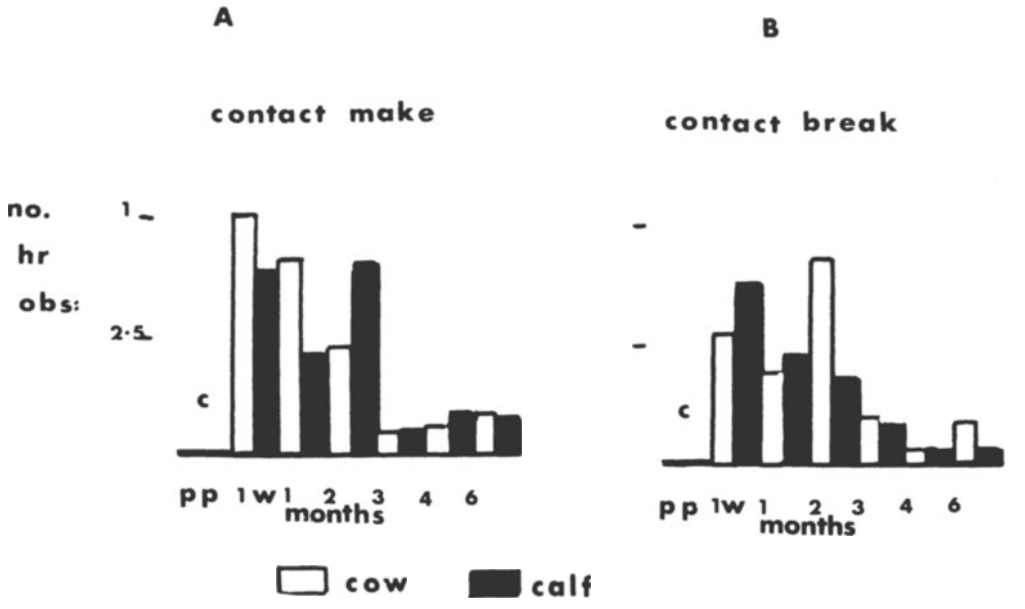
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but after about one month it was the calf which maintained this bond by contacting its mother more and breaking contact with her less. The stockman's saying, then, is not strictly accurate, since intially the calf finds its own place to lie and shelter, while the cow seeks it out. Later, however, at about two months, it is the calf that seeks out the mother and maintains the bond.

Figure 27.

Contact making and breaking between cows and calves from birth to six months old.

1,2,3,4,6 = months from birth. 8 cows and 8 calves, total number of observations 457. Vertical axis number per hour observed. Horizontal axis age of calf. pp = post partum. Iw = end of first week. c = in contact whole time.



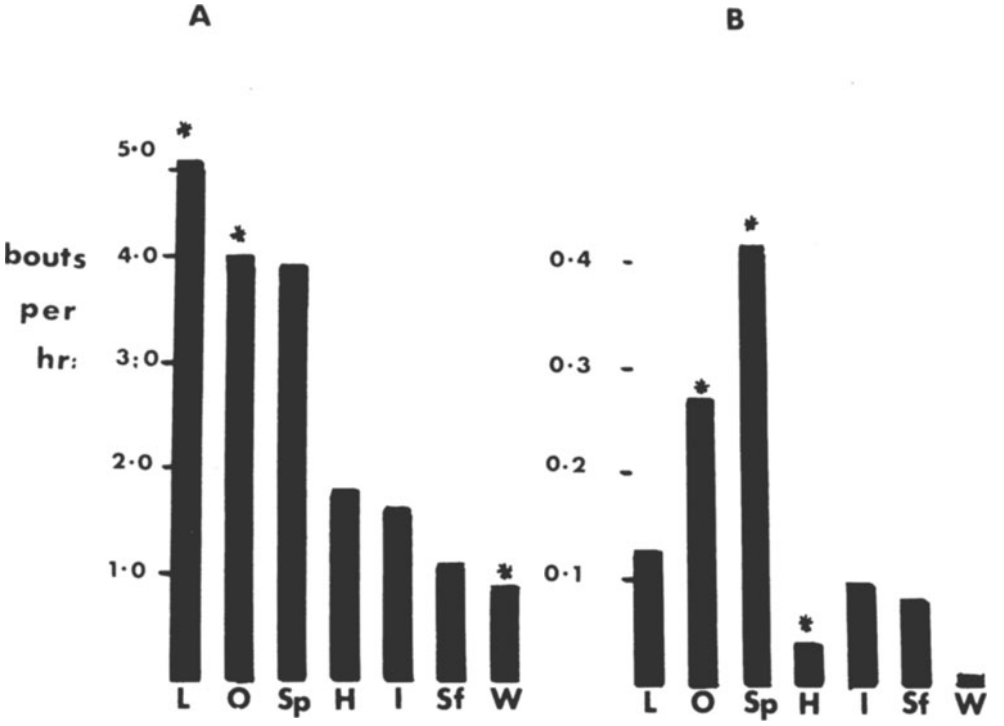
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Individual differences

If we examine this contact between cow and calf in specific cases, we find first of all that there is an overall difference in the amount of time, (or number of times) that these various forms of contact are made by individual dams (Fig. 28).

Figure 28.

A. Total social contact for individual cows.
L = Lesley. O = Olwen. Sp = Spot Eye. H = Helen. I = Irene. Sf = Spotty face. W = White lady.
B. Total contact with individuals other than their calf for different cows.
* significantly different from mean $p < 0.05$, T test
Note: Change in scale of vertical axis between A and B.



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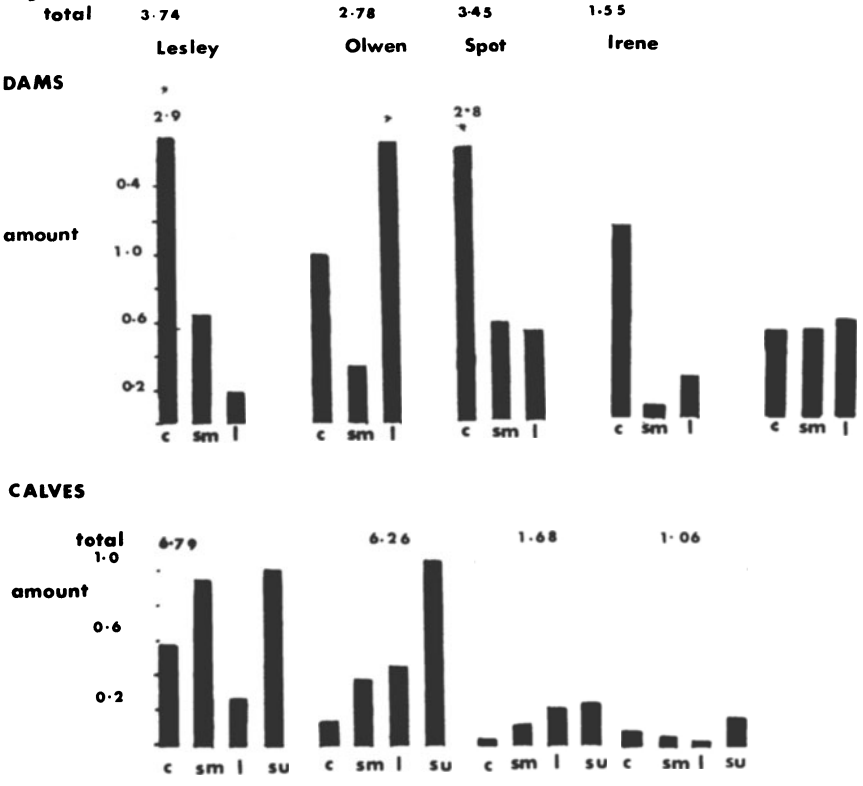
We might call those dams which spend more time in contact with their calves 'better mothers' but we should also take into account other indices that tell us something about the relationships between individuals, such as how close they chose to be to each other(see Chapter 6).

Figure 29 shows that not only do the cows vary in the total amount of contact with their calves, but also in the type of contact (compare cows). Their is also variation in the type of contact made by the calves to the cows, but these differences are not significant for this sample.

The figures of total contact for the 4 dams and their calves in Figure 29 suggest that the more frequent the contact made by the cow with the calf, the more frequently the calf will contact her. However Spearman Rank Order Correlation for 7 cows and calves indicates this is not significant ($r_s = 0.43$ $p > 0.05$).

Figure 29.

Individual scores of the various types of contact betweeen 4 mothers and their calves in number of minutes per hour (licking and suckling).
Total contact scores are also given for each animal.
c = calling; l = licking and rubbing; sm = smelling; su = suckling.



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CHAPTER 6

The social organization of the herd

Having come to some conclusions concerning the relationship between mother and calf, we will now look at the cohesion of the herd as a whole by noting which animals associated with one another over a period of time.

For this study we recorded 'proximity data', which consisted of:-

1. How far the mother was from the calf.
2. How far the nearest neighbour, other than the calf, was from the cow, and who that nearest neighbour was.
3. How far the nearest neighbour, other than the mother, was from the calf and who it was.

Analysis of this information tells us:-

i) How close mother and calf preferred to be and how this changed as the calf grew up.
ii) How far adult cows preferred to be apart, and which individuals they preferred as neighbours.
iii) How far calves preferred to be apart, and which individuals they preferred as neighbours.

The observational periods began between 8 - 9 a.m. and continued until 5 - 6 p.m. on most days. Several recordings were also made of the animals from early in the morning (5-6 a.m.) up to 9 p.m. or dusk in the evening.

The activity of the observed cows and their calves and the distance between the two were recorded every fifteen minutes, as was the distance of the cow and calf from their nearest neighbour; and that animal's identity.

Eight spring-calving cows and their calves, and six autumn-calving cows and their calves are included in this analysis. These were the same animals as those recorded for the continuous observations, so direct comparisons are possible.

The distances between individuals were divided into seven categories:-

1. Touching
2. Several centimetres to 5 metres
3. +5 metres to 30 metres
4. +30 metres to 50 metres
5. +50 metres to 100 metres
6. +100 metres to 200 metres
7. Over 200 metres.

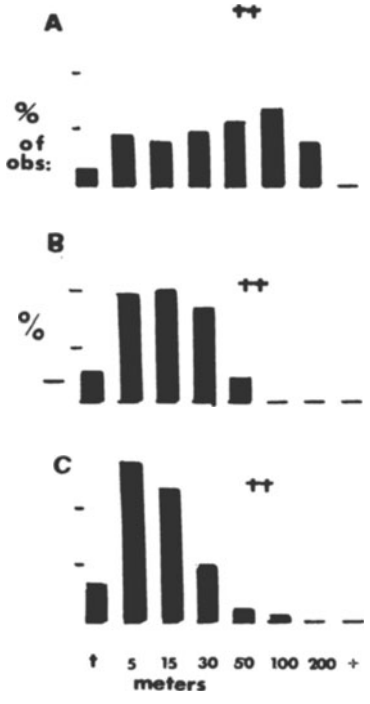
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The observations were also divided according to the age of the calves. The total number of recordings was 6,037, representing 1,509.25 hours of observation. Figures 30 shows the preferred distances between:-

a) The cow and calf
b) The cow and others
c) The calf and others

All three of these distributions are significantly different ($P<0.01$). The most interesting thing is that dams and calves tend to remains further apart (A) than the dams to others (B) and the calves to others (C). A (dam to calf distance) also shows a flatter distribution indicating more variation in the distance apart than B and C.

Figure 30



The distance between A) mothers and their calves; B) cows and their nearest neighbour (other than their calves); and C) calves and their nearest neighbour (other than their mothers) from the first 6 months of the calves' lives.
Total numbers of observations for A = 5546; B = 3390; C = 2954.
++ = significantly different distribution for pair combinations ($P < 0.01$. Kolmogorov-Smirnov).
Horizontal axis
t. = touching
5 = up to 5 metres
15 = +5 - 15 metres
30 = +15 - 30 m
50 = +30 - 50 m
100 = +50 - 100 m
200 = +100 - 200 m
+ = + 200 m
Vertical axis = percentage of observations at that distance.

The observations were made throughout the first six months of the calves' lives and we can see that most of the time they stayed between fifty and one hundred metres from their mothers. There may, however, be significant changes in this distance at different stages of the calves' development, so we broke these data into various periods of a calf's life from birth to six months (figure 31). Here we see that for the first three hours of life the cow and calf were much closer than at any other time. There was a great change by the end of the first week, when the distance between the two had increased to between 1 and 30 metres If we look at the daily recordings over the first week (Figure 32) we see that this change was gradual after the first three hours, which discounts the possibility of a sudden change in the relationship, marking the end of the imprinting period.

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Figure 31

Distances between cows and their own calves from birth to 24 weeks.
A = post partum, B = end of first week, C = end of second week, D = end of 1st month, E = end of 2nd month, F = end of 3rd month, G = end of 6th month. Vertical axis: percentage of observations.

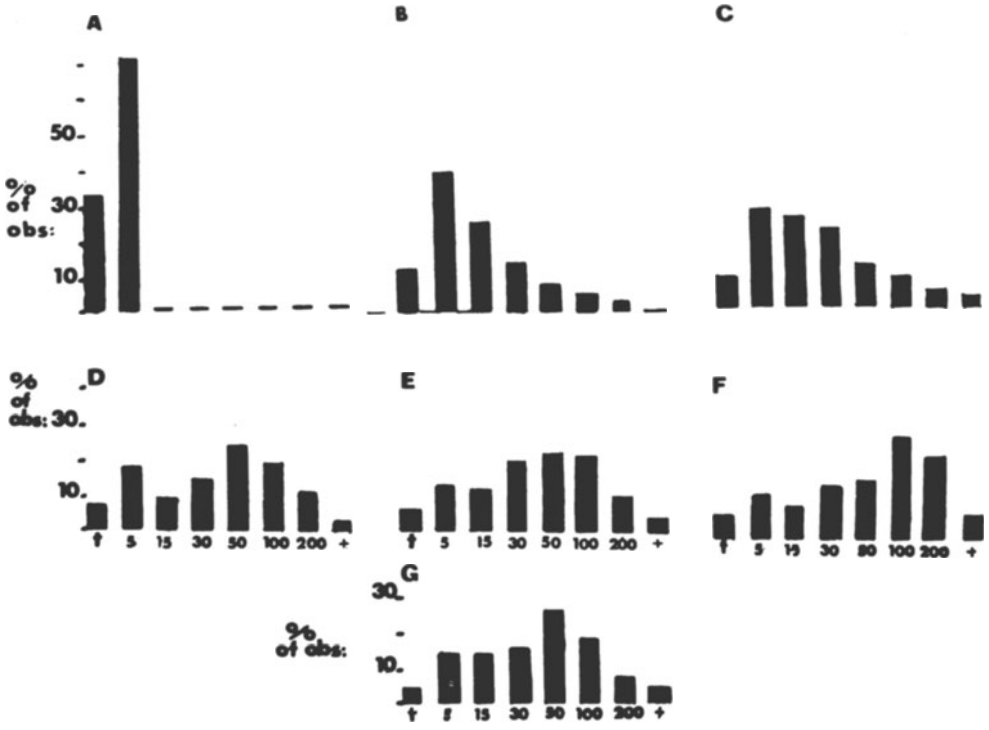
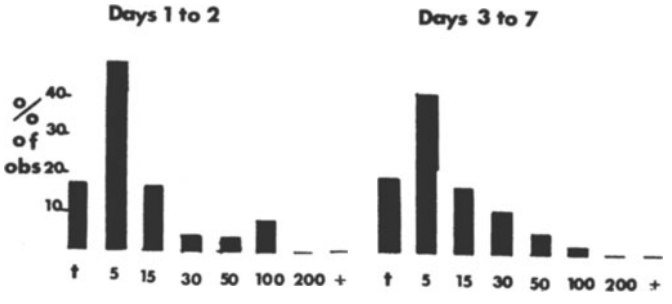


Figure 32

The difference in distance between the mother and her calf for (A) day 1 and 2, and (B) day 3 to 7, (no significant difference Kolmogorov-Smirnov test). Vertical axis: percentage of observations. Horizontal axis as Figure 30.



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By the end of the second week the calf was slightly further away from its mother (between five and fifty metres) and by the end of the first month they were even further apart. Mother and calf remained over fifty metres apart most of the time until week 24 (Figure 31). Does this increase in distance between the two animals correspond to a weakening of the bond between the cow and calf over this time? If we look at the percentage of time spent touching the calf, we find that this did not really change over this period, but was about 10%. The change in relationship as we showed in the previous chapter, is in the type of bond not its strength; as the calf matures it becomes more responsible for making and maintaining contact rather than the mother (see Figure 27, page 102).

Between weeks 7, 9 and 13 and 14 the time the cow and calf spent apart gradually increased, but these distributions are not significantly different. By about six months however (24 weeks), there is a significant difference in the distribution pattern. The cows and their calves tended to be nearer to each other again, with a peak of thirty to forty metres apart. This distribution shows similarities with the distance that cows normally kept from each other whilst grazing (compare Figure 30B with 31G). In other words, the cow/calf distance had changed to that more characteristic of adults. Touching, although reduced to about 5% of the observations, remained fairly constant between two and six months.

The observations so far analysed were all made on single-suckler cows from the spring-calving herd. In order to test whether external conditions, such as the weather, affect the distance between cows and calves, we looked at the distance between eight cows and their calves in the autumn-calving herd (Figure 33), but we found no significant differences between the two sets of results. The time of year the calves were born therefore did not affect mother/calf distance, nor did differences in management or breed, since the two herds were also different in these ways (see page 116).

Individual differences in the distance dams choose to be from their calves.

The time spent at dif erent distances from the calf for six of the cows is presented in Figure 34. This is constructed from the data for the first three months of lactation.

It is obvious that there are individual differences in these distributions. But are these differences significant? To test this, the figures for each of ten cows and fourteen lactations were tested against each other. Some tended to be significantly nearer to their calves than the average (e.g. Lesley (1975), Fuschia (1975), White Lady (1974) and (1975), while others were further away (Irene and Helen) all these

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were different at the $p<0.05$ level (Kolmogorov-Smirov, 2 sample test)! Table 14 where they are ranked . Those at the top were closer to their calves than those at the bottom.

Figure 33.

The distance between mother and calf for (A) spring calving herd, and (B) autumn calving herd. (No significant difference). Vertical axis = % of observations. Horizontal axis = distance (see Fig: 30).

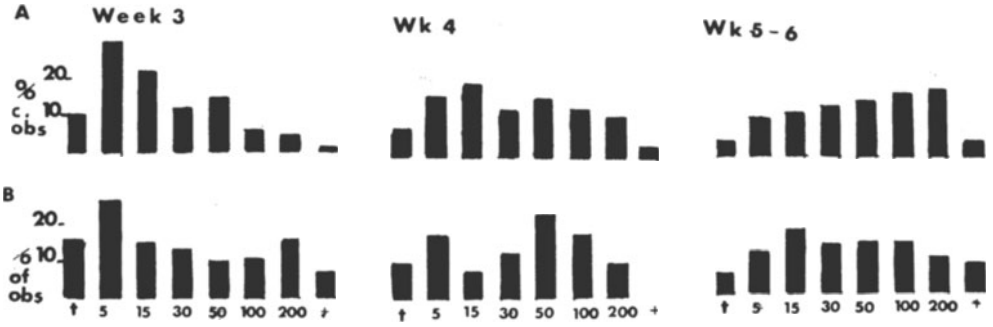
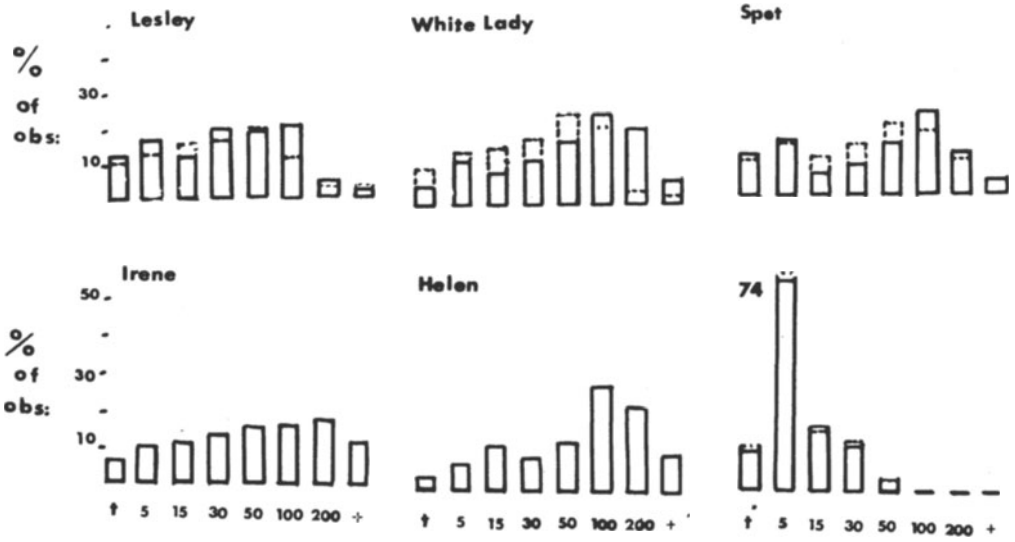


Figure 34

Individual differences in the distance between mother and calf for the whole lactation.
_____ 1974 for Lesley, White Lady and Spot. 74 = 1 twin
- - - 1975 - - - : 2nd twin.



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There were many reasons for this difference in individuals that we might suggest, but the one that seems particularly important is past experience. The heifers (cows with their first calf: Irene and Helen) were in general further away from their calves than the more experienced cows. One heifer, number I7 was recorded only four times out of twenty half-hour periods within even a hundred metres of her calf. On six other days she spent most of the time looking for it, and on the remaining ones we could not even find the calf, it was so far away and well hidden! The following year, however, this cow was habitually much closer to her calf and she was never recorded looking for it. Whereas the older cows who were more experienced although they showed differences in how far they strayed from their calves: on the whole they remained closer to them than the younger cows. If we look at the differences between two lactations for two of the older cows (Figure 34, Spoteye and White Lady - whole line 1974, dotted line 1975) we can see that they spent more time nearer their calves during the later lactations. ($p<0.05$ t test. Table 14).

Table 14.

Ranking order of cows distance from their calves for six months post partum. Closest top, furthest bottom.

\+ = significantly closer ($p<0.01$) blank = no significant differences distance
\- = significantly further ($p<0.01$) Kalmogorov Smirnov 2 sample tests

	Lesley 1975	Lesley 1974	Fraser 1975	Spot Face 1975	White Lady 1975	White Lady 1974	Rowena	Olwen	Spot Face 1974	Di	Fraser 1974	Irene	Helen
Lesley 1975	X	+		+	+	+	+	+	+	+	+	+	+
Lesley 1974	-	X			+	+	+	+	+	+	+	+	+
Fraser 1975			X			+	+	+	+	+	+	+	+
Spot Face 1975	-	-		X		+	+	+	+	+	+	+	+
White Lady 1975	-	-			X	+	+	+		+	+	+	+
White Lady 1974	-	-	-	-	X	X		+			+	+	+
Roweena	-	-	-	-			X				+	+	+
Olwen	-	-	-	-	-	-		X			+	+	+
Spot Face 1974	-	-	-	-					X		+	+	+
Di	-	-	-	-	-					X	+	+	+
Fraser 1974	-	-	-	-	-	-	-	-	-		X	+	+
Irene	-	-	-	-	-	-	-	-	-	-		X	+
Helen	-	-	-	-	-	-	-	-	-	-	-		X

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Three sets of twins were also studied and quantitative results collected. The only one presented here is that of cow 74. It is interesting that she remained closer to both her calves than any of the other cows. It is likely that the calves were responsible for this since they approached more often to suckle, probably because less milk was available for each calf. However, this cow showed no preference for either calf, nor was any preference noted in the other two pairs of twins.

Comparisons of two measures of 'mothering'

We have presented here and in the previous chapter two measurements of the relationship between individual cows and their calves:

(1) The amount of contact between the dyad and that initiated by the mother.
(2) The amount of time spent at different distances from the calf.

We might expect that individuals with a high score for contact with their calves such as Lesley and Olwen would have spent more time closer to them. However, this was not necessarily the case. Spearman rank order correlations show no significant correlations between these two methods of measuring "mothering" ($p>0.05$).

Table 15. Spearman Rank Order correlations for contact of dams with their calves and closeness to their calves for 7 cows in 1974.

Cows	Contact rank	Closeness rank
Olwen	1	3
Lesley	2	1
Fraser	3	5
White Lady	4	2
Spot Face	5	4
Irene	6	6
Helen	7	7
$r_s = 0.34$	$p>0.05$ NS.	

We must conclude therefore that neither of these measures alone would be a good indicator of the closeness of the bond between the cow and her calf.

In order to assess whether or not a cow is a 'good mother', we could say that if she spends a lot of time in contact with her calf, and/or remains near it for longer periods than the average, the bond between cow and calf is likely to be better developed than normal, and she might therefore be considered a 'good mother'. These results illustrate that one yardstick, such

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as noting the nearest neighbour, and using that alone as an index of sociability or mothering would be a gross oversimplification and lead to incorrect conclusions.

Relations of dams and calves to other cows and other calves

In order to investigate other aspects of the cows and calves social life, we can compare:
(a) what percentage of time the calves spent at different distances from their nearest neighbours (other than their mothers);
(b) the same observations from the cow,
These distributions are shown in Figure 30B & C. We can see that they show highly significant differences (Kolmogorov-Smirnov $p<0.01$).

The cows tend to be further away from their calves than from other herd members, and both the cows and the calves prefer to associate more closely with other individuals than their calves or dams.

The cows and calves have different preferred distances from their neighbours. The cows prefer to be about fifteen to thirty metres apart. The calves closer (from five to fifteen metres). If we use proximity measures as an index of 'sociability' then we could say that calves are more social than the cows.

The preference for association within age groups

The next question, then, is who both calves and cows prefer as neighbours. Figure 35 shows clearly that cows preferred cows ($p<0.01$ t test) and calves preferred calves ($p<0.01$ t test) and that this did not alter very much throughout the first six months of the calves' lives. By the sixth month, both the cows and calves were not showing such an obvious preference, there was a significant change (t test $p<0.05$) as the calf started behaving and being treated more like an adult at four months old.

Figure 36 shows that calves showed less of a preference for calves as neighbours when over 30 metres away. Cows on the other hand, showed no significant difference in their perference for cows as nearest neighbours whether they were near or far away.

The changes in distance between calves and their neighbours as they grew up

Figure 37 shows the changes in distances from the nearest neighbour (other than the mother) for seven calves from birth to six months. The most obvious trend is that as the calves grew older, they preferred to be further from other individuals, so that the greatest percentage of observations were between one and five metres in the first week and between

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five and fifteen metres by the end of the third month (Fig 37E). The end of the first month shows a significant change (Kolmogorov Smirnov 2 sample test $p<0.01$). This contrasts with the nearest neighbour distance of the dams through the same period where there was no significant change. We can conclude that, as the calves matured, the distance they preferred to be from other individuals increased, but their dams did not show any obvious changes in the preferred distance from their neighbours during this period.

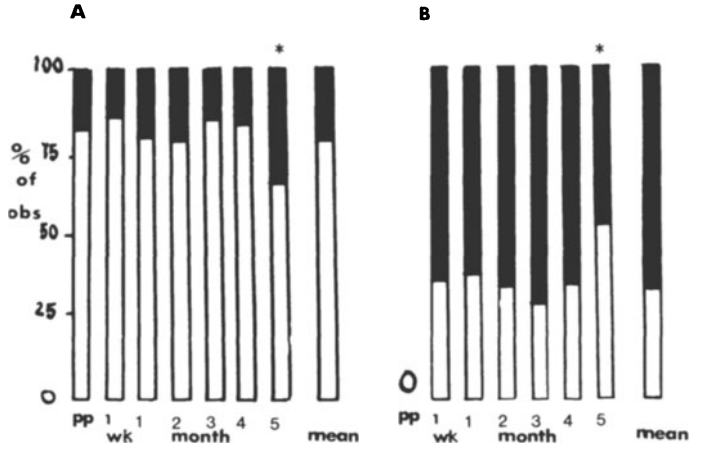
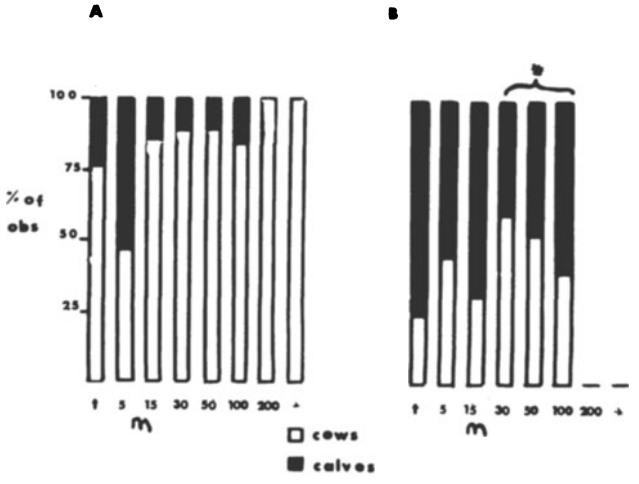


Figure 35. The changes in preference for cows as nearest neighbours as the calves grow older. (A) cows, (B) calves. Blank column = cow's nearest neighbour; Black columns = calf's nearest neighbour. pp = post partum

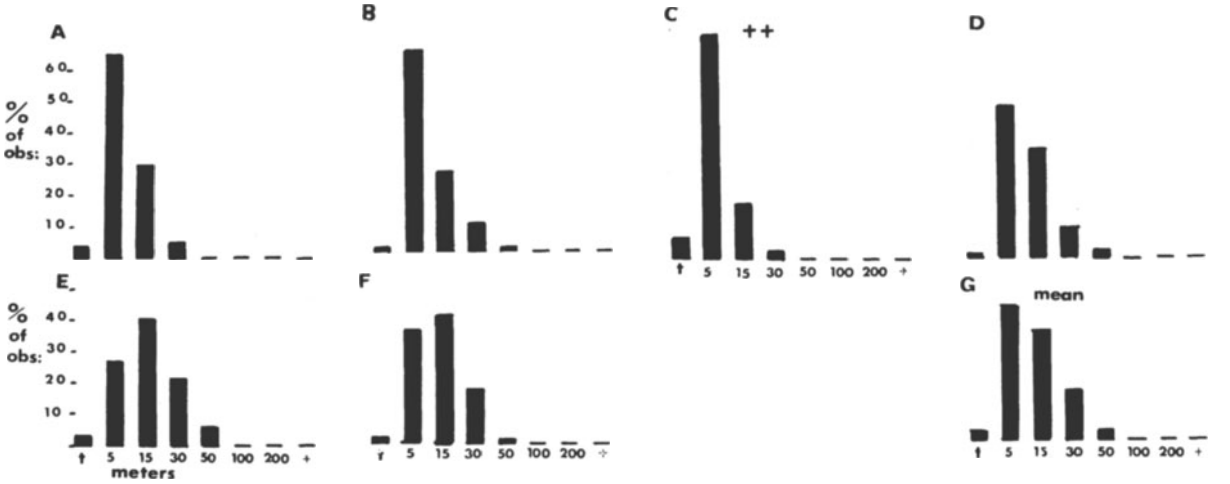
Figure 36. The percentage of observations when cows (A) and calves (B) have other cows (blank) or other calves (black) as nearest neighbours. Cows (A) prefer cows, and calves (B) prefer calves. 9 cows and 7 calves. Columns 4, 5 and 6 of B when considered together are significantly different from 1, 2 and 3. ($p<0.01$).



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Figure 37.

Difference in the distance between calves and their nearest neighbours (other than their mothers) as they grow up.
A = end of week 1. B = end of week 2. C = end of first month.
D = end of second month. E = end of third month. F = end of sixth month. G = mean distribution (total number of observations 3390).



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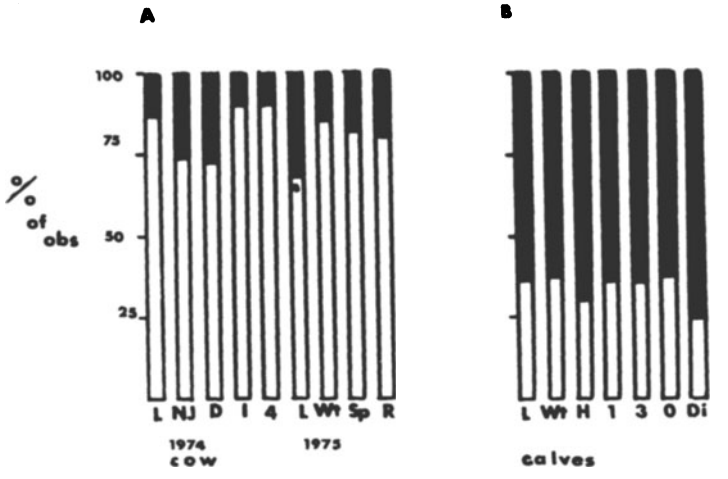
to be from other individuals increased, but their dams did not show any obvious changes in the preferred distance from their neighbours during this period.

Differences between individual calves in their distances from their neighbours.

Individual calves showed very little variation in their obvious preference for calves as nearest neighbours (Figure 38B). No calf showed a significant difference.

Figure 38.

Variations between individual cows (A) and calves (B) in their preference for other cows or other calves as their nearest neighbours.
Cows = blank; calves = black.
* = significantly different from the mean ($P<0.01$).



If we look in more detail at the individual calves distances from their neighbours (Figure 39) we see that Lesley's and White Lady's calves are significantly different from the mean in being closer to their neighbours (Kolmogorov-Smirnov 2 sample test $p<0.01$).

There were some close associations between individual calves, such as between the calves of Brown, White Lady and Frazer, and between twins or adopted calves, however, we have not analysed this in detail. Close associations between calves are probably controlled by similarities of requirements which in turn depend on similarities in age. Thus, two young calves lie close together in the same hedgerow because it is the most sheltered spot. Their faithfulness to location ensures that this association is frequent through the first weeks of life (see page 91). Because they are familiar with each other, they may continue to associate closely and this association continues to adulthood and possibly for life.

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Figure 39. Differences in the distance between individual calves and their nearest neighbour (other than their mother).

* = significantly closer than the mean to nearest neighbours ($p<0.05$ Kolmogorov Smirnov 2 sample test).
t = touching

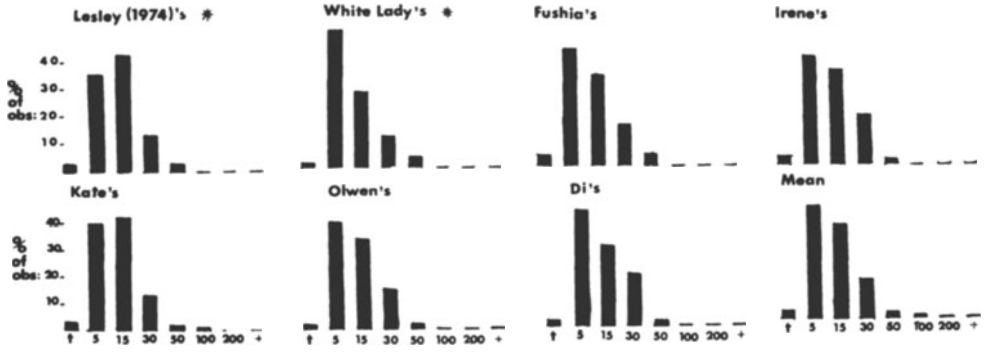
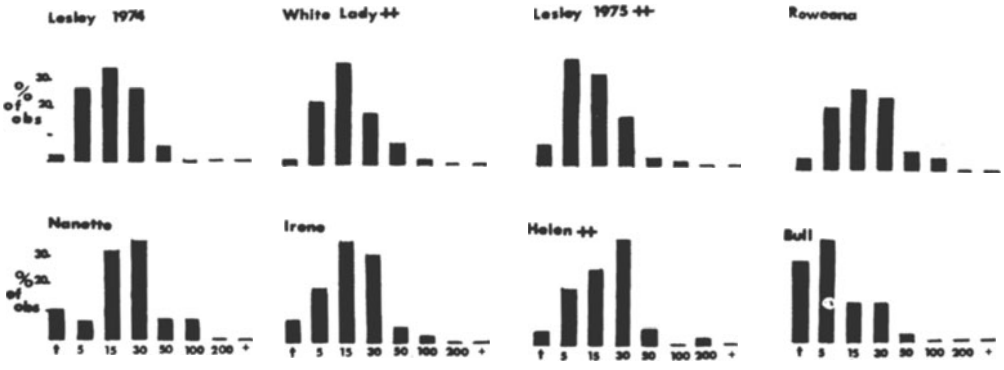


Figure 40. Differences in the distance between individual cows and their nearest neighbours (other than their own calves).

++ = significantly different distribution from mean (Kolmogorov Smirnov 2 sample test).



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Differences between individual cows in distance from neighbours.

Figure 38A shows that individual cows vary very little in their preference for cows rather than calves as nearest neighbours. L(Lesley) in 1975 is somewhat of an exception and was recorded near calves significantly more often than any of the others, although she preferred cows for 70% of the observations.

In order to look more closely at the differences in neighbour preferences between individuals we took a sample of nine cows and the bull. Figure 40 shows how four of these animals differ significantly from the mean distribution. White Lady and Lesley preferred to be nearer their neighbours than the mean. The bull, however, is nearest of all, preferring actually to touch the cows. But of course these observations were taken during the two months that the bull was with the cows and the majority of the time there was an oestral female with him, the figures thus reflect the close association which is to be expected. Helen, a primiparous cow, is the only animal of this sample which preferred to be further away from her neighbours than the mean, showing a peak at between thirty and fifty metres away. Interestingly enough, we saw that she also preferred to be further from her own calf than the others (Figure 34). So it looks as if she is less 'social', whereas White Lady and Lesley are particularly 'social', preferring to be nearer their own calves as well as their neighbours.

Cows' preference for specific individuals

We have studied overall age preferences of association but it was also possible to assess preference of association between named individuals.

In Table 16 we show the numbers of times that sixteen individuals in the herd of thirty-eight were recorded nearest to four of the other cows. Only the figures that are very different from the average are given and an asterisk marks apparent preference of association. A dash marks a significantly low number of observations indicating that they tended to avoid one another.

The first interesting point, which confirms other studies (eg: Sambraus, 1978; Reinhart 1980a Bos indicus) although most cattlemen are aware of it, is that cows do prefer to be with some cows rather than others, and others apparently prefer not to be together. For example, Short Tail was close to Spot Face twice as often as to any of the three others. In the entire herd Rebecca preferred Lesley and White Lady and avoided Twiggy, Buttocks, Brown Spot and Lolita. White Lady showed more obvious dislikes and likes, preferring Spot Face, Rebecca, Helen, Norah,

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Fatty and Rump Patch, avoiding Roweena, Brown Spot, Buttocks and Lolita. In addition to her individual preferences for White Lady, Rebecca, Brown, Fatty and Roweena, Lesley 1975 showed more preference for associating with calves (as we have seen in Figure 38). Lesley, Spot Face, White Lady and Rebecca were cows which formed a sub-group of their own but others such as Rebecca, Fatty and Helen were probably also part of this sub-group, since they associated frequently with two or more of these four. Figure 41 shows the significant bonds between individuals (as indicated by nearest neighbour preferences) and illustrates the complexity of the relationships between individuals in the herd. Another sub-group consists of the cows at the bottom of Table 16, Roweena, Brown Spot, Buttocks and Lolita, all of whom associated significantly less with Lesley, Spot Face, White Lady and Rebecca than any of the others.

Family relationships may affect sub-grouping too. As calves grow up and give birth, their calves may associate with each other, and in this way, interlinking sub-groups of related animals and their associates are built up in the herd. (Reinhardt(1980a) found some in Bos indicus). Analysis of the rest of the herd suggests the following groupings although of course there is much mixing between groups (Figure 41).

TABLE 16
Preference of Association Between Cows

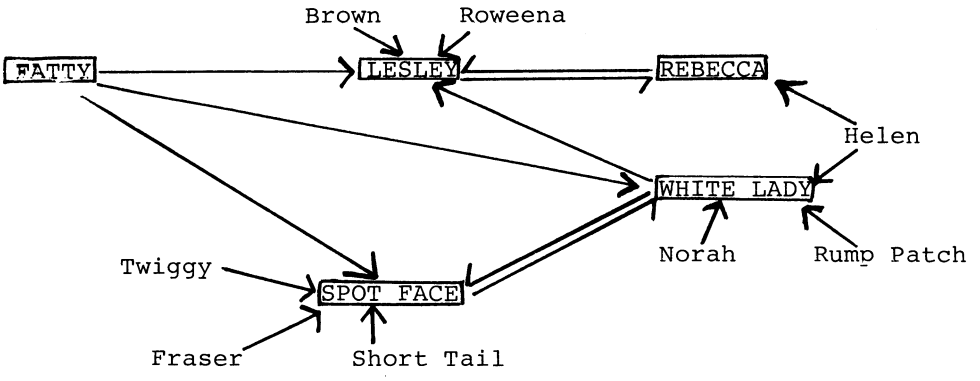
	Lesley	Spot Face	White Lady	Rebecca	Total
Lesley	-	5	13	15*	33
Spot Face	8	-	17*	13	38
White Lady	22*	28*	-	21*	71*
Rebecca	14*	5	19*	-	38
Fraser	12	16*	6	11	45
Short Tail	7	16*	6	8	37
Brown	26*	12	4	13	55
Helen	9	10	19*	24*	62*
Norah	11	7	14*	6	38
Fatty	13*	26*	21*	5	65*
Twiggy	6	22*	5	2*	35
Rump Patch	12	5	15*	5	37
Roweena	13*	1-*	2-*	1-*	17
Brown Spot	0-*	2-*	1-*	2-*	5-*
Buttocks	1-*	2-*	0-*	4	7-*
Lolita	2-*	5	1-*	2-*	10-*
Calves	119*	67	66	71	323
Total	211	234	228	223	966
Mean	7.03	8.06	7.86	7.68	53.88

*significantly different from the mean $p<0.05$ t test.

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Figure 41

Significant associations in one group of cows in the herd (Group 4)



→ = significant preference of association.

FATTY = key members of this group.

Group 1

Nanette + calf, Zeena + calf
Dexter + calf

Group 2

15 (steer 18 months)
9. Buttock, Jigsaw, Di and their calves

Group 3

Rump Patch, Roweena, Spoteye, and their calves.

Group 4

Lesley, White Lady, Rebecca, Spot Face, Brown, Fatty and their calves.

Group 5

Lolita, Black Tits, Brown Spot, BB.Toom, WC, Croquet, and their calves

There was a difference in how closely these groups associated together. Thus the central group (4) consisted mostly of older cows and was very easy to distinguish because the cows were usually closer together. Group 1 was added to herd in May and was equally easy to distinguish for about four months. This group usually remained on the periphery of the herd, although by the end of the summer Nanette (an older cow) had moved into associated with the central group. On the other hand, groups 3 and 5 were not easy to identify and frequently one or two of the individuals were nowhere near the rest of the group.

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There were some cows, for example, Rump Patch, Roweena, Spot Eye, Fraser and Norah, who were not members of particular groups, but moved around independently showing no particular preferences. These were apparently 'loners'. There are also indications that some animals tend to remain on the periphery of groups, while others are central. This is further discussed in Chapter 7.

In my (MK-W) own small herd of cattle (used for experiments in Chapter 8) it was clear that mothers and daughters continued to show some preference of association even when the daughters had calves of their own, Reinhardt (1980) found similar preferred associations. The maternal relationship of the heifers in the larger herd was not known. However, Fraser, had a very close relationship with one of the steers which broke the fence and joined the herd in June, and this animal was later found to be her son from the previous year.

These results were based purely on measuring the nearest neighbours, but a clearer pattern would have emerged if the nearest two or three neighbours had been recorded. Good stockmen may first become aware of something wrong in the herd if they notice that a particular animal which is usually to be found associating with a certain group is not there. All we have done here is to confirm that these preferences really do exist, although we are sure there are many more complex associations between individuals within the herd than we have yet been able to measure.

Dominance and affiliative relationship between cows

Horned animals, although not adapted particularly to killing, are often capable of killing or severely injuring each other. In fact, animals of the same species rarely kill or injure one another under these conditions, and a popular theory to account for this is the existence of 'dominance hierarchies', whereby certain animals have undisputed priority of access to scarce commodities. It has been argued that this reduces aggression between individuals and saves the fighting which would have a debilitating effect on the herd. Maynard-Smith (1976) and Dawkins (1976) have pointed out that 'dominance hierarchies' could benefit survival at the bottom of the hierarchy as well as at the top, since a weaker individual would do well to recognise that he is likely to lose a fight and submit. They point out that in this way populations with a mixture of 'hawks' (aggressive individuals) and 'doves' (peaceloving individuals) would be the most stable in evolutionary terms. Hawks and doves are found at opposite ends of a dominance hierarchy in which an

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animal's position depends on such things as the status of its mother, its age, sex, physical strength and so on. This theory seems to fit certain species (mainly primates, rodents and domestic hens) which have been studied fairly extensively and it would seem a sensible strategy where food is scarce, since it ensures the individuals most fitted to the environment are the ones to survive and breed. However, what may hold true for some species cannot be automatically assumed with other species and it is unhelpful to use 'dominance hierarchies' as a blanket term to explain social organization in herd animals unless there is quantitative evidence of its importance (see Kiley-Worthington 1977 for review). Some recent studies on cattle at pasture (eg: Köch 1968, and Zimmerman-Müller 1978) drew up ranking hierarchies based on very few individual encounters between any two pairs (eg: Köch from none to 6). In order to allow for reasonable statistical analysis at least 10 aggressive type encounters between every pair are necessary. This leads to many 1000 of hours observation in even a small group, which to date has not been adequately demonstrated in any study in a grazing situation.

Where others have attempted impartial observation to assess a possible dominance hierarchy in cattle, the conditions were in many cases highly unnatural. Many of the observations and experiments to date have been made on small numbers of housed cattle where what is being tested may not be a 'dominance hierarchy' but an increase in aggression as the result of confinement. We need detailed studies on cattle in as near a natural situation as possible to find out whether the social structure is the same as when the animals are confined. The question becomes not simply one of dominance, but of all the relationships within the herd. If animals are forever having to compete with one another why do they live in a group at all? Some of the answers seem obvious, for example:

1) greater protection from predators,
2) increased reproductive potential, and
3) help with finding food.

While such questions can only be answered by detailed studies of completely wild populations, we thought it important to look not only at aggression but also particularly at behaviour likely to bind the herd together. We measured aggressive behaviour that might be linked with dominance assertion (head lowering, threatening butting and avoiding or withdrawing from another animal) and at the same time we observed behaviour likely to increase herd cohesion: licking, grooming or rubbing and smelling another individual. The total numbers of both these types of encounter between individuals (per 100 hours of observation) are shown in Table 17.

During the winter feeding of hay, there was a predicted increase in aggressive encounters(line 2). This was the result of competition for a limited resource which was not present on the summer grazing. (I.5 compared to I84/cow/100hr) summer grazing

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and winter hay feeding respectively). During this hay eating period the number of affiliative interactions were reduced. This was because the animals were following their primary interest at that time: they were eating.

The time post-partum also affected the amount and type of interaction between individuals. Immediately after birth, as we have seen, the mother spends a great deal of time licking and grooming her offspring, while the calf smells her and searches for the teat as soon as it is on its feet (Chapter 4). At this time butting and threatening were high. This was in order to ensure close bonding between cows and calf during this crucial time (see page 77).

Table I7.
The frequencey of dispersive and affiliative behaviour in summer and winter grazing with hay feeding.
(n : occurances /cow/100 hrs). * $p < 0.05$.

Situation	Dominance/'dispersive' behaviour		Affection/'cohesive'behaviour					Skin Irritation		Total time and number of cows
	Butt + threat	Avoid/ with-draw	Groom cow-mother	Groom calf-mother	Groom cow-calf	Smell cow	Head extend to cow	Head throw	Head toss	
Summer grazing	1.0 0.5 (1.5*)	0.6	1.2	0.9	0.1	0.5	1.1 (3.8*)	0.7	0.6 (1.3)	150 hours 36 cows
Winter + feeding of hay	88. 96. (184)	96.	8.0							10 hours 36 cows
Post-partum (3 hours)	102. 102. (204)	0	700. (calf) 800. (cow)							30 hours 12 cows

The main interest of this table is that total numbers of either aggressive or affiliative encounters are low in the grazing situation.

In social living species with no need for constant competition for a resource (because of its equal availability to all, for example food in a grazing herbivor), behaviour related to conflict (aggression) or to reducing conflict (e.g. dominance hierarchies) would be relatively rare compared to behaviour related to binding the group together, such as affiliative behaviour.

Table I7 shows that there was significantly more affiliative behaviour than behaviour that might be related to conflict in the grazing situation. It is in this type of environment that free living cattle spend the vaste majority of their time. This underlines the importance of affiliative behaviour in this species.

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Sufficient data to allow proper statistical analysis of individual interactions (both dispersive and cohesive) would require approximately 140,000 hours of observation for a herd of 38 individuals given the rates of interaction at 2 - 3/cow/100 hours (row 1 Table 17) typical in a free range situation. This was not collected, therefore the analysis can go no further.

Therefore whether or not it is necessary to suppose that the dominance hierarchy is there (although it has not been satisfactorily measured in the grazing situation to date) and that its function is to control the overt aggression; or rather to suggest that the herd is kept together and organized by cohesive bonds is a matter for conjecture at this stage. We suggest that the underlying organization of the herd may rely on cohesive behaviour (such as mutual touching, smelling, grooming and remain close) rather than disruption (such as threatening, fighting and avoiding) or the establishment of a "dominance hierarchy" to control this in such large grazing species as cattle. "Love not hate" may be the predominant organization motif.

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CHAPTER 7

Daily routine and use of pasture

Daily routine

The aspect of cattle behaviour that has received most attention to date is the distribution of their behaviour patterns through the day. Grazing patterns vary according to the availability and type of pasture, but studies such as those of Hancock (1953) show that cattle graze for about eight to ten hours in every twentyfour and they ruminate for a further four to five hours - total of 12-15 hours eating, which is about as much time as horses spend grazing (Francis-Smith 1976). The total time spent in various activities between 8.00 and 13.00 hours has already been discussed (Chapter 5, Figure 23, page 91).

Most authors agree that for cattle the day starts before dawn when they begin to rise and graze. The early morning feeding or grazing is followed by an idling period before an evening grazing time as the sun goes down. This grazing period may continue into the night but by eleven or twelve o'clock the cows have usually settled down to sleep (Hafez and Schein 1962). The management of dairy cattle was radically altered because of these studies. Before the research of such people as Castle et al (1950) it was believed that cattle slept as soon as it became dark and did not rise until dawn, and they were therefore given little access to food or grazing at night. When it was found that cattle did graze after dusk this policy was change and today cattle are normally allowed access to pasture at night as well as during the day, with consequent increases in yields at the morning milking.

Most of the research into how cattle spend their day has been done with dairy cows and heifers, so suckling periods and the interactions with the calf were not taken into account. In addition, the animals were usually observed over short periods of time, (about one or two weeks) during which the weather and other variable influences seem to have remained fairly constant, although Hafez & Schein (1962) did mention that the environment had an effect on grazing. Our observations of single-sucklers started at calving and continued at weekly intervals over a six-month period. During this time there were many influences which clearly affected the circadian rhythm. The most important of these were:-

1. Changes in the day length.
2. The differing demands on the mother as the calf matured.
3. The availability and type of pasture or food.
4. Changes in the weather.

During the observation period the temperature varied from about -5^{o}C, to the hot summer of 1975 when temperatures went up to 43^{o}C. The weather ranged from freezing blizzards to

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Figure 42. The time spent in different activities for cattle in four different environments. (08.00 - 18.30 hrs A-C)
A = at grass (50 acres field).
B = open-fronted yard ad lib hay & straw
C = open fronted yard; rationed hay & straw
D = C for 24 hours. st - stand; l - lie; e - eat;
o - "other activities"=; w - walk; li - lick
* - significantly different P<0.05. t test)

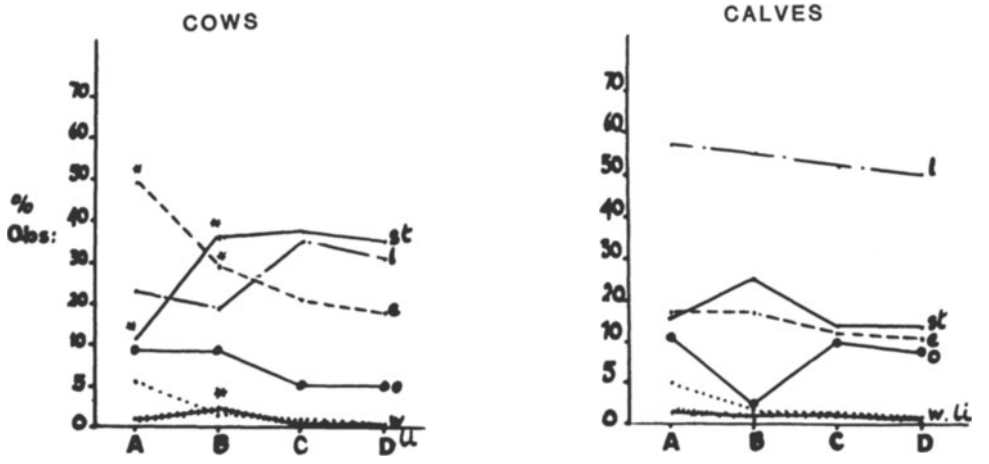
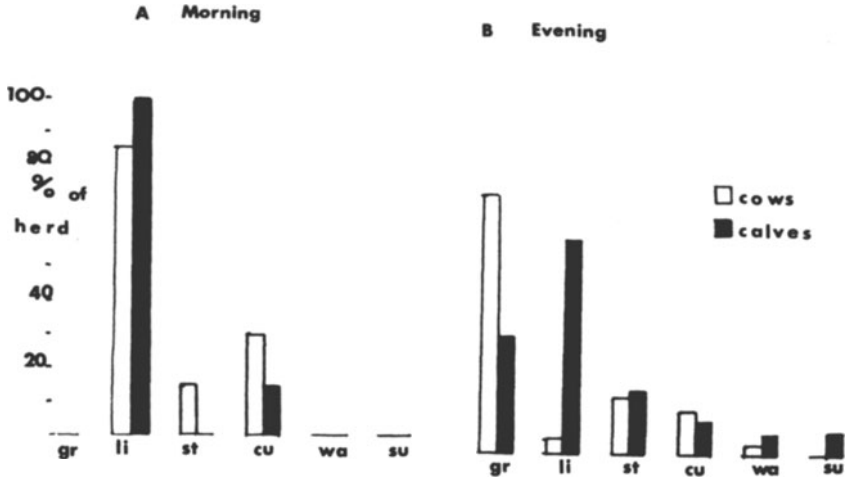


Figure 43. The percentage of the herd of cows and calves (vertical axis) engaged in the different activities for a sunny early morning (A) 7.30 to 9.30 am) compared with the cool evening (B) (5.00 to 7.00 pm) on a July day.

gr = grazing; li = lying; st = standing; cu = cud
wa = walking; su = suckling.



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sleepy hot July afternoons, and the wind veered to every point on the compass. We had some of the worst floods in recorded history (autumn 1974) as a result of downpours, and a dry, drought-ridden summer (1975). Under these varying conditions, it was not surprising that the animals did not follow the expected rhythms, and in fact, it was extremely difficult to find any constant pattern in the way the cows and calves spent the day. The observational hours were usually between 08 - 08.30 and 17.30 - 18.00. We were lucky enough to persuade some friends to help us with the twenty-four hour watch on some cattle that were inside in November 1974.

The following outline points out the most important variables (e.g. day length and extremes in the weather). Better defined patterns are impossible to outline due to the confounding effects of many variables.

Daily rhythms

Early morning. The cattle were not systematically watched at dawn, but from observations on 4 occasions it was evident that their behaviour was governed largely by the weather. On a dry day, not too cold for the season, they would begin to get up before dawn to graze for a period of about two hours. Shortly after dawn, they would settle down again to idle or rest. Figure 43 shows the results of the observations period from 07.30 - 09.30 on 27th June. None of the cows or calves grazed during this period which was devoted to rest and sleep.

Evening. Systematica recordings normally ceased at 18.30, but on several occasions were continued until dusk. There was usually an evening grazing session at dusk (Figure 43), the actual time varying with the season. During April the evening grazing period had sometimes begun by 17.15 (sunset 19.00) but at this time on a hot long day in June (sunset 21.15) the cattle were settling down for a rest, having fitted in an extra grazing period from 15 - 17.00 hours.

It was quite obvious that the length of day was not the only factor contributing to variations in the circadian rhythms and that the temperature drop at dusk usually signalled the beginning of a grazing period. If, however, the temperature dropped before this or the day was cool, then the crepuscular grazing period was not well defined.

Influence of the weather on circadian rhythms (Figure 44).

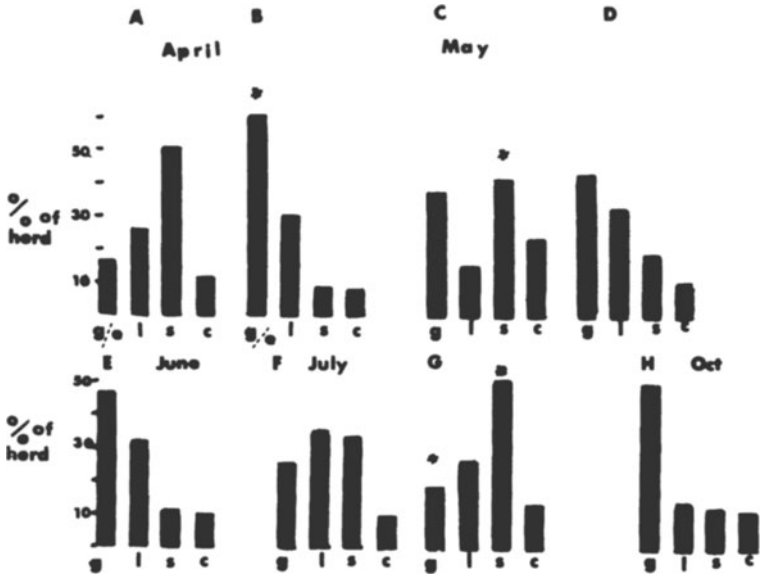
The effect of high or low temperature on behaviour is difficult to separate from other weather effects and the effects of availability of pasture, (since there was less pasture available when the weather was cooler in the early spring and autumn). There was more grazing and eating when the temperature was lower (Figure 44D, E and H). In high temperatures (Figure 44F and G) the cattle lay down more. When the weather was very

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cold (less than 5°C) accompanied by high winds or rain, or alternatively very hot (more than 40°C), the cattle spent more time standing in sheltered or shaded places (Figure 44A & G).

Figure 44

The Influence of the weather on the behaviour of grazing cattle.



Vertical axis: % of the herd performing different behaviours
Horizontal axis: different maintenance behaviours
g/e = graze and eat hay; g = graze;
l = lie; s = stand;
c = cud.
* . $p < 0.05$ t test.
The records were taken at hourly intervals through the day (8.30 am - 6.00 pm). These are the average figures for the day for the cows. Comparison with the calves are not given as developmental effects obscure those related to the weather changes.

A. 26.4. April storm and blizzard, very cold day, animals standing and sheltering more than usual at this time of year.

B. 36.4. Normal overcast day with sunny patches in April. The spring grass has come through and the animals are spending significantly more time grazing.

C. 7.5. A rainy day at the beginning of May, the cattle spend more time standing and less lying than in D.

D. 14.5. A mild sunny May day.

E. 13.6. A hot June day but the animals still graze an average amount.

F. 20.7. By the third week in July the temperatures have risen further (20°C) and the cattle spend significantly more time lying down, and rather less grazing.

G. 30.7. Another hot July day, but the Gad flies were about and so the animals spend less time grazing and much more standing.

H. 28.10. By late October there is a grass shortage and the animals spend more time grazing, and less lying and standing.

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In hard rain cattle tended to congregate behind available shelter, such as a hedge or wood, and stand with their backs to the prevailing wind. This of course increased the time spent standing, but grazing was decreased only in very hard rain (Figure 44A and C). Blizzards, storms and strong winds had the same effect and the animals would stop eating and shelter (Figure 44A).

Other influences on the circadian rhythms

The availability of pasture. Several authors (e.g. Blaxter 1967 and Tribe 1930) have suggested that the time spent grazing is controlled not just by the amount of pasture available but by the availability of digestible herbage. We did not do digestibility studies but the cattle spent more time grazing on days when there was less pasture available (Figure 44 B with D). The amount of time spent lying down did not vary greatly throughout the day so extra time grazing meant that there was less time for standing idling.

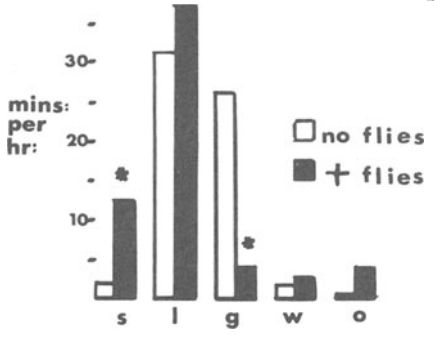
Gadflies. Apart from making the cows and calves 'gad', which itself is said to affect milk production and possibly calf growth rate, gadflies also made the animals crowd together. In this case they gathered in a shaded deep ditch where they stood for much of the day (Figure 45). Although this increased the amount of time the calves spent standing, it did not significantly affect the time grazing or standing for the cows (Figure 45).

Since the actual time gadding was under 1% for the observed animals, we do not think that it can have any serious effect on production unless the animal injures itself in the process.

Figure 45

The effect of Gad flies on the maintenance behaviour of calves.

blank = no gad flies on 28.6.74. black = with gad flies on 21.6.74. vertical axis = minutes spent in activity. horizontal axis: s = stand; l = lying; g = graze; w = walking/leaping; o = other activities. * = significantly different ($p < 0.05$).



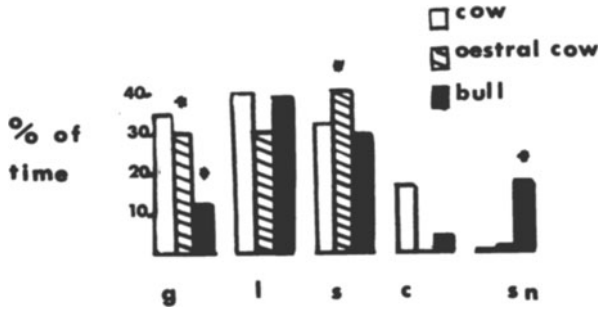


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Sexual Behaviour. The bull forms a strong bond with an oestral cow and will spend up to 50% of the time touching or keeping near her (page 60 et seq.). During this time he grazes very little while she spends more time standing and less grazing than the other cows (Figure 46).

Figure 46. The effect of oestrus on the time spent in different activities by an oestral cow, and bull tending her.

g = grazing; l = lying; s = standing; c = cudding; sn = sniffing.
* = significantly different at $p<0.05$ t test.



Frequently there are several other cows or oestral partners who circle around and form a group and these also show differences in the daily behaviour pattern, although after two or three hours they usually disperse to graze.

Although quantitative 24 hour recordings are needed to back up these observations, the indications are that the total amount of time in any twenty-four hour period spent grazing and lying down probably varies little, although it may be differently distributed according to temperature and other features of the weather. Very hot, very cold and very wet weather reduce the amount of grazing, but this may be made up at night or when the temperature changes. The availability of pasture seems more important than the weather in controlling overall time spent grazing.

The effect of management practices on the time spent in various activities

Cattle outside. In certain cases, for example, when the cattle are milked twice a day or kept confined and fed only once or twice a day, management practices almost completely govern how the animals spend the day, and how they use the pasture, however, the only interference with the single-suckler cattle at grass (apart from such rare events as the castrating of the bull calves) was that of feeding during the winter and early spring.

During the winter, the food (hay, straw and urea blocks) was brought on a trailer along the road which adjoins the winter downland pastures. As the feeding time approached (between 09.00-10.00) the animals would wait for the appearance

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of the tractor and call. After the food had been scattered in the field, the cows would spend two to three hours eating it and lying cudding among the remains before they began to wander off to graze in the rest of the pasture. The use of pasture during the winter was clearly affected by this management practice, but the relative time spent in the four major activities was not.

Figure 47

Contact between dam and calf.
A. Dam licking calf. B. Calf rubbing dam.





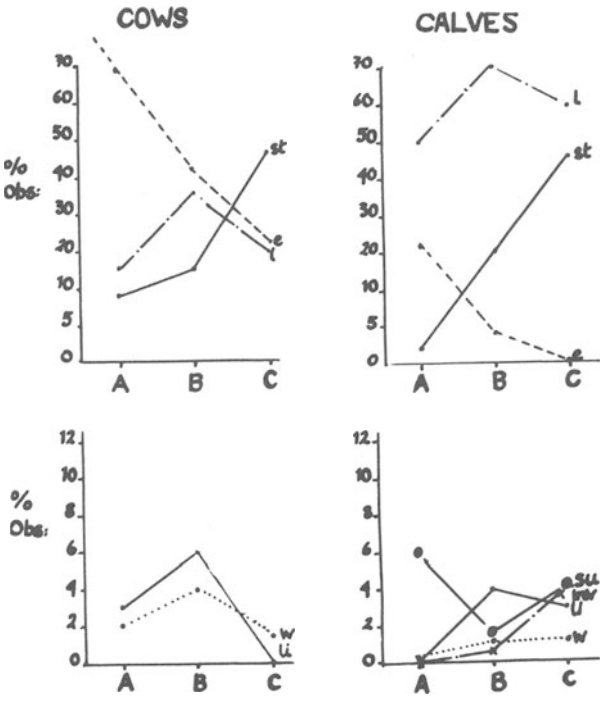


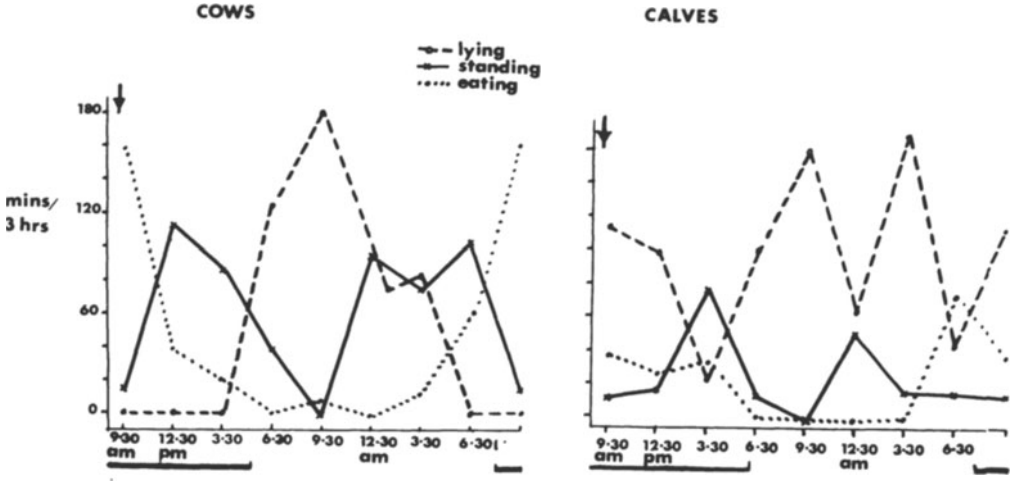
Figure 48. The % of time spent lying (l), standing (st), eating (e), walking (w) and licking & rubbing themselves (li) through the day for cattle inside with ad libitum hay & straw.

A = 9 am - 12 pm
B = 12 - 3 pm
C = 3 - 6 pm
su= suckle
inv = investigage

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Figure 49

The 24 hour rhythms in lying, standing and eating for free stall ration fed cows and calves.



The influence of the environment on the daily pattern is illustrated in Figure 42, page 125, in which a, b and c contrast the time spent in different activities for the cattle outside with others inside under two regimes (between 08.00 and 18.30 hours).
We can see that the field cattle spent much more time eating and substantially less standing than those inside. The ad libitum (B) fed yarded cattle spent more time standing and less eating than the grazing cattle (A). They also spent more time walking which is surprising. There were no significant differences between the ad libitum (B) and ration fed animals (C). Records for the whole 24 hours show no significant changes in the total amount of time spent in the different activities.

The early morning for the ad lib fed autumn calvers was spent resting and idling until gradually the animals would begin to collect around the hay and straw racks about half an hour or so before feeding time. Some would begin eating the straw left over from the previous day. The importance of the feeding time in controlling the daily activities is illustrated in Figures 48 and 49. The animals were fed their hay and straw with some concentrates at about 8 am and for the next two hours over 90% of the cattle were eating. The afternoon would be spent mainly lying down, resting and cudding the morning feed (Fig. 48 and 49). From 3 to 5 pm the predominant activity was standing and feeding intermittently (Figure 49) until they settled down for the night between 8 and 9 pm. During the night after 9.30 pm there was a gradual decline in the amount of lying by the cows until 6.30 am. These patterns are less well defined in the calves who had ad

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libitum hay and concentrates available and were also still suckling their mothers (Figure 42D).

The key question is how, if at all, the confinement of cattle affected the time spent in the various activities. Figure 42 compares the percentage of observations of the various activities performed by cattle inside and outside.

Inside, the cows spent less time eating, which is hardly surprising since their food was readily available at central points. Grazing cattle have to walk to get food even though the pasture may be plentiful. The extra time available to the cattle indoors as a result of reduced feeding time was made up (as the significant increases in the figures show) by standing idle rather than lying down. Those outside spent slightly more time lying down, but the difference was not significant. These results are slightly surprising since the confined cows had a deep bed of straw and there seemed to be no particular reason why they should stand rather than lie down, but it may be that enforced proximity to other cattle discourages lying. Outside in the field they sometimes lie as close as two metres from each other, but more often they are at least five to ten metres apart. This was just not possible within the confines of this free housing system though the individual's space allowance was quite generous by modern standards (Brambell Report 1965 Cattle: MAFF Codes of Practice 1974).

If enforced proximity (occasioned both by confinement and the concentration of the food supply) does disturb the animals, we might expect that these conditions would also influence the number of antagonistic encounters (that is, butting, fighting and withdrawing) between individuals, since increased aggression is often symptomatic of conditions of physiological stress (Kiley-Worthington 1977). The number of aggressive encounters between individuals in the field is very small (Table 17) among the confined cows it was much higher. Nickolson (1974) measured the number of interactions in our own small herd and found that the number of aggressive encounters per hour per cow when confined in an open-fronted yard was fifteen times greater than among the same cattle in the field (32.3/Cow/100 hours).

Table 18.

Encounters/cow/100 hours for ration hay fed animals.

Butt + withdraw + threat		licking, smelling + rubbing other individuals	
Inside:	32.2*	Inside:	7.8
Outside:	2.1	Outside:	7.2

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One might expect there to be more contact of other kinds (e.g.: licking, smelling and rubbing) between individuals inside, but this proved not to be the case (outside cattle: 7.2 per cow per 100 hours; inside cattle: 7.8 per cow per 100 hours (t test p 0.05) (Table 18 compared Table 17, page 122).

The cows spent more time rubbing and licking themselves when confined (Figure 42B), partly no doubt because they had more time to fill, although the increase may also reflect the number of convenient and readily available objects to rub against (about half the recorded rubbings were against inanimate objects). This rubbing and licking can become a severe problem in housed cattle and calves (see Chapter 9). Cattle outside spent slightly more time walking, although the difference was not as significant as one might expect since cows spent surprisingly little time walking even when grazing (Figure 18). The confined cattle certainly had enough space to make up the walking time, although it is possible that the incentive to walk in circles is not very great!

We have already seen how the cows and calves outside differ in the amount of time they spend in various activities. Generally, confinement seemed to have little effect on how the calves spent their day, although they spent slightly more time lying down than standing. The calves spent more time investigating the environment when outside in the field, presumably because there was more to investigate (Figure 42).

Inside and out, the calves prefered to be near other calves and cows near cows (Figure 35, page 113). There was no obvious increase in the amount of contact between confined calves. They showed a marked preference for the creep areas where they were fed and where the bedding was drier.

It was particularly interesting to find that both cows and calves showed preferences for particular parts of the yard, something that has previously been described as 'territorial behaviour' although here we feel it is a misnomer. We use the term 'territorial' to refer to areas which are defended from intrusion by other animals and this was not the case with these cattle. The preferred areas of the cows and calves are shown in the accompanying sketch map (Figure 50). Since the animals kept to particular areas (at least for the short period of the observation) their neighbours also tended to remain constant, so it seems they were also showing a preference for associating with other animals just as they did outside (Table 16). For example, animals 20 and 77 were normally to be found together, as were the twins, numbers 653 and 654. This preference for certain areas when confined is particularly interesting since it did not occur in the field where the animals moved as a herd through the whole area available (page 135 et seq.).

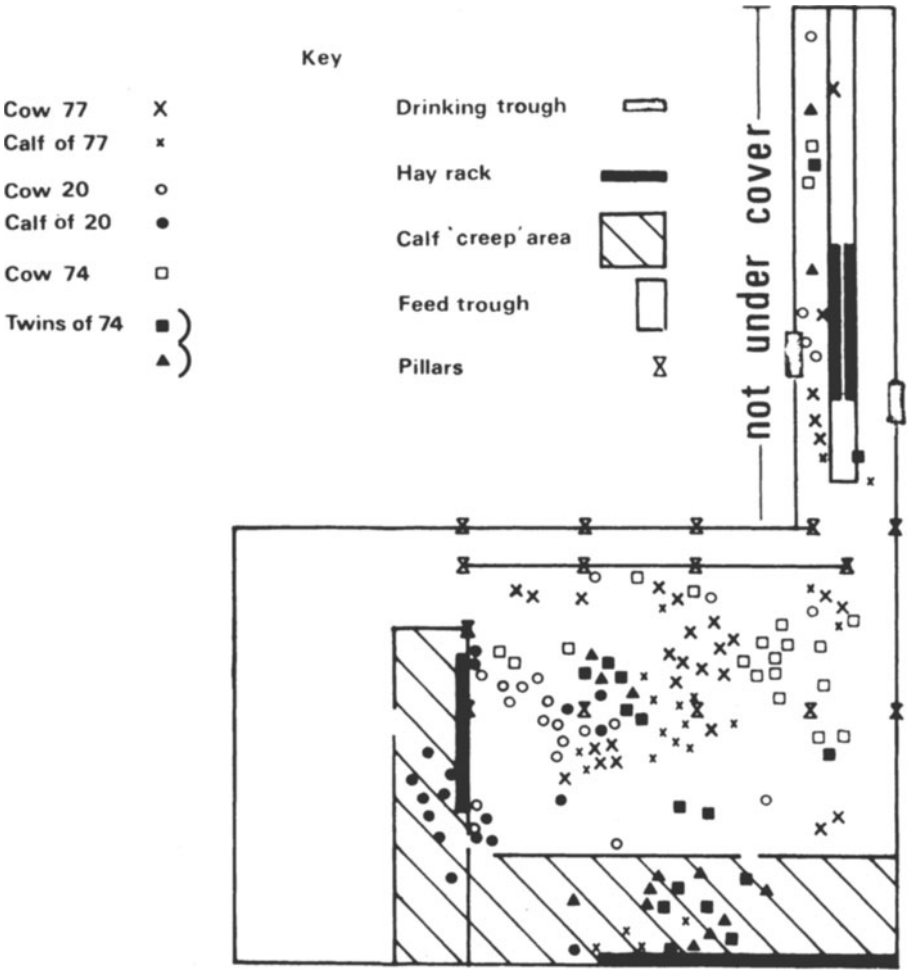
In some other species (e.g. the Uganda kob, Buechner 1961) a rigid form of territorial behaviour occurs when the population density is high, but it is unknown among less dense

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populations. Animals in zoos also frequently exhibit similar forms of behaviour, although no detailed observations have been made to date. The suggestion is that this preference for particular areas in a confined environment is an adaptation to high population levels. If this is so, its function is as yet unclear, although we can speculate that cows, like people, may become attached to the place they come to recognize as "home".

Figure 50

Plan of the straw yard where the suckler cattle were studied. The positions of 3 cows and 4 calves are plotted over a 5 day period (1 plot every 2 hours). Note the grouping of the plots, that is the faithfulness to location of the individuals.



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The use of pasture

During the second week of May 1975 the spring-calving herd was moved to the water meadows beside the river Cuckmere. Here the animals had approximately fifty acres of available pasture divided into four fields. The accompanying map (Figure 51) show the terrain and how it was used. The more interesting features of the pasture are described below.

Shelter belts. Certain areas around the hawthorn and blackthorn hedges were used as shelter belts (marked ///, Figure 51) and in the cold weather at the beginning of the year the calves were usually to be found in these areas. The direction of the prevailing wind seemed to make little difference to which side they stood. Later in the year when the gadflies became a pest both cows and calves would stand in these shelter belts, in particular on the north side of the hedge between fields (b) and (d) where there was a deep ditch big enough for almost the entire herd to squeeze into.

Vegetation. In the water meadows the main vegetation types were tufted cocksfoot and yorkshire fog-dominated pastures in the low-lying areas, and ryegrass and clover-dominated ley on the higher ground. However, the pasture had not been replanted for fifteen years and there were many other grasses and dicotyledonous species (e.g. dandelion, sheep's parsley, docks, daisies, plaintains) throughout the fields. The animals tended to avoid patches of nettles and thistles (see Figure 51).

Areas that were favoured by the calves, but also in hot weather by the cows, were the hollows which tended to flood every year (the drainage is poor in the alluvial/wealden clay fields near the river) and there was consequently little vegetation. Those areas provided slight shelter from cold winds, or a cooler earth surface in hot weather.

There was also a few marshy areas which remained wet throughout the summer, presumably due to underground springs. The wet area in field (d) where pond mint grew and a strong smell of peppermint filled the air was hardly ever explored by the cattle, but a similar area in field (b) attracted much attention from investigating calves, and later during the drought its continuing green sward was attractive to grazing cows.

Cattle paths. The formation of the cattle paths (shown by dotted lines Figure 51) was interesting, since at the beginning of the season there was only the main track (which was used occasionally by tractors) running the length of the pastureland fairly close to the river. As the summer progressed and the grass grew more slowly a series of other paths, branching out from the gateways and leading into the pasture, rapidly became established. The paths were formed because cows, like man, tend to walk where others have walked before, even when this is not the most direct route to the destination. Since it is obviously not advantage-

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ous to graze where others have already eaten the choicest shoots, the paths petered out where the cows stopped travelling and started grazing.

A path was also formed on either side of the drainage ditch separating fields (b) and (c). One of the primary reasons for this was that there was only limited access between the fields so a cow in field (c), for example, trying to get back to her calf in field (b), would have to walk the length of the drainage ditch. The trek often took two or three hours however, as both cow and calf, (although they could see each other over the ditch), would be diverted into grazing or dozing intermittently. This relaxed relationship between cow and calf is in direct contrast to the close relationship between mare and foal or ewe and lamb, either of which would call incessantly and rush about at such a separation (personal observation).

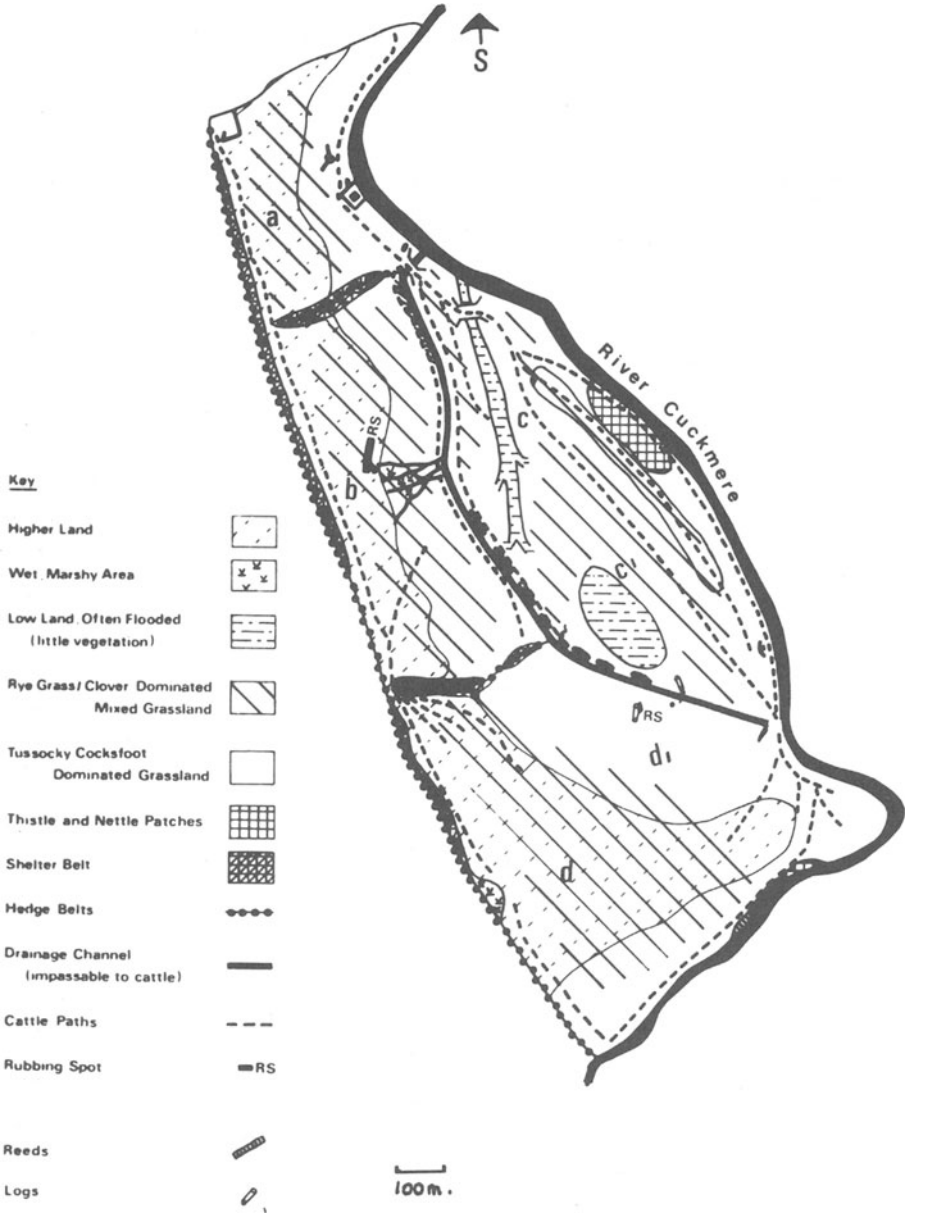
Rubbing places. Rubbing places are distributed throughout the area as shown (Figure 50). They consist of objects such as tree stumps and lumps of concrete with occasional fence posts or an old gate. On steep slopes or patches of bare earth which often started off as molehills, the cattle would rub their whole head in the earth and thereby gradually extended the bare patches (see Figure 50). All cattle rubbing, spend time smelling the rubbing places both before and after rubbing and it may well be that such behaviour is important for disseminating the smell of the individual and for identifying and being identified as members of the herd.

Cattle movements and field preferences

Since the different fields offered different facilities we might have expected the animals to spend more time in one than another. To test this, the positions of all the members of the herd were plotted at hourly intervals for twenty days between May 14th when they were moved to the water meadows, and July 23rd. Figure 52 shows the percentage of time the cattle were recorded in the different fields (fields (c) and (d) have been subdivided on the map to create areas of more or less the same size for the purpose of analysis) and we can see from this that there was no appreciable preference for any particular field over the whole period. This might indicate that the distribution of the cattle through the fields is random, but this is not the case. Cattle, tend to congregate in groups.

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Figure 51. Map of the river meadows where the suckler cattle spent the summer, showing vegetation and features of importance to the cattle.



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Figure 52. The preference of the cows and calves for different fields between 14th May and 23rd July, 1975 (total observations 2627).

Vertical axis = % herd (cows and calves)
Horizontal axis = different fields (see Figure 50).

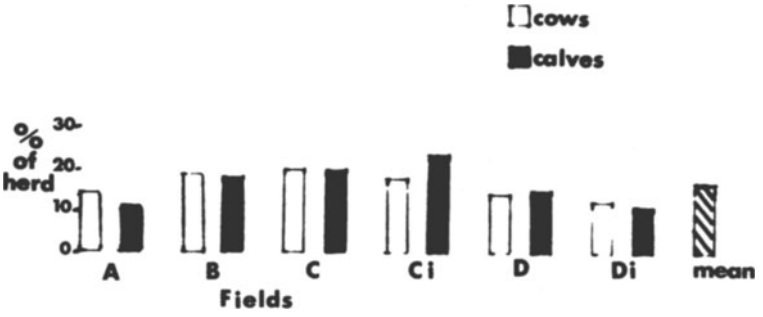
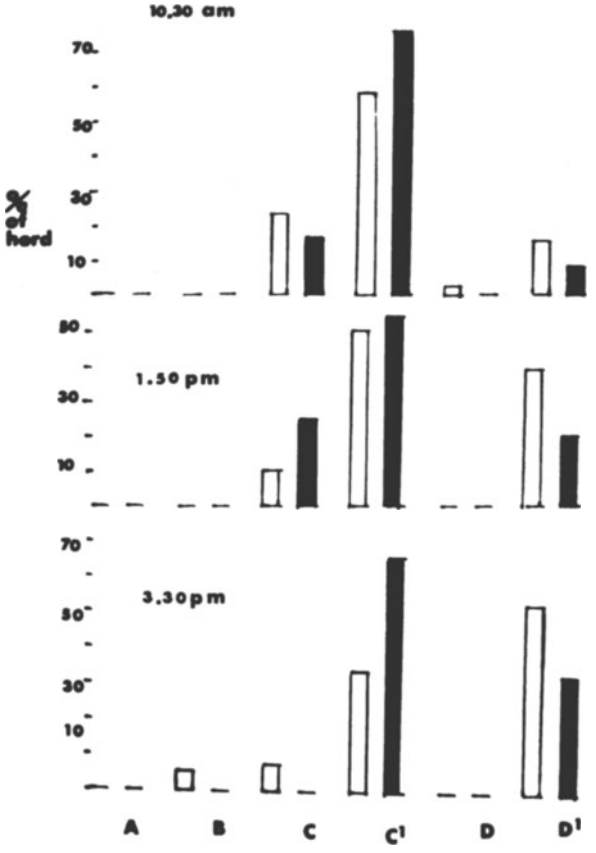


Figure 53. The percentage of animals in the different fields at different times of the day on 3.6.75.

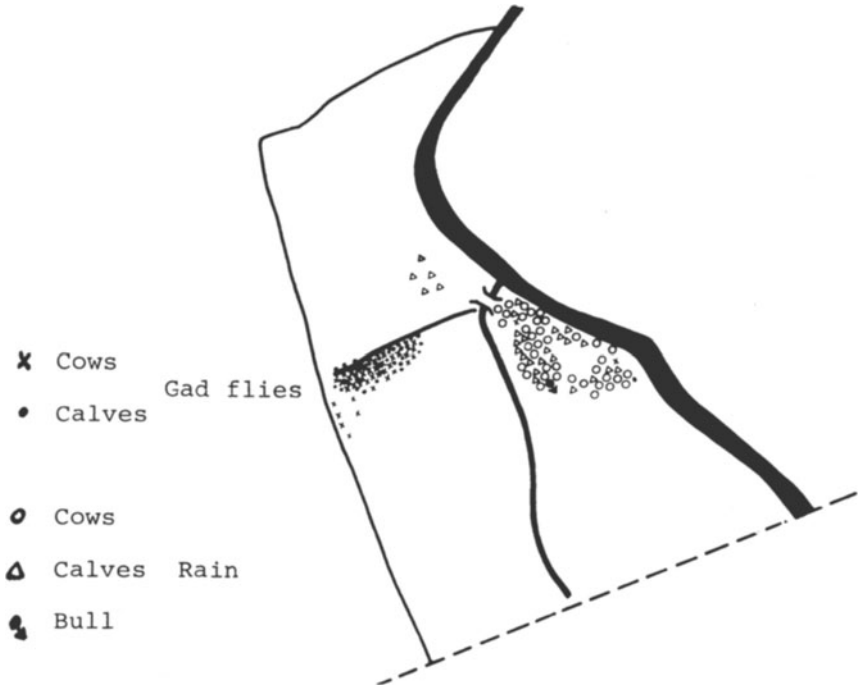


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Effect of other factors on field distribution

Herd distribution varies from day to day. The light rain, for example, which fell on June 4th (after a month or so without rain) caused the animals to group (Figure 54). Gadflies had a similar effect, causing the animals to pack tightly together in the large ditch at the edge of field D (Figure 54). While grazing, however, especially at the end of the summer when the grass was more scarce, the animals were more widely dispersed (Figure 55)

Figure 54. The effect of gad flies and rain on behaviour. Note the grouping in rain in an open area, and the tight grouping in a shelter belt when gad flies were about.



Individual differences in pastural use.

Figure 56, page 142 shows the movements of 4 cows and 1 calf around the fields during a 3 hr period. Differences in distances and direction are evident. The calf and cow (Dex) moved only 200 metres.

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Movements throughout the day

In order to show how the cows moved about during the day, the positions of all the animals were plotted at three times: 10.30 am, 1.30 pm and 3.30 pm on several days (Fig. 57, page 143). Characteristically, it is the cows which moved first to a new area, and were followed by the calves. This is easily explained. The calves spent a comparatively large proportion of their time lying down and sleeping in group (see Chapter 5), during which time the cows moved off to graze, possibly in another field. When the calves woke up they followed the herd in search of mother and milk. This pattern is illustrated in Figure 53 where we can see that by 3.30 pm cows were drifting south to field C, but the majority of the calves had only reached C i.

Individual movement. As well as plotting the movements of the herd, we also made hourly recordings of certain individuals. Figure 56 shows the movements of cows Rebecca, White Lady, Dexter and Spotface as well as Spotface's calf between 12.00 and 5.00 pm on May 20th - a sunny spring day when grass was plantiful. The two cows Rebecca and White Lady had shown a preference for each other as nearest neighbours (page 113), but on this day, although they followed more or less the same path, they showed rather different patterns, with White Lady taking a long diversion down to the end of field (C), for example. On the other hand, Spotface (who also showed a positive association with White Lady in the nearest neighbour data - Table 16, page 118), did not venture into the farther fields (D and Di) but restricted her activity to fields C and Ci.

Social facilitation. We have already seen that herd movements were influenced to some extent by the weather, availability of pasture and gadflies, and possibly 'social facilitation'. If one animal starts grazing it is likely that others will shortly copy (Benham 1980). Certain animals are more likely to be copied than others. In the Alps, farmers attach a bell to those animals they know control herd movements. However, social facilitation is very difficult to measure, isolated from synchronization (Birke & Clayton in press). It is a factor that must be considered in controlling grazing, however we made no quantitative measures.

The bull. On the few days when none of the cows was in oestrus the bull appeared to be merely another member of the herd, with no influence on the behaviour of other herd members, and if anything being more of a follower than a leader.

A strong influence on the bulls' movements was the presence of an oestral cow, with whom he would form a strong tending bond throughout her oestral period (see Frazer 1968 Hafez & Schein 1962 and page 64, Fig. 15). Figure 57 shows the movements of the bull and the cow Rebecca plotted at hourly intervals between 10.30 am and 3.30 pm. At the beginning of the day she was not in full oestrus and it was not until 11.30

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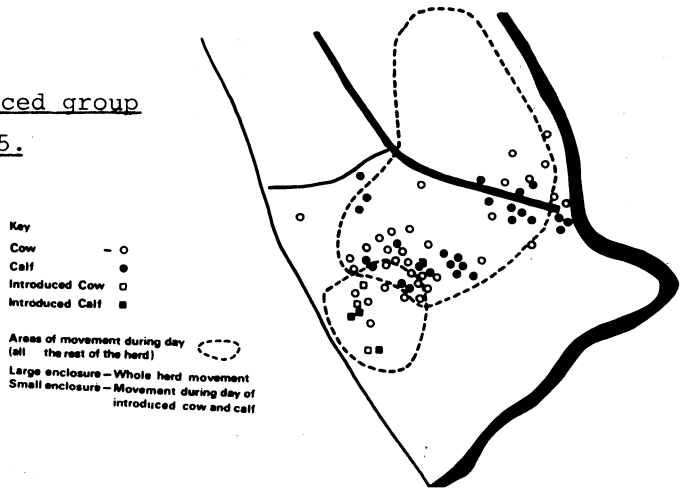
am that she came together with the bull. For the rest of the day, however, they kept together and she was mounted fifteen times and they mated on four occasions. Their preoccupation with the courtship and mating procedure often meant that the bull and oestral cow were left behind as the rest of the herd moved on to graze further afield. The calves, both male and female, showed a great deal of interest in the sexual behaviour of the bull and oestral cow and would mill around them, often six or seven at a time. (page 63 et seq. and Figure 57, page 143).

As well as the cows and their calves the herd included one bull and five steers. A larger proportion of bulls to cows may have been more 'natural' but since this study is partly aimed at increasing knowledge in relation to husbandry, this typical single-suckler herd amply served our purpose.

Grouping within the herd. Having established that certain individuals within the herd had a preference of association with other individuals (page 115, we were also interested in trying to ascertain whether particular animals tended to have a preference for the centre of the group while others kept to the periphery, since Clutton-Brock et al (1976) had found this to be the case with a herd of Highland cattle on the Isle of Rhum. We did not keep records of the positions of all the individual herd members, but our data tends to confirm this supposition. In particular, older cows which had formed strong individual associations within a group (Rebecca, White Lady and Lesley, for example) tended to keep to the centre of the group, Figure 41, page 119 although Spotface (also an old member of the herd and a member of the same group) was found to be on the periphery on twenty occasions out of a recorded thirty-two. A small group of cows consisting of Dextina, Nanette, Flo and Fils jointed the herd after the winter and they tended to keep together as a sub-group on the periphery of the herd for two months (Figure 55).

Figure 55

Positions of introduced group to the herd on 5.6.75.

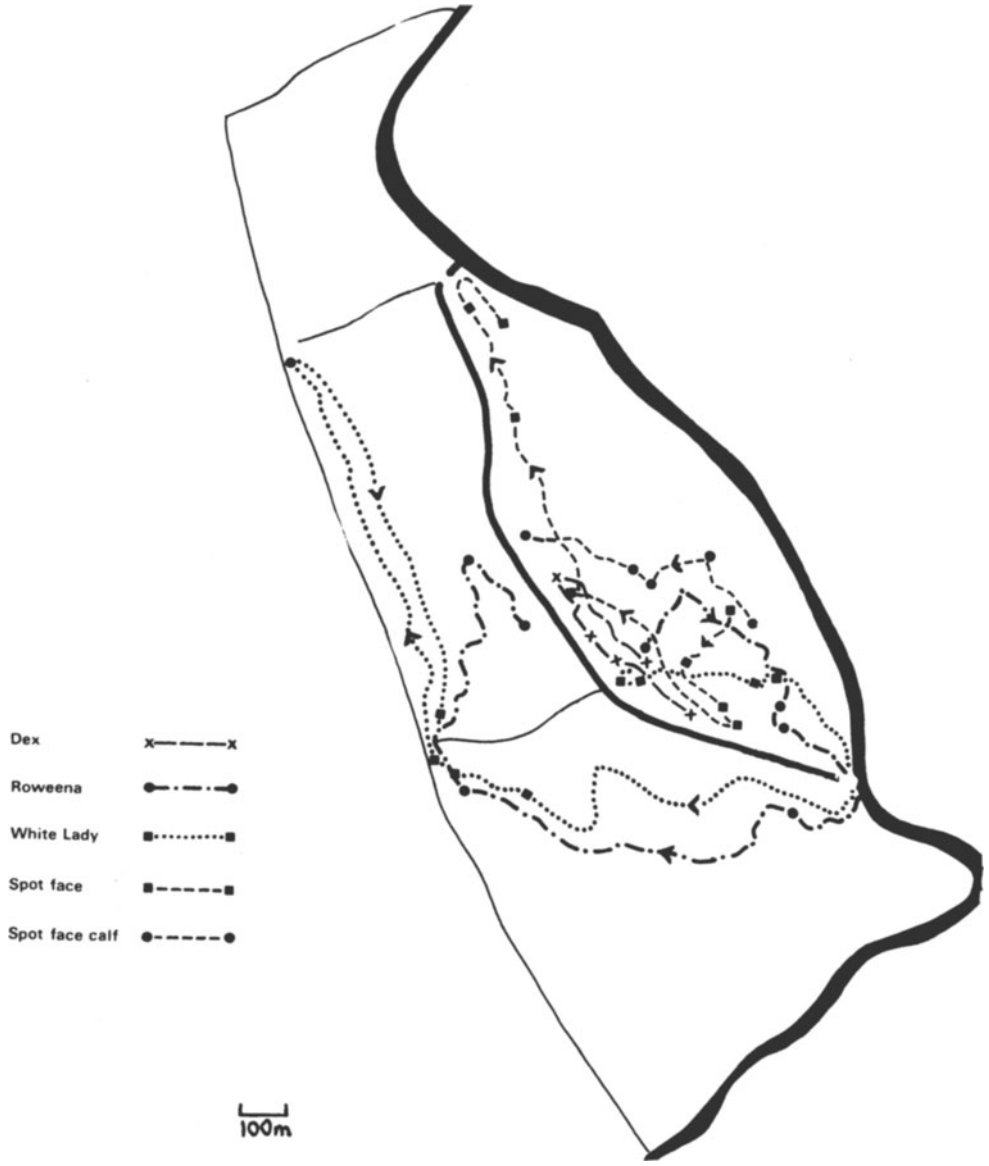


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It is reasonable to assume that the group structure becomes more developed and association between animals becomes stronger the longer they are kept together (see Reinhardt 1980a).

Figure 56.

The progress of 4 cows and 1 calf around the fields from 12.00 pm to 3.00 pm on 20.5.75.



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Figure 57.

The position of animals in the herd throughout the day on a warm day in June. A cow was in oestrus and her movements with those of the bull are also shown.



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CHAPTER 8

Fostering and Adoption in Beef Cattle.

Although there are a number of observational and anecdotal studies on how and when the dam recognizes her calf, there is very little experimental work. There have been studies on maternal behaviour and recognition of the young in sheep (e.g. Alexander & Shillito 1977) and goats (e.g. Hersher et al. 1963). Cowley & Darby 1970 have worked on fostering in cattle.

An understanding of cow-calf recognition makes possible the manipulation of maternal behaviour to enable a single-suckler beef cow to raise two calves and so become a double-suckler. It is generally recognized that single-suckler cattle are not profitable on many farms and it has also been argued that they are a very expensive and inefficient way of producing protein if fed concentrate diets. On the other hand, cattle can make use of marginal grazing areas where more intensive husbandry is not possible, and if each cow were to raise two calves on these poorer grazing areas, protein production would be more efficient.

One way of getting a cow to raise two calves is to induce super-ovulation so that she gives birth to twins. This procedure is still in an experimental stage, however, and very expensive. The second way is to make the cow accept as her own calf one brought from elsewhere, for instance from the dairy industry, which produces more calves than it needs. The problem is that the cows are frequently uncooperative, and many of them will not accept a second calf, and even where a calf is accepted, it tends to be 'fostered' rather than 'adopted', ending up poorly grown compared to the cow's own calf. The problem is therefore primarily behavioural, particularly in the beef breeds. It is important for the survival of the beef calf that it is rapidly and exclusively recognized by its mother from whom it receives milk, care and attention. Since the survival and quick growth of the calf are essential for the raising of commercial beef, the selection by man has tended to enhance and reinforce the naturally evolved maternal behaviour of the beef breeds.

By contrast, dairy cattle have usually not raised their own calves for generations and have been selected for less rigid maternal behaviour and therefore tend to adopt or foster calves much more easily (e.g. in multi-suckler systems, or when a milking cow is rejected from the milking herd and becomes a suckler animal).

There have been many experiments on 'imprinting' or mutual recognition between mother and offspring, particularly with birds - starting off with Lorenz (1935) in which he succeeded in imprinting himself on goslings.

Studies of other species (e.g. rats, primates and goats) suggest that factors other than breed and genetics should be taken

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into account in assessing maternal behaviour, in particular the female's previous 'experiences', e.g. Zarrow and Denenberg (1964), Mason (1965), Liddell (1956). A cow's maternal behaviour may be affected by whether she was reared in isolation (Donaldson et al 1972), has ever had or reared calves previously and whether or not she was bucket-reared, among other things.

If a calf dies in a single-suckler herd it is common practice to substitute another which the cow usually accepts after the two of them have been confined together for a day or two. We had eight calf deaths in the two herds studied in 1974/75 and found imprinting of the calf on the dam is strong, but not irreversible in the beef cow. She does not stop behaving maternally on the death of her own offspring. When a cow has twins she shows no preference for either calf (we studied five sets in 1973/75), so we know that when attempting adoption, or fostering, it is not the presence of two calves which is disturbing. Our aim in this study was to have a second calf adopted by the mother so that she behaved as if she had had twins.

The first task was to classify the behaviour of the cows to calves into three categories: 'positive' (adoption); 'negative' (rejection); and 'tolerance' (fostering). 'Adoption' meant the cow acted towards the calf as if it were her own. Fostering is the usual behaviour in multi-suckler systems and occasional double-suckler herds, but true adoption is rare. Table 19 gives the classification of behaviour under each of these headings. In multi-suckler systems the cows can usually be classed as 'rejectionists' (R2 or sometimes R1) if they have to be confined or tied before they allow the calves to suckle. All the introduced calves in this study were fostered (F1 or 2), and all but one cow eventually allowed sucking by the introduced calf when they were loose in the field after 2 weeks. We were aiming however at adoption (A2).

It was not possible to test all the variables quantitatively because of the cost of experimental animals, and the small sample available. This does not however invalidate the work as the aim was to develop a practical system which could guarantee a consistently high adoption rate (around 85%) with beef suckler cows.

In the first series of experiments there were 6 cows used, each for two lactations. One cow's calf died in each lactation after several days, and therefore two further adoptions were performed. Thus 14 adoptions were attempted in the first series.

In the second series of experiments 5 of the same cows were used for 1 to 2 adoptions, and 4 other cows used for 1 to 4 adoptions each. One of the cows in this series was a heifer who was double suckled herself. The total number of adoptions performed in the second series was 23.

A list of the cows, their breed, age and the number of lactations is given in Table 20.

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Table 19. Classification of the behaviour of the cow to the introduced calf.

Cow's response to introduced calf:

Negative	(R) Rejection	1) cow persistently attacking calf at any time. 2) i) butt calf) ii) kick) when calf attempting iii) circle) to suck
Tolerant	(F) Fostering	1) calf allowed to: i) suck with own calf between cow and calf ii) between back legs 2) calves suck from opposite sides in normal position.
Positive	(A) Adoption	1) i) calf allowed to rub and butt cow ii) calf suckled alone if mother distracted iii) cow licks calf 2) i) calf sucks alone without mother being distracted ii) cow seeks calf out, stands over and protects it against predators

The main variables that were considered, apart from the cows individual differences were:-

i) The time post-partum that the calf was introduced.
ii) The age of the calf at introduction.
iii) The behaviour of the calf at introduction and subsequently.
iv) The recognition of the cow by the calf.
v) The recognition of the calf by the cow,
and how these were established (that is by the relative importance of auditory, visual, olfactory, gustatory and tactile cues).

1. The time post-partum that the calf was introduced

On a commercial farm with a suckler herd, cows calve in the field and birth dates are not always known, nor is it always possible to be present at the birth. Initially, therefore, we aimed at introducing the second calf at about twenty-four hours post partum (this was done for the first five calves), since this allowed time for the farmer to collect the cow and obtain another calf for introduction. Although other treatments were also given to these cows, much of the difference in success between the first and second years (Series 1) was attributed to the calves having

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been introduced too late in the first year, when recognition by the mother of her own calf had been firmly established. Analogy with other related species (e.g. sheep, Hersher et al 1963) and observations on single-suckler cattle on the Downs suggest that the critical period for calf recognition was only a few hours after birth. We therefore aimed at introducing the remaining calves at birth. However, in the first series 2 were missed so these introductions were done later (six and twelve hours post partum), and two introductions were made two weeks post partum due to the death of two calves.

Table 20. The cows used for the adoption studies.

Cow's name	Breed	How reared	Age at first adoption	Number of lactations single-suckled before experiment	Number of calvings at which adoptions attempted
W.C.	Hereford X Friesian	Mother - single suckled	5	2	3
Daisy	Hereford X Friesian	Mother - single suckled	5	2	1
Grey	Beef Shorthorn X Angus (blue-grey)	Mother - single suckled	5	2	3
Pamela	Charollais cross	Mother - single suckled	6	3	8
Peggy	Charollais cross	Bucket	4	1	6
Dolores	Charollais cross	Bucket	4	1	3
Peppercorn	South Devon	Mother - single suckled	5	2	3
Kicker	South Devon	single suckled	4	1	4
Clover	South Devon	single suckled	3	0	4
Heifer	Hereford X Blue-Grey	single suckled	3	0	1
Kale	South Devon	double suckled	3	0	1

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Table 21 shows in both series that when the calf was introduced at birth, fewer aids were necessary to prevent the cow hurting the introduced calf than when the calf was introduced later. This confirms that recognition of the calf is established in the first

Table 21

The time of introduction and treatment of cow and calf. Their effect on recognition assessed by the "aids" required to allow the calf to suckle.

1ST SERIES

Time post partum introduced:	2 weeks	24 hrs					12 hrs	6 hrs	At birth				
Methods used to reduce sensory cues available:		Name of cows:											
	P2 P4	WC	Pa	Gr	Pl	Do	Pa	Grl	Do	WC	P3	Pa	He
Rub calf with afterbirth		+	+	+	+			+	+	+	+	+	+
Olfactory confusion: Xylocaine sprayed up nostrils of cow				+	+	+							
Wash own calf in detergent									+	+	+	+	+
Visual confusion: Calves same colour				+	+								
Visual confusion: Cow blindfolded 2-6 hours	+						+				+	+	+
Aids to prevent calf being attacked, and allowed to suckle:													
Confinement	+ +	+	+	+	+	+	+	+	+	+	+	+	+
Distraction (feeding)	+ +	+	+	+	+	+	+	+	+	+	+	+	+
"Fear" (stand by)	+ +	+	+	+	+	+	+	+	+	+	+	+	+
Shout	+ +	+	+	+	+	+	+	+	+	+			
Mechanical:													
Tie legs	+	+	+	+	+	+		+	+				
Tie head	+	+	+	+	+	+		+	+				

2ND SERIES Number of cows in each category.

Time of introduction:	5d-1wk	3 days	24 hrs	6 hrs	At birth
Method:	1	6	1	3	6
Rub calf with afterbirth				2	6
Mask both calves with scent		6	1	3	6
Wash own calf				3	6
Aids needed: Confinement of calves time p.p.	2 weeks	2-5 day	2 days	2 days	1-2 days
Distraction	+	3	+	-	-
"Fear" (stand by)	+	+	+	-	-
Shout	-	-	-	-	-
Tie legs	-	-	-	-	-
Tie head	-	-	-	-	-

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Table 22. The adoption rating of the introduced calves in relation to their learning of suckling positions (end of 3rd week post partum). + occurs (+) sometimes - never occurs. Rating Table 19.

Calf		P3	H F2	Pa F5	Pl RD	WC MoT	P4 An	Pa Fl	Gr A	D Pin	WC Ary	Pa Bl	Gr GB	P Fr	La Fo
Normal position		+	+	+	(+)	-	-	-	-	-	-	-	(+)	(+)	(+)
Learnt after introduction	(1) synchronised sucking with cow's calf		+	+	(+)	+	+	+	+	+	+	+	(+)	(+)	-
	(2) suck between cow and calf				(+)	+	+	+	+	+	+	-	(+)	(+)	-
	(3) suck between hind legs						+	+	+	+	+	-	-	-	-
Adoption rating			A_2	A_1	A_1	A_2	A_1-F_2	F_2	F_2	F_2	F_2	F_1	F_1	R-F_1	R

few hours after birth. Therefore for successful adoption the adoptee must be introduced as soon as possible after birth.

2. The age of the calf at introduction

From the practical point of view, control over the age of the introduced calf is difficult. Hersher et al (1963) found that the age of the lamb substituted for the mother's own was not crucial. For these reasons the calves used for the adoption studies were bought at the market and ranged in age from a few days to about two weeks old. It could be argued that very young calves are more likely to be accepted by the cow, as they will behave in the same way as the cow's own. However, it is often impractical to obtain very young calves, and if such a calf is recognized as alien by the cow, it is much less likely to be able to withstand being knocked about, or to learn the necessary sucking position swiftly enough (see below) to survive.

3. Behaviour of the calf

If the calf was too active and persistent in its attempts to suckle immediately after introduction, the cow rapidly recognized that it was not her own and attacked it. If, on the other hand, it lay still and behaved like a new-born calf, it was more likely to be accepted. Studies on single-sucklers showed that cows, when looking for their own calves, initially recognized a group of calves which they approached, and then chose their own from the group using olfactory and visual clues. However, they never confused older and more active calves with their own, so it seems that cows respond to behavioural cues specific to the age-group of their calves. Once this point had been established, we devised ways of keeping the introduced calves quiet (at least until the natural calf was on its feet and sucking). One solution would have been to treat the calf with mild sedative before it was introduced, but a cheaper and more

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practical solution was to ensure that the introduced calf had a full belly and was therefore likely to lie quietly.

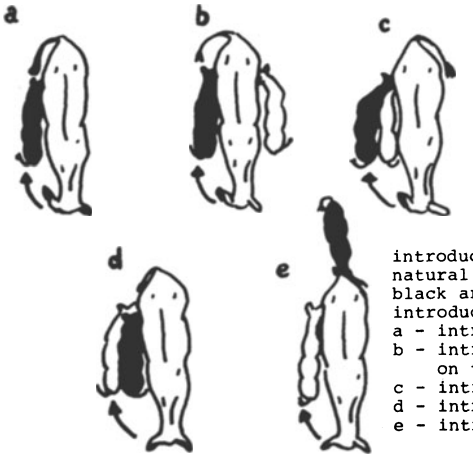
The second important factor in the calf's behaviour which was found to have a radical effect on the subsequent mother to introduced calf relationship was how and when it sucked. If within two to three days after introduction it learned to suck at the same time as the natural calf and from a position between the cow and calf, or from between the hind legs (Figure 58), the cow would gradually accept it. If, however, it persistently tried to suck from the conventional position at different times from the natural calf (Figures 58a and b), the relationship would rapidly deteriorate, and the cow might attack the calf on sight (that is R1, Table 19).

Table 22 shows the importance of learning the sucking technique for successful adoption. The first calf (W) did not have to learn any of these techniques, just as natural calves never do, because it was successfully adopted at birth. X1, X2, RD and McT never had to learn to suck between the back legs of the cow as they were successfully adopted, nore did the 5 calves introduced at birth in Series 2 (AI & A2 from Table I9). The calves An, F1, A, Pin & Ary were all fostered to the F2 level and

Figure 58.

Unsuccessful (a to c) and successful (d and e) suckling positions used by the introduced calves.

The backward position of the cow's ear nearest the adoptee, and the swishing of her tail are indicators that the cow has not fully accepted the adoptee.



introduced calf - black
natural calf - white
black arrow indicates possible head swing of cow to detect introduced calf.
a - introduced calf suckling alone.
b - introduced calf suckling in synchrony with natural calf, on the opposite side.
c - introduced calf suckling on outside of natural calf.
d - introduced calf suckling on inside of natural calf.
e - introduced calf suckling between back legs.

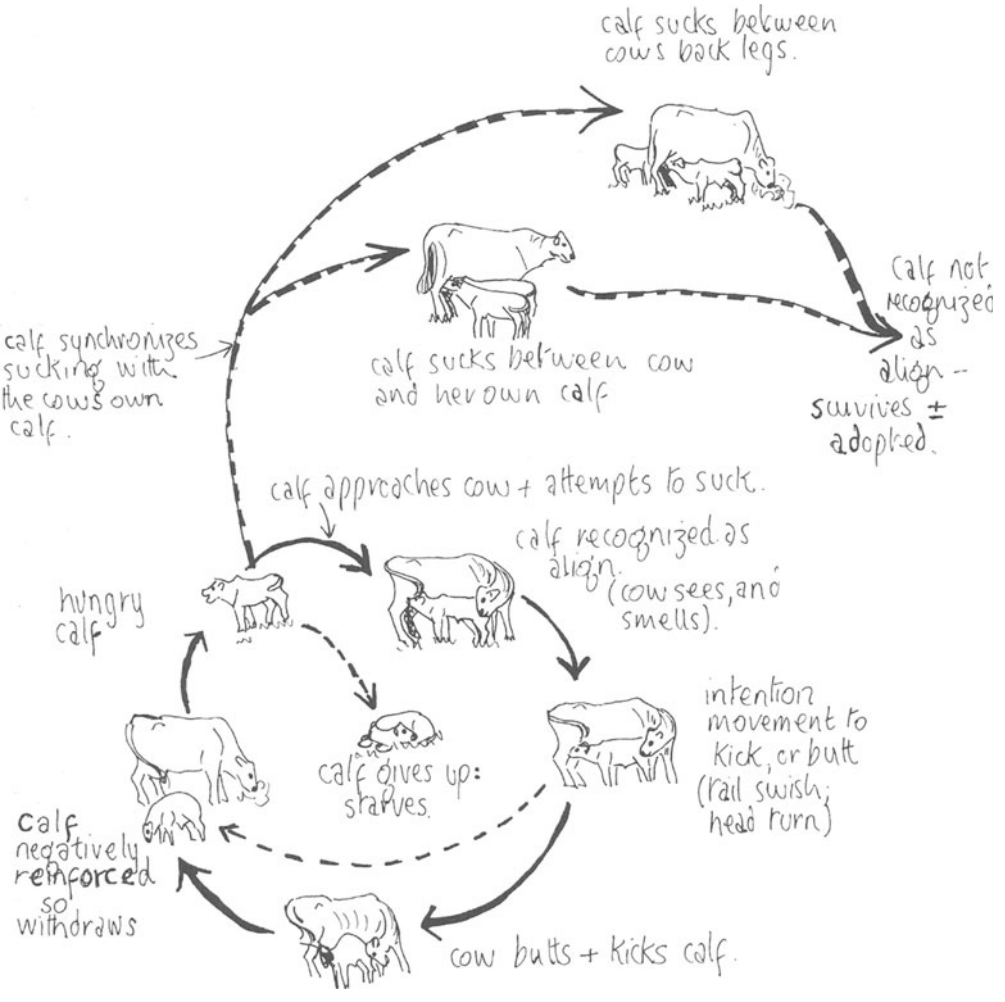
had to learn all these techniques. B1, GR, Fr and Fo never learnt these techniques and were subsequently either rejected or only fostered to the F1 level.

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Figure 59 summarizes the behaviour of the introduced calf in relation to the cow and the final consequence (starvation) if it does not learn the appropriate sucking behaviour.

Figure 59.

The importance of learning appropriate suckling behaviour for the foundling calf.
The "Viscious Circle of Starvation" (▬▬ lines) and the "learnt response spin off" (▬▬ lines).



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4. Recognition of the cow by the calf

The reason why it is relatively easy to raise many mammalian species away from their mothers is that the young mammal is initially an opportunist and will attempt to suck from any convenient female, or even an inaminate object. It normally learns quickly who is its mother as she is the only one allowing it to suck unmolested; and where it obtains the milk reinforcement. We therefore did not anticipate any problem with the calf recognizing and attempting to suck from the cow (if she would co-operate) providing of course that the calf had had suckling experience. This is not always the case in calves brought in, and so they were all tested to make sure they could suck, and if necessary they were suckled on another cow for a couple of days before introduction. Once the introduced calves had obtained milk from the potential mother, they were normally keen to approach her again and suck more, unless they were badly kicked or butted. Even then they would persistently try to suck for two to three days.

5. Recognition of the calf by the mother

This is the crux of most adoption problems. In order to test the relative importance of the different sensory modalities and how long after birth they become important in the recognition of the calf, various tests were conducted. Table 21 gives the results.

Familiarity. The cow is unlikely to become familiar with a calf that she has recognized as alien. It was considered important to enforce contact between the mother, her own calf and the foundling and each cow was confined with both calves until a bond had been established. In practice the bond was judged to have been formed when the foundling was able to suck at least synchronously with the natural calf without being attacked by the cow. The time until this was established (indicated by a black dotted line at F2 in Table 19) varied from one day to three weeks.

Olfactory recognition. The importance of smell in the establishment and maintenance of mother-young bonds has long been known, and is shown in traditional techniques such as covering a lamb, calf or foal to be adopted in the skin of the mother's own dead offspring.

Lately there have been a number of studies of the importance of olfactory recognition in sheep and goats, and several have shown that olfactory recognition is rapidly established (e.g. Hersher et al 1963 and Klopfer 1971). However, Baldwin and Shillito (1974) showed that maternal behaviour would continue to be exercised if the mother was unable to smell at all - several anosmic sheep still cared for their lambs satisfactorily. Cowley & Darby (1970) stress the importance of smell in calf recognition.

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Initially, it is possible that the mother recognizes the new-born calf as her own because it is wet with fluids from her body, and therefore has her own smell. This may be very important in the first bonding, and as the calf dries and matures and develops its own smell, she learns to associate this with her own fading smell on the calf. Therefore, in order to stimulate successful adoption there are three possibilities.

1. To prevent the cow smelling anything by temporarily anaesthethizing the olfactory tract. This was attempted in three cows by squirting Xylocaine (a local anaesthetic) up the nostrils, but there were problems with this technique. It was not easy to be sure that the tract had been totally anaesthetized and in any case, the anaesthetic wore off after a couple of hours which was not long enough for the cow's odour to have faded from the calf. To be effective anaesthesia would have to last for fifteen to twenty hours, and this would probably affect other behaviour such as touching and eating. We also tried putting vaseline in the cow's nostrils (Crowley and Darby 1970), but the three introductions using this device were not particularly successful.

2 . To make the foundling smell like her own calf by rubbing it with afterbirth or birth fluids. The intention was to rub all calves before introduction, but for practical reasons this was not always possible. On several occasions a cow that was about to butt a calf was apparently inhibited from doing so by smelling its coat and often she licked it instead; so this technique probably did have some effect.

3. The third method was to use a masking smell on both calves to reduce the number of olfactory cues available to the cow and prevent her discriminating between the calves. This was the most successful. Here the natural calf was first removed and washed in warm water and detergent. There are, of course, problems with this technique, not least of them being the youth of the calf and its susceptibility to chill, as well as the difficulty of removing all olfactory clues from the calf. Thereafter both calves were covered in the same pungent smell; cheap scents and eau de cologne were the most successful.

Visual recognition. As we have seen in Chapter 3, visual communication is well developed in cattle, and there are indications that visual recognition of the calf and lamb may be important, (e.g. Crowley and Darby 1970 and Alexander & Shillito, 1977). Two of the introduced calves in the first year were similar in colour to the cow's own calf, and both were successfully fostered (P1 and Do). The calf of P1 was subsequently totally adopted on the death of her own. The behaviour of the single-suckler herds also suggested that visual recognition of the calf was established within the first week (see Chapter 5), and we tested the importance of visual recognition in the first hour after birth by blindfolding the cow at five introductions (Ra, P3, Pa, He and P4). All of these were more successful than those of the previous year despite the fact that one calf was introduced twelve hours after

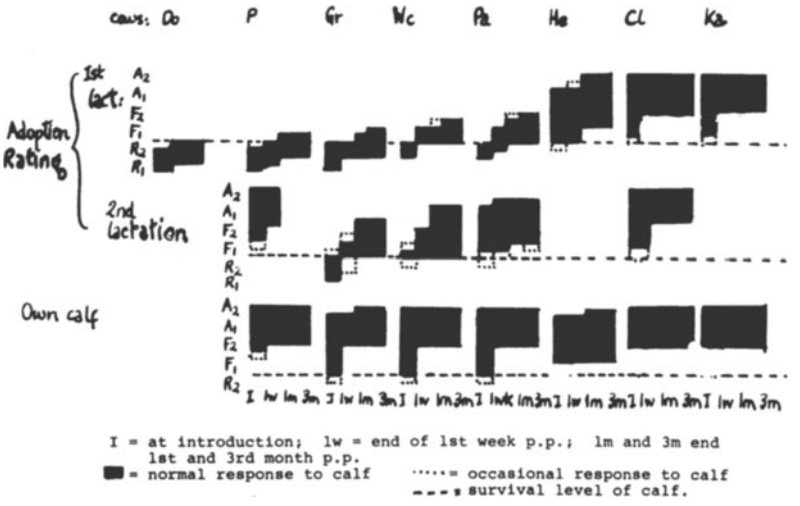
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birth (Ba) and one two weeks after birth (P4). One (H3) was a wild young Blue-grey cross Sussex heifer who nevertheless successfully adopted a Friesian calf as a result of blindfolding the cow from half an hour before, until six hours after birth, introducing the foundling at birth after it has been washed in birth fluids and washing her own calf in detergent. In the second series of adoptions, the cows where the calves were introduced at birth were blindfolded for 1-3 hour periods. All of these calves were adopted.

Even when all three of these treatments were used together, the cow was still able to discriminate between the calves in favour of her own and in fact the only total rejection followed the use of all 3 methods. (Fo, Table 22), It appears, therefore, that although olfactory recognition may be important, it is probably not the only method of recognition even immediately after birth.

Figure 60.

Changes in adopting rating with time towards the foundling for 8 cows from adoption.



Auditory recognition. Other fieldwork on single-suckler cows at grass had established that during the first three days of life, it is very rare for the calf to call unless in distress (Figure 19, page 82). As long as it is fed regularly and does not get lost or hungry, it has no reason to call. It follows that initial recognition of the calf by the cow is not normally established by sound. Espmark (I97I) observed the development of auditory recognition by reindeer cows during the first two weeks after birth. We made play-back tests with recorded calls to the calves mother, and others of the same age. There were no differences

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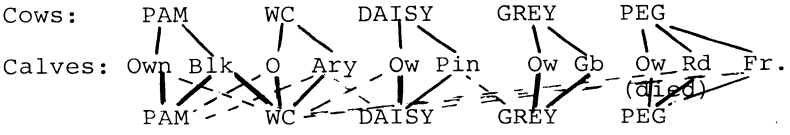
in the cows' response to either. However this does not mean that the cows do not recognize their own calf's calls because with such experiments with cows there are two major problems. Firstly, that of emulation (see page 62),(when the sound of any other cattle call may induce a response) and secondly that of habituation, when the cow gives up responding to the calls after a period of (in this case) about 10 minutes. Play backs of the dams call to her calf caused no increase in response over another cows call. Again this does not mean there is no recognition.

Gustatory and tactile recognition. Gustatory and tactile cues may well be used by the mother since she touches, rubs and licks her calf frequently particularly within the first few days of birth (page 82). Washing the cald will, of course, interfere with those cues. There are indications that the texture of the coat after birth may be an important cue for recognition as it is covered in slime. Rubbing the introduced calf with the placenta in all cases caused the cows to lick the calves at least for short bouts. Figure 61.

The permissiveness of the cows.

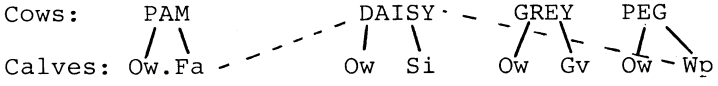
The suckling relationship sought after (one cow with her own and an adopted calf) are shown in A. B shows the actual suckling that occurred, in the first year with several calves cross-suckling other cows. There was a considerable reduction in the cross-suckling in the second year (C) when the calves were more satisfactorily adopted. (D) Series 2 adoptions. All calves adopted, but suckling from Pep, Pa and Cl as well as own mothers.

SERIES I. A. The cow & calf sucking relationships sought after



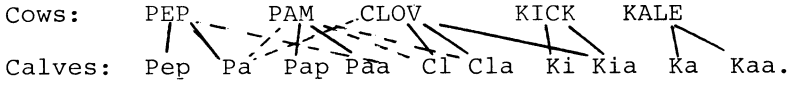
B. Sucking relationships obtained in the first year.

C. Sucking relationships obtained in the second year.



SERIES II.

D. Sucking relationships obtained.



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Changes in behaviour towards the calf with the passage of time.

Figure 60 illustrates how the acceptance of the calf changed over the first three months. It can be seen that as time progressed, there was a general trend towards greater acceptance of the calves.

Changes related to the age of the cow.

We varied the treatments and time of introduction for the two lactations, but the greatly improved acceptance in the second and subsequent lactations with adoption may have resulted from the cows' previous experience of adoption (WC, Pa and Gr Table 22).

In the second series of adoptions, 5 of the same cows were used for 1-2 adoptions, one for 6 more (one each lactation). Three of the additional cows were used for 4 adoptions each. There was little doubt that the experience of double suckling increased the likelihood of adoption - despite the other variables. All cows improved with each lactation so that after 3 lactations, it was possible to perform the adoption in the field without the calf being introduced at birth and the cow confined (4 cases to date).

Increased permissiveness of cows.

An unforeseen effect of the successful adopting was that the mother became more permissive of other calves sucking as well as her own and her foundling. Calves rapidly learn to take advantage of this tolerance and it was not uncommon to see four calves sucking on one cow! It is particularly interesting that this new behaviour was not confined to the foundlings but was also practised by the natural calves, although they cross-sucked less than the foundlings (as shown in Figure 61).

The individual differences in permissiveness of the cows and opportunism in the calves are not conducive to equal growth of the calves and production is affected accordingly. For the moment the best solution to this problem is to try to synchronize calving as far as possible so that the calves are of more equal age and size.

Permissiveness is not confined to double-sucklers, and single-sucklers sometimes tolerate sucking by strange calves, with the result that orphans can often survive reasonably well in the field, but the onus is on the calves to initiate sucking attempts.

In the second series of experiments, although the majority of the calves are adopted, nevertheless the cows were very permissive of suckling. The problem appears to be that if two calves are suckling whom she accepts and therefore does not want to kick off, she can no longer control others sucking her from behind or between . Provided the calves are all of approximately the same size, this does not appear to matter. The

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experimental/commercial herd now consists of cows and their calves who vary in age by approximately 3 months. This has proved a viable commercial success.

In conclusion, it is possible to draw up a plan to ensure the adoption of a foundling calf by a single-suckler beef cow.

1. Confine cow in loose box approximately twelve hours before she calves.

2. When contractions begin, blindfold cow.

3. Remove calf at birth and wash in warm water and detergent and/or use a masking smell (e.g. Eau de Cologne).

4. Immediately on removal of her own calf, rub the foundling with amniotic fluid from the cow, and/or the same masking smell used on the natural calf.

5. Ensure the foundling is well fed before introduction, then introduce both calves simultaneously.

6. Leave cow blindfolded for eight to twelve hours. Watch for sucking by either calf, particularly her own, in order to ensure a healthy calf.

7. Remove blindfold and watch cow. If she attacks the introduced calf, stand by her and shout at her if necessary while it sucks. It may be necessary to feed the foundling calf with a small amount of milk or milk substitute for several days, but this should be avoided if possible.

8. Keep checking cow and calves over the next two days, and if necessary, stand by cow to ensure both calves are obtaining sufficient milk.

9. In two to three days when regular suckling by both calves has been established all three can be released. Keep them isolated from the herd for a further week to ensure strengthening of the bonds between cow and calves.

10. Allow them to rejoin the herd.

If these instructions are followed, the normal success rate for adoption (A_1 or A_2) is 85% with cows with single-suckler experience; 90-95% with heifers; and 95-100% with cows with previous experience of adoption.

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CHAPTER 9

Behavioural Problems of Cattle

We have until now in the majority of this monograph considered the behaviour of beef cattle in as natural a situation as possible: out all year and raising their own calves. In modern farming, however, there is a tendency to intensify animal husbandry which usually entails housing the animals and, in beef production, introducing the intensive feed-lot and barley beef systems. The freedom of the cattle is therefore restricted to a greater or lesser extent by management conditions. In some systems, particularly in Europe, the animals are yoked for the majority of their lives and have almost no freedom to do anything except lie down, eat and drink, but even then they tend to form some relationships with their fellows. In other systems they are loose-housed and are physically able to behave much as normal.

There is evidence that production in some forms of intensive husbandry is disappointing and the mortality is often unnaturally high. In addition, disease such as mastitis is common, and there are frequently problems of infertility or pathologically abnormal behaviour, such as penned calves licking themselves or their stalls which may cause the rumen to become full of hair balls or lead to lead poisoning from the ingestion of paint. The underlying reasons for such outbreaks should be considered and it is becoming ever more evident that the farm animal has certain psychological needs. If these are not fulfilled behavioural or physiological problems may emerge and production be reduced. An expensive and inconclusive way to assess these psychological demands is to conduct a series of experiments on penned animals. A more pragmatic approach is to build an ethogram of 'normal' behaviour of free-ranging cattle, as we have tried to do in this book and apply some of the conclusions to improve management techniques. In this chapter we shall briefly mention some of the behavioural problems of cattle, although these have been reported in more detail in a separate study (Kiley-Worthington 1977).

On the whole, cattle do not appear to show as many behavioural problems as pigs or poultry; for example, they rarely show a pathological increase in aggression or develop pathological stereotypies. There may be three reasons for this:

1. They are not kept under such extreme restricted, and/or crowded conditions as pigs or poultry.

2. They have, as we have seen, a society based on tolerant relationships with each other - probably because of the habitat and distribution of food resources to which they have become adapted.

3. The fact that few ruminants of any species rarely develop stereotypies (unlike non-ruminant ungulates, canids, felids and primates) even under extremely restricted and confined conditions such as in zoos, suggests that rumination may have

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do with the ability to adapt to restricted living conditions. It is suggested that this may be by the ruminant being able to switch his attention to self stimulation, in this case rumination, (see page 86 and Kiley-Worthington 1977 page 74-79).

Stress. The word 'stress' has been bandied about in the last few years, and it has been used as an explanatory term for anything that goes wrong. The term was coined for use in medical contexts by Selye (1950) who found that different species had similar physiological responses to 'stressors', for example, burning, freezing, introduction to bacterial infection and so on. These physiological responses, which Selye called the "General Adaptive Syndrome" (GAS), consisted, among others, of a rise in heart rate and blood pressure, increased activity on the adrenal glands, and an increase in blood corticosteriod levels. All these responses are geared to preparing the body for violent movement (e.g. running away) and their effect in this respect is beneficial. The GAS allows the animal to overcome physiological emergencies, combat disease and remain healthy, but the snag is that when the 'stressors' continue to operate for prolonged periods, the body is constantly preparing for action and the effect is mal-adaptive and leads to such disorders as ulceration, artery thickening and heart problems. Stress is a physiological response of the body, but this tells us nothing about behavioural disorders.

Figure 62. A double suckler cow and her calves.



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A cow tied up for a long time, perhaps in the close vicinity of another cow of whom she is afraid may be expected to be "physiologically stressed". This is the sort of situation in which many animals develop and perform stereotypies (i.e. performing one activity repeatedly). Familiar examples are lions pacing up and down their cages in a zoo, or sows in stalls repeatedly licking or biting their chains. It seems likely that the performance of stereptypic behaviour switches the attention from the alien and inescapable environment to the stereotype, and it is thus an adaptive form of behaviour which allows the animal to tolerate an otherwise insupportable situation. Conversely, such behaviour may indicate an inadequate, "boring" environment - insupportable because of lack of stimulation, such as sows crib-biting in confined stalls facing a white wall.

Cattle, however, rarely develop such stereotypies. Is this because they are unusually adaptable, or just that they are insensitive to their environment? It may rather be that they have a ready-made way of switching their attention from the external problem-ridden environment to a form of self-stimulation by ruminating. Ruminating of course is essential to their digestion, but it might help to explain why cattle and sheep will pseudo-cud' (cud more than is necessary (Gordon, 1968)) when in restricted environments with low-fibre diets (e.g. veal calves Kiley-Worthington in press).

Infertility. In modern cattle artificial insemination is becoming standard practice, although the conception rate is often not as high as the farmer would like. The Agricultural Ministry's policy in Britain, and elsewhere in Europe and America, is to reduce the number of farmer-owned bulls running with herds and supplant them with the use of artifical insemination by selected bulls used countrywide. This, together with the increasing cost of buying, feeding and keeping a bull, has made it unusual for the small farmer to have his own bull, and it is also tending to discourage larger farmers from using bulls. Perhaps a note of caution is needed here. In the first place, there are problems of oestrus detection and insemination (e.g. Esslemont 1980) and secondly, there remains the problem of promoting behavioural oestrus in cows which are still suckling. Although the hormonal mechanisms are not totally understood it does seem that the presence of the calf and frequent milk let-down are important in inhibiting behavioural oestrus. The problem may be even greater in double-sucklers where two calves are suckling. It has been found, however, that the presence of the bull in itself can stimulate oestrus and increase the conception rate of suckling cows (e.g. Petropalovskii and Rykova 1958), so farmers might be advised to run a vasectomized bull with the herd even though they use AI for actual insemination. Further, the cost of hormone treatment and handling the cattle and the risk of not conceiving from AI (losses in the UK per annum estimated at £50/cow Esslemont 1980) makes it no less expensive than the price of a bull plus the cost of feeding him as a member of a large herd.

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The widespread use of AI carries a further danger: the gene pool is being seriously reduced. A number of breeds (e.g. the Lincoln Red) which were fairly common soon after the last war are now 'rare'. This may have very serious long-term consequences (Jewell and Anderson 1978) and unlike plant seeds, long term storage of animal genes is not possible.

Intersuckling stereotypes. Another behavioural problem that occurs mainly in dairy herds, but also occasionally in beef herds, is that of intersuckling. Here one adult cow suckles another, so that sometimes when milking time comes, the herdsman is confronted by beautific bovine smiles and empty udders. Herds have even had to be disbanded for this reason (Wood et al.1967). In beef suckler herds producing less milk this problem is not very serious, although occasionally I have seen adult cows with calves sucking their own mothers. This occurs particularly in the dairy breeds (Guernseys, Jerseys and Friesians) which have less rigid early calf recognition and plenty of milk, it also occurs in Friesian cows demoted to beef herds after several lactations in the milking parlour (Kiley-Worthington 1976 and personal observations). One way of overcoming this problem is to separate mother and daughter for some time before the daughter calves.

Crowding and aggression. One of the major problems of modern agriculture is 'crowding' and its effects. It is not easy to tell when the animals are over-crowded, and it is not very helpful to define it in terms of the number of square feet allowed per pound liveweight (e.g. Codes of Practice 1974) since what is important is the interaction between an animal's internal physiological state and its environment, but this vague statement is probably even less helpful. If we look at Figure 30 we find that the preferred distance for cows from one another at pasture varies greatly, but is most often between fifteen and fifty metres. If we were to allow this amount of space (30 square metres per cow) for each individual in a housing system it would clearly be uneconomic. However, the histogram also tells us that cows will choose to be closer than fifteen metres for 45% of the time, and that 5% is actually spent touching. We might therefore suppose that in free housing it would be sufficient to allow the animals say 10 square metres each, but there is yet another problem to be taken into account. It is evident that as the spece allowance decreases, the amount of aggression increases (primates:Southwick I966; pigs Ewbank & Bryant I972, & page I22 &I32 this work). If the cattle have been dehorned they can do one another little physical harm. In this case the space allowance can be quite small provided that there is adequate trough/feeding space (one third to half a metre per cow) and plenty of room (6 sq. metres per cow and 3/calf up to 6 months) for all the animals to lie down at one time.

Crowding and confinement can also change social relationships. In primates, and probably to a much lesser extent in cattle, they lead to the development of a more obvious dominance hierarchy, possibly symptomatic of social stress (e.g. Rowell 1966 Gartlan 1968). Here the main problem is not that individuals are

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injured by other aggressive animals but rather than the animals at the bottom of the hierarchy are frightened to approach other animals and therefore the feed trough, and end up not getting enough to eat (e.g. Rowell 1966 in primates). A solution is to provide a much greater feeding area or trough space.

Bulls. The management of bulls running with cows is usually no problem. Even dairy bulls, which are often aggressive and dangerous tend to be quieter when run with cows. It must be mentioned that bulls are aggressive partly because they are kept in isolation (this is used as a research technique to increase aggression in psychological studies) and partly because people, even their handlers, are afraid of them (see Kiley-Worthington 1977 for discussion). Since they have a sophisticated system of visual and olfactory communication they can probably detect this. It is also possible that the aggression of dairy bulls is partly genetic in origin because in selecting for milk yield or other characteristics, temperament (except in extreme cases) has been ignored. Aggression may even have been selected as a particularly 'masculine' characteristic and therefore believed to be associated with high libido. Our advice to breeders is to purchase a young bull whose relatives are accustomed to running with cattle and which are not particularly aggressive, and provided that he is (1) run with other animals throughout the year and (2) correctly handled by people not afraid of him there is little likelihood of his becoming difficult to manage.

Bull beef has traditionally been produced in Europe and, (because of the extra 15 - 17% growth rate), is gradually being accepted in Britain. There is some concern that groups of sexually mature bulls will fight much of the time and also will be very dangerous for human handlers. All the indications from studies of closely related species and feral cattle are, however, that bachelor groups of young males are a normal part of the social organization and that they are not constantly attacking and injuring one another, so one need not expect an increase in aggression within such groupings provided they are not subject to other pressures such as lack of space or inadequate feeding areas (Kiley-Worthington 1977, p.60-61). Even where adult and old dairy bulls which have previously been isolated are kept together in groups at grass (as, for example, by the Milk Marketing Board) the animals fight little, and provided they are treated like other cattle follow more or less the same behaviour patterns (Hunter & Couttrie1969). Crowding, since it leads to an increase in aggression in most animals, is likely to produce the same effect in grouped bulls and is not recommended although there is no reason to believe that grouped bulls require more room than cows.

Environmental complexity. One of the main important contributory factors to behavioural problems may be a dull, monotonous environment. The surroundings may be physically dull, with a lack of objects and change; the food may be monotonous and rapidly consumed and life may be socially dull, as for a bull kept in isolation, or for very small groups of animals. The beast is bored and has much time to fill and it may adapt itself by sleep-

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ing more or by resorting to repetitive acts such as pacing about the pen, or swaying on its feet or licking and chewing at inanimate objects. It may also attack its fellows (see Kiley-Worthington 1977, page 27-35 for review).

On practical and cheap way of increasing the interest of the environment in a cattle yard is by partitioning it. This can also be used to separate the less confident animals from the others, so reducing their persecution. Cubicles have also become popular because they provide a varied environment and make it difficult for animals to attack one another, but they have not always been successful. They are often too short and uncomfortable so that the animals are reluctant to enter the cubicles, preferring to lie in the often unbedded and dirty passageways. Subordinate animals often fare rather worse in these conditions, particularly when they do not go into cubicles.

The fact that cattle tend to become faithful to certain places, whether in free housing (page 134, Figure 50) or cubicles, suggests that conditioning (training) could ensure that each animal would return to its own place, and would thus reduce competition. This could easily be done by allowing the animals their food only when they were in the correct place.

One misunderstanding of the needs of animals is that they must be kept 'as quiet as possible'. In other words such mild disturbances as seeing people and delivery trucks coming and going or changes in visual stimulation or noise levels, are considered bad. It must be borne in mind that as far as we know, as the environmental changes decrease, so the threshold of reaction to change will drop. An extreme effect of this is seen in broiler houses where an environmental change, such as a sudden noise or a stranger coming into the normally quiet unit will induce hysteria, panic and even death among the chickens. If these animals are accustomed to changes of one sort or another most of the time then such a response is very rare.

On one of the herds we worked with, for example, the farmer maintained that we were 'causing stress' to his yarded sucklers because we were in their yard observing them for long periods of time. He thought they would grow slower because of the disturbance we were causing, but had he spent just half an hour with us in the yard he would have discovered how wrong he was. On this farm, like many others, the only time that the stock were observed by the stockmen was when there was something to be done to them - when they were to be fed, sorted into different groups, vaccinated, or handled for veterinary or other reasons. They therefore learn that when the men arrive there was going to be excitement of some sort, and they respond by getting up, calling and moving around. As ethologists, at this stage we were not interested in this kind of behaviour thus we had remained in the yard as quietly and as unobtrusively as possible for long periods, so that the animals become accustomed to us and eventually apparently ignored us. After the first 4 days, the cattle totally

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ignored our arriving and going, although they would become disturbed when the farm workers arrived.

Group size. We can conclude as a result of this study that cattle are extremely social animals. They choose to associate in large groups of up to 300 individuals if space and food permit. However, within these large groups there are sub-groups which are apparently based on family groupings, peer groups or 'familiarity' groups (Reinhardt 1980b and this study). There are also preferences amoung individuals for certain other individuals. When managing cattle it is suggested that it is important to keep the groups as constant as possible and to avoid the frequent mixing of groups and re-sorting on the basis of size (as dealers and fatteners are apt to do) if behaviour is not to be disturbed and the rate of growth is to be maintained. Cattle prefer to associate as age classes and it is standard and successful practice on many farms to keep them in such groups.

Learning. Cattle, like other mammals, collecting information about the environment all the time and behave appropriately. Much of this behaviour is learnt, and sometimes this learning is an asset to the running of the farm, such as when cows learn where and when they are to be milked and come up to the byre accordingly. We have seen how important it is for the fostered calf to learn the time and position for sucking (Figure 58 & 59). Sometimes learning is a nuisance, for example, when a cow learns to associate a white coat with the vet and probably something painful, and turns from a gentle doe-eyed creature into a wild exopthalmic beast.

A sensible approach to animal husbandry, and one which could both cut down labour demands and be used as occupational therapy to overcome boredom in housed cattle, would be to use this ability of the animal to learn and to work for rewards to make it look after itself. It could be taught to press a lever with a foot to release its food allowance, for example, and I (M.K-W.) once taught a herd of cattle to respond to a car horn, and come up to milking in six trials (Kiley-Worthington & Savage, 1978). It is interesting to note how quickly learnt responses are imitated and transmitted through a herd. This can be seen in a herd learning to use the automatic drinking bowls by depressing a lever. It is not necessary for every individual to learn by trial and error since once one has discovered the technique the others learn by imitation (personal observation). If some of the technological effort today used in designing labour-saving devices were channelled instead into designing 'self-service' systems it might be possible to design a farmyard where the animals look after themselves entirely!

There is another type of learning - Pavlovian or classical conditioning - which is learning based on reflex response rather than on conscious control. The most important example of this in the management of cattle is the let-down of milk as a result of stimuli associated with milking, such as the noise of

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buckets being rattled, the appearance of the herdsman, and so on. The conditioning of bad behaviour by mismanagement or lack of handling should obviously be avoided, but is relatively common, particularly in large milking herds.

Stockmanship. It has recently been found that dairy cattle respond differently to different people in their milk yields (Seabrook 1975). It was thought initially that this was as a result of the routine that the dairyman adopted, but eventually this theory was discounted and the important factor was found to be related to the 'attitude' of the person to the animal. This is only a beginning in the study of man-cow relationships. Almost anyone who has had much to do with animals knows that some people have an affinity with them, and some do not. The question from the farmer's point of view when trying to pick a stockman is how he can measure this, and choose the best man. Seabrook (1975) suggests this can be done by classifying people into the two categories of 'introverts' or 'extroverts' - introverts making better dairymen! Such a simple classification of people is not really possible - any more than the classification of cows into 'dominant' and 'submissive' is of any use. It will be of more use and interest to study the detailed personality profiles of both man and the animals he is to look after (methods of drawing simple personality profiles for eland have been attempted by one author (Kiley-Worthington 1978).

Feeding. A change which is particularly ludicrous in a world increasingly short of food is the recent trend in the West away from feeding cattle cellulose and giving them high protein low-fibre diets which other animals and humans cannot do without. Cattle, like other ruminants, have a very important characteristic in that they are able, with the aid of their rumen bacteria, to convert cellulose to protein. Furthermore the feeding of low-fibre diets, reduces rumination and may give rise to some stereotypies such as the licking and chewing of objects and their own coats, causing injury to the rumen and consequently reducing growth rate. If government subsidies make it more profitable for the farmer to feed high-protein diets to ruminants, it seems that we should work out the real long-term cost in energy-consumption, housing, and use of non-renewable resources and assess the ethical considerations before accepting that this is the best way to raise beef.

The central idea for beef production is to 'finish' the animal to slaughter weight in the quickest possible time, and also to produce lean carcasses. Most of the research effort that has been directed towards behaviour has been in the field of feeding, and this has mostly involved measuring the live weight gain or milk yield as a result of feeding different substances in varying quantities. The lesson to be learnt from ethological research is that the fodder an isolated cow eats voluntarily in an experimental cubicle at the research institute does not necessarily indicate what she would eat in the group as a member of a herd kept in a farm situation where so many environmental factors have an effect.

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For example, she may not be able to get to the feeding trough because she is too frightened of the other animals; she may be much colder or hotter than she was in the experimental situations; she may be able to choose between different foods; she may be constantly interrupted by other things happening around her, or she may eat more or less simply because the others are there and are eating (social facilitation). All these factors, and many others, may affect the quantity and type of food she eats, and the use she makes of it, and thereby affect the weight gain and/or time to 'finish'.

Bedding has been removed from most modern cattle houses (in order to reduce labour requirements), and has been replaced by slats and drains. These are scraped with a tractor and the slurry is swept into pits. The slats which the animals walk and lie on, are made either of wood or, more commonly, concrete, with gaps between, from half an inch to over one inch wide. to allow the faeces and urine to drop straight through. Despite some attention to ventilation in such buildings, the total environment is often damp, smelly and uncomfortable. These conditions, in combination with crowding and large herd sizes, can cause considerable disease problems. Al though these are combated by extensive use of preventative medicaments, including antibiotics, the cures can cause their own problems (e.g. Swann Report 1969).

The behavioural problems of cattle are normally the result of many environmental factors, rather than dependent on one. This is illustrated in Table 23. It is becoming more obvious that in order to overcome these, environments must be designed taking into account the cattles' environmental demands as well as the workers and the economics of the system. Behavioural problems can usually be considered a symptom of poor environmental design. Their treatment with drugs and surgery is inadequate in terms of production and ethically unacceptable. A more constructive approach is to redesign the environments to avoid the development of these problems which so often grossly affect production.

The ethical considerations of modern animal husbandry are becoming of more concern to the public and hence governments and producers (e.g. Fölsch 1978). It is not the intention here to discuss this in detail. However, a point that seems to be little emphasised, but which could be useful in such discussions is that cattle, like any other species, have evolved morphologically, psychologically and socially through several millions of years in order to maximize their survival. One of the characteristics of cattle is that they are extremely adaptable to a variety of environments. However, there is little doubt that the modern developments of high input, high protein feeding and the keeping of the animals under restraint or crowded conditions often goes outside the limits of their adaptation. This applies to the social environment, for example very large or abnormally constituted groups (e.g. large dairy herds (300-400 animals) or feedlot fatteners (often of several thousand animals) or alternatively

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isolation such as veal calves or dairy bulls.

It would seem that such developments are irrational as the animal is evolved to live with a certain type of social organization and feed requirements. Thus to optimize these and hence health and production, a more sensible approach would be to use the knowledge we already have on the ethology and physiology of cattle to develop more appropriate environments. One example of how this could be done is given in Chapter 8 where the calves raised on dams compare very favourably in production with intensively reared mother isolated animals.

Table 23.

Relationship between environment and behavioural problems in cattle.

	Physical environment															Social environment		
Environmental causes:- / Behavioural changes:-	Sudden environmental change	Restriction (tied)	Insufficient space/individual	Restricted rumination	Absence of key stimulus	Absence of bedding	High Temperature	Low Temperature	Poor ventilation	Draughts	Low intensity lighting	High intensity lighting	Monotonous Environment	Isolation	Group too large	Absence of male/female
Increase in aggression	+	+	+	+		+	+		+		+		+	+	+	
Increase in activity	+		+	+		+		+		+	+		+	+	+	
Reduction of fertility/ non-recognition of oestrus			+		+		+	+				+		+	+	+
Oestral behaviour causing disturbance	+	+	+			+	+	+	+	+	+		+	+	+	+
Insufficient libido		+	+		+									+	+	+
Mother ignoring young	+		+												+	
Mother preventing suckling			+				+								+	
Mis-mothering	+		+												+	
Non-recognition of mother by young	+	+	+											+	+	
Non-suckling of young	+	+	+		+									+	+	
Attacking young	+	+	+											+	+	
Intersuckling	+			+	+								+	+	+	
Crib-biting & wood eating	+	+	+	+	+	+	+	+	+	+	+		+	+	+	
Self-licking	+	+	+	+	+	+	+	+	+	+			+	+	+	
Licking surroundings	+	+	+	+	+	+	+	+	+	+			+	+	+	
Abnormal defaecation														+	+	
Intake reduced	+	+	+	+		+	+		+	+	+	+		+	+	
Intake increased		+	+					+					+	+	+	
More sleeping		+		+			+					+	+	+		

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CHAPTER 10

Ecology and the Sociobiology of Cattle

There are two main reasons why we have studied and described the behaviour of cattle in detail. The first, as we have explained, is to understand how cattle normally behave when left largely to their own devices, with a view to being able to improve management techniques, building design and so on to avoid some current problems which may well be the direct or indirect result of insufficient consideration of the psychological needs of cattle.

The second reason for this study and the one that concerns us in this chapter is a more academic or theoretical one. It is interesting and stimulating to investigate the social organization of cattle for its own sake - and to ask why cattle behave as they do. Similar questions which are predominantly related to evolution are currently the concern of many theoretical biologists (e.g. Wilson 1975; Dawkins 1976).

Much of the twentieth-century biology is founded on Darwin's ideas of evolution based on the 'survival of the fittest'. This argument can and has been widely applied to certain changes in the morphology and physiology of animals and plants. It can also be used to explain differences in behaviour. The central idea proposed by Darwin was that animals die out if they have either behavioural or physical characteristics which do not enhance their chance of survival. Animals unable to run fast enough to escape predators, for example, are the first to be killed and so leave few offspring. On the other hand, characteristics that enhance survival, like being able to run fast or a tendency to group together for protection against predators, lead to more offspring and in this way the characteristics become more common in the population.

However, animals often behave in ways which appear to be altruistic (for example, mothers protect their young) and which obviously do not increase their individual chances of survival. Whynne Edwards (1962) suggests that animals do not behave purely egotistically but will often act in a way that is of benefit to the group even at the cost of their own survival or reproductive potential. He quotes grouse which come together on communal meeting and mating grounds (called 'leks'). Here the birds seem to practise selective breeding so that not all males mate with females. The benefit is to the group as a whole although individuals also benefit by the group control which keeps the population within limits consistent with the food supply.

The controversy between the 'group selectionists', who believe that individuals behave in a way which will benefit the group, and the 'individual selectionists' has not been entirely resolved, although at present the latter are gaining ground rapidly. The problem is that both sides of the argument are extremely

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difficult to prove or disprove, and very frequently one finds oneself chasing one's own tail while little is learnt about the animal or its behaviour. With this warning in mind, we will try, as an intellectual game, to suggest an explanation for the social organization already described in this book.

Since the time of Darwin, of course, there have been great developments in the field of genetics and we now have considerable knowledge of the mechanisms of inheritance and behaviour, which has led to the re-opening of discussions on why different animal species behave as they do. Many questions relating to differences in social organization recently have been explained in evolutionary terms.

As several people have pointed out, altruistic behaviour can be explained on straight forward Darwinian 'survival of the fittest' grounds as long as we think of the individual genes as the important unit rather than the bodies that carry them. Dawkins (1976) suggests intriguingly that we can think of genes as being potentially immortal while the body carrying them is merely a vehicle to house them for the moment.

If the bodies are merely gene-carrying machines, programmed to do everything in their power to propagate copies of these genes, then it is easier to explain altruistic behaviour by what has been called 'kin selection'. The central idea is that if a body (or set of genes) has invested much energy and effort into producing young, and by so doing has perhaps jeopardized its own survival and the number of young it may produce in the future, then it may be in the genes interest to ensure that the offspring survives even if this puts the parent at risk, since the offspring carries half the parent genes and much investment in time and energy (Trivers 1972).

Similarly, if the chances of multiplication of individual genes are enhanced by co-operative and sharing behaviour, then such behaviour becomes dominant in the particular species in that particular ecological niche. If, however, the environmental conditions radically change, we might then expect the social behaviour of the species to change too. This was proved to be the case in the Uganda kob (Beuchner 1961) which show different mating strategies according to the area and density of the population. To date the majority of thinking along these lines has concerned wild animals' behaviour, such ideas can be applied to explain the free-ranging behaviour of Bos taurus as described here. In the first instance we must consider how and in what way domestication may have affected their social organization and communication.

The effect of domestication on Bos taurus

Darwin (1859) and later Maynard-Smith (1966) pointed out that artificial selection (the selection and control of breeding in our domestic livestock) will have profound affects.

(1) It will increase variation
(2) It will reduce viability.

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However Maynard-Smith's arguments are based on genetics of inbred populations. The early domestic cattle may well have been inbred to some extent but the actual amount of inbreeding is disputable.

Let us suppose that these 2 criteria are applicable to domestication of cattle. Certainly a glance at the morphological variation of domestic cattle breeds will underline the first statement when compared to their wild cousins such as wild buffalo or bisons. The question here is to what extent is this true of behaviour. If morphological variation is paralleled by behavioural variation then presumably Darwinian arguments concerning the social organization of the species will have very little relevance. This is often thought to be the case which is why they are not often used on domestic species.

There is no doubt that when encountering handling and training cattle there are some notable areas in which their behaviour does appear to be very different from their wild relatives, and this applies to several other domestic species (eg. the horse Kiley-Worhtington in press, and dog (Fox 1980)). These differences are in particular in behaviour related to man. In the first case the domestic species are less frightened of man. However, we know that wild species can be tamed and easily handled provided this is begun when they are young. Similarly there are numerous examples of domestic species that are feral and very frightened of man. Clearly then this is a learning process not genetically programmed.

More interestingly however and something which has been underlined by my (M.K-W) recent experiences with training a young red deer stag (Cervus elephus) is the extent to which domestic animals (eg. horses and cattle in particular) appear to cooperate in training programmes with man. Thus wild ungulates, even home born, are usually more difficult to train, not necessarily perhaps because they do not understand the requirements of the trainer but more usually they do not cooperate in doing it. The red deer stag despite being approximately 1/8 the weight of a South Devon bull and having been handled rather more was nevertheless much more difficult to teach to lead and lunge (go around on a rope) than the young bull. He was and remained until his death at 3½ years unreliable when being led and trained. Other examples of training with zebras, eland, etc. suggest a similar response. However, wild caught adult horses for example are broken even when adult with success and thereafter usually become reliable mounts in western America.

Thus we are suggesting that one aspect in which domestic species' behaviour may vary genetically from their wild cousins is in terms of cooperation. What man presumably did on domesticating a species is select for those easiest to handle and train as a result in part of their willingness to cooperate with him.

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There is another aspect of behaviour that man has seriouesly changed in at least some cattle. This is in respect to milk let- down. Here selection has encouraged the let-down of milk to stimuli other than the calf, and made the modern dairy cow. As a consequence of this, the dairy cow is less rigid in the recognition of its own calf and often allows other calves than its own to suck. The beef cow, on the other hand has not had its behaviour changed in this respect and thus has an early and rigid recognition of its calf (see Chapter 8, page 144) allowing it to suckle exclusively; a behaviour obviously of importance from the evolutionary point if view and nearer to the original undomesticated cow as far as we know (Amoroso & Jewell 1963).

What of the effect of domestication on social organization and communication however? The interesting thing here, is not how the behaviour of cattle has apparently changed over the course of domestication but how little change there appears to have been. Thus, when they are given the opportunity to live more or less unmanipulated by man (as the cattle in this study); their social organization and other social behaviour is very similar to that of their wild cousins, such as the wild buffaloes and bison (Table 1), and very similar to that of their closest relative Bos indicus which has been described in detail (Rheinhardt 1980). It can be argued that there is less selective pressure from man on such things as social organization, but nonetheless the survival of cattle under man's care would not often seem to depend on the retention of a complex social structure, although in the absence of pressures to change, the genes continue apparently unaltered.

On the other hand, cattle have adapted to many different management systems, and it is clear that their social organization must also have adapted to some degree. An example is given in this monograph where it is found that confined cattle show more aggressive interactions than the grazing field cattle (Table 17, page 122). This in turn gives rise to a more definite well defined dominance hierarchy which may be an artefact of the situation. This social reorganization in confined areas has physiological origins. It occurs almost universally in mammals and it can be argued is a sensible evolutionary strategy where resources are very restricted. It is not however the normal social organisation of free ranging groups.

We have no evidence of changes in communication during domestication. However, our knowledge of this subject is at this stage rather rudimentary. It may be for example that domestic cattle are more able to pick up signals from people than their wild cousins as a result of familiarity and learning. It may be in turn that tendancys to learn to do this have been selected for by man. We must not under-estimate such possible abilities as the story of Clever Hans aptly points out.

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If then we can suggest that the behaviour of cattle, with the above exceptions has changed not a great deal during domestication, how can we explain the particular social structure that cattle have?

The evolution of social structure in cattle

First let us look again at the habitat to which the evolution of cattle has suited them, since it is a major influence on communication and social behaviour. Originally cattle were probably nocturnal or crepuscular creatures, feeding, grazing and most awake and alert during the early morning and evenings, and possibly some of the night (see page 121 et seq.). Of course, in their usual habitat - the plains on the edge of forests - they would be liable to be preyed upon by members of cat, dog and bear families. Food was probably widely dispersed and, except at certain times of the year or in very bad weather, readily available and plentiful.

These factors are important in our arguments. If cattle had been selective eaters and dwellers in the deep forest, they might have remained solitary or semi-solitary animals like the bongo, the bushbuck or forest duikers, since it would have been difficult for them to maintain contact in large groups or to find sufficient food for the group within any given area.

This then is the answer to the first part of our question - why are cattle social? Since food was widely dispersed and usually plentiful there was nothing to be lost by being social. In fact, the chances of individuals surviving in their particular habitat were apparently greater when they lived in herds, for although a large herd might attract more predators than solitary animals or small groups: it is also better fitted for protecting its members (e.g. bison, McHugh 1958).

Another reason for associating in herds is that the chances of an individual being taken by predators will be less if there are more animals from which the predator can choose.

If, however, the herd had become too big, the food supplies in one area become exhausted and the cattle would have had to move on, leading a migratory life like the bison, gnu or caribou, which associated in very large herds. Another possibility is that they could split into smaller groups when food is scarce, as do some other species. We know cattle will associate in herds up to 300 when food is readily available (Darwin 1859), but we cannot say what the optimum group size is, or even if there is one.

Maynard-Smith (197) proposed that a mixture of aggress -ive and non-aggressive individuals in a population leads to an Evolutionary Stable Strategy (ESS). This reduces aggression and injuries. It is often assumed that a "dominance hierarchy" does this. However such ideas have been developed by studying species of

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birds and primates where there is usually strong competition for food. In large grazing herbivors however, this is not the case. It would seem therefore that behaviour designed directly to increase the cohesion of the group would be more important and lead to the Evolutionary Stable Strategy . From our study this does appear to be the case (page IIO) and the same applies for Bos indicus (Reinhardt and Reinhardt I98I).

Most affiliative behaviour (cohesive) is practised between kind (particularly mother and young, page 85 and Rheinhardt in press). The next most common affiliation is between peers (page 85). Thus the basis of the social groups which appear to be long lasting, are (a) mother offspring groups, and (b) peer associations. Relatedness of basic social units would appear to be an evolutionary sensible strategy if behaviour such as mutual protection is exercised which may well be the case in cattle.

The emphasis of much of the present work has been on mother calf relationships and their ontogeny, and it is this aspect which is particularly interesting from the sociobiological point of view.

We have looked in some detail at how mothers and calves behave towards each other, and other members of the group. We found that fron an early age calves preferred to be closer to other calves than to their mothers (see page 113, Figure 35) and cows similarly preferred their peers. In this way calf groups are formed apart from the cows. In other species (horses, Tyler (1972), gnu Estes (1966)) this is not the case, and the young stay very close to their mothers all the time. Why should there be this difference? The most obvious explanation is shelter-seeking from cold or equally hot weather (eg: Reinhardt 1980 Bos indicus; Underwood 1975 and pers. observation eland - Taurotragus oryx). If young calves are born in the early spring when the weather is bad and cold, they will increase their chances of survival if they find sheltered places away from the wind and lie up in them as many cervid's young do (Lent 1974). If they were to follow their mothers out into the feeding areas, they would use up more energy in keeping warm and be more likely to succumb to the cold. If foals are born in the autumn, following the dam into exposed areas has detrimental effects on their health and survival (pers. obs. M. K-W). Young animals need more shelter than adults to retain their body heat which they lose rapidly because of their small bulk in relation to surface area. Since all the calves are seeking sheltered areas and tnese are limited, calf groups are formed. As a result of being a member of a calf group, the chances of the individual surviving an attack by a predator are increased (because there are more animals for the predator to choose from) so this grouping is both physiologically and behaviourally sound.

The young of other species have different behavioural strategies to enhance survival. Young deer (cervids) often lie up away from their mothers for up to several weeks after birth without associating with one another. It has been argued (e.g. Lent 1974) that during this time the young fawn's strategy for

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protection is that of camouflage and lack of smell, so that it is not easily detected by predators. Another alternative strategy is practised by many of the plains dwelling ungulates (zebras, horses,gnu and others). Here the young are very precocious and within minutes of birth they are up, sucking and following their mothers, and often able to run faster than a man. In these species the safety of the young lies in its close association with its mother who will protect it. There is also safety in numbers and these species are usually herd-dwellers with seasonal, synchronized breeding. The gnu, for example, can apparently delay the birth of calves by two weeks at least if the rains are late (Estes 1966). This is extremely important as it ensures that the young are all born at a time of year when the weather is good and food plentiful. Also, the chances of an individual calf surviving predator attack are greater if there are a lot of calves of the same age. There are several characteristics which help to ensure synchronized births given the central controls of day length on oestrus, these are:- (a) a particularly long gestation period (e.g. horses and zebras: 11 months); (b) anoestral periods for parts of the year (horses, sheep, gnu and caribou) and (c) delayed implantation, where the egg is fertilized after copulation but not implanted into the womb, often for several months, and is therefore not growing (many rodents such as badgers, and a few species of ungulates).

Bos taurus however has none of these 3 characteristics. Thus if it is a species that is potentially breeding throughout the year, there must be some strategy whereby the young if born in the autumn or winter are more likely to survive. We suggest that this strategy is the shelter seeking behaviour of the young. The limited availability of shelter results in several calves sharing it. Their loyalty to location (page 88) ensures frequent association between individuals which in turn as a result of familiarization helps to develop bonds between peers and thus helps keep sub-groups together in herds.

Many species of both temperate and tropical artiodactyls are territorial in the sense of the male taking up territories defended against others (e.g. Leuthold 1966 Uganda kob, Waterbuck Kiley-Worthington 1965, Spinage 1974), many cervids (eg. Miller 1974). However many of the bovidae are not (eg; Eland (Underwood 1975), buffalo (Sinclair 1974), bison (McHugh 1958), Bos indicus (Reinhardt 1980), and Bos taurus this study. Why should this be?

The advantages of territoriality may well be that there is selection for particularly strong males given that there are considerable costs to the male in taking up territories. However the disadvantages are that females must remain near the mating males territories during the breeding season and this might well exhaust food supplies in a large species such as the large bovids. I suggest therefore that it is advantageous for a large herbivor to be non-territorial where the males follow around the females on their daily round of consumption, rather than the females having to visit them. In this way the females can maintain

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their close associations with their famliy groups without having to leave them to visit males resident in another place.

Another relevant factor to social organization and the "kindergarten formation" (as Reinhardt calls it (1977)) is rather a simple explanation. Animals with similar physiological demands might be expected to associate together. Thus heavily pregnant females will be in search of much highly nutritive food, however they will not want to move far or fast. Young animals still suckling will require less food and spend less time eating (as we found in Figure 18), more time resting and investigating. Thus they will tend to associate together. A similar social organization was found in the eland in the wild where young males, breeding females, and calves tended to form their own separate groups for most of the year (personal observation Loskop Nature Reserve, and Underwood 1975). This very association of animals with similar physiological needs also enhances the bonds between individuals simply from long association, as long as no stronger factors arise to break them, such as young males in conflict over females. These sub-groups of sex or age peers within the herd are then kept together by the bonds maintained between generations such as mother and offspring, established in infancy and maintained with contact behaviour. The outward expression of these complex webs or bonds between individuals and their formation and maintenance are the social and sexual activities we have described in some detail such as mutual grooming, smelling or touching, playing, butting and fighting, and circling, chasing and mounting.

Up to this point we have been considering behaviour which is common to most individuals and apparently more or less genetically determined, or instinctive. The importance of learning in the behaviour of cattle is very considerable. If cattle were not capable of learning and remembering we would not be able to keep them the way we do in most farm yards. Learning plays a crucial role in the survival and development of the individual: a young calf learns not to approach and try to suck from a cow other than its mother if it is to avoid being kicked (see Chapter 8); a cow learns which other animals it can approach and when (see Chapter 3). The cow has to learn to recognize the communicative significance of signals and, of course, the animal learns where resources are likely to be found in its physical environment. It is probable that cows have a great capacity for learning toppgraphy (Chapter 7).

Perhaps the best example of cows' learning ability and adaptability is their success as a domestic animal. If they had been unable to adapt to different environments and management techniques, there would be many fewer of them around today!

We have reported here the result of four years' work studying the behaviour of cattle. We do not pretend to have covered every aspect, or to have investigated anything as

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thoroughly as we would like. There is further and more detailed information on other aspects of cattle behaviour reported and references to some of these will be found in the bibliography.

There remains much to be discovered concerning behaviour, the social organization of cattle, and its socio-biological explanation, but perhaps this monograph has added to our present knowledge.

Perhaps one can conclude with a platitude, which nevertheless became more and more evident as the work progressed: that the more we learnt about the behaviour of cattle, the more we realized how little we really knew!

Summary

Chapter 1. The origin and evolution of cattle and the methods used. The evolution of cattle (Bos taurus) from the Auroch is discussed in relation to behaviour. The effects of domestication on cattle behaviour is considered. The herds, their management; the methods used; the activities scored and the statistical analysis of the data are described.

Chapter 2. The cow's world. Relevant information to understanding the species specific behaviour as the result of the anatomy and physiology of the receptors and brain is presented.

The implications of these features for understanding behaviour are discussed.

Chapter 3. Communication. A description of the visual displays of cattle is related to causation. Evidence of tactile, olfactory and gustatory communication is also discussed. A description of the calls of cattle related to general motivation levels is given. The functional implications of these displays are discussed.

The displays related to sexual behaviour are used as an example of the inter-relationship of the visual, auditory, olfactory, tactile and gustatory components.

Chapter 4. The birth of a calf. The signs of approaching parturition are described. Behaviour of dam and calf for the first three hours post partum from detailed analysis from 12 births are presented. Contact between mother and calf is greater immediately post partum than at any other time thereafter.

Chapter 5. The development of behaviour in cows and their calves. The maintenance and social behaviour of cow and calf are described and quantitatively analysed.

The social activities were aggressive, sexual and affiliative. It was the later group in which both calves and

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cows engaged in most. Most social activity occurred between dams and their calves. There was a significant individual difference in the amount dams contacted their calves and this changed with age and lactation. The ontogeny of social contact + suckling behaviour are described from quantitative analyses.

Contact with other members of the herd tended to be within their own age group. Individual differences in social contact for both cows and calves are shown.

Chapter 6. The social organization of the herd. Nearest neighbour data and other types of interaction between individuals is analysed. Calves tended to be closer to their nearest neighbours (and showed a significant preference for calves), than cows. There were individual differences between dams in the distance from their calves. These reflected the experience and age of the cow. The cows also showed marked individual preferences and avoidance for others in the herd as measured by nearest neighbours. This allowed a division of the herd into sub-groups.

There was much more affiliative behaviour (e.g. mutual rubbing, licking, touching and smelling,) than aggressive or disruptive behaviour (threatening, butting, avoiding and withdrawing) in a grazing situation. It is argued from this data that dominance relationships are less important than affiliative behaviour in grazing cattle.

Chapter 7. The daily routine and use of pasture. It is shown that environmental conditions and distribution of food have an effect on the amount of time spent in the various activities and how the various activities are distributed throughout the day. Thus in this study grazing cows spend more time eating and lying than housed cows, which stand more. However, there were no significant changes in the calves' behaviour as a result of housing.

The circadian rhythms of activities were affected greatly by feeding regimes, crowding, day length, and the weather (temperature, rain and gadflies).

The cattle used parts of their pasture for specific functions (e.g. shelter belts, paths, rubbing places and preferred grazing and drinking places.) They showed no particular overall preference for individual fields within the study areas. Certain cows were usually to be found on the periphery of the herd, while others were customarily at the centre. The calves followed the same movement patterns through the area as their dams but somewhat later.

Chapter 8. Fostering and adoption in beef cattle. Here fostering and adoption in beef cattle was studied. These breeds have been selected for early recognition of the calf, and more rigid maternal behaviour towards the calf. Recognition of the calf

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by the mother is established within the first few minutes after birth. The mother uses olfactory and visual cues for initial recognition. Tactile and gustatory cues may also be involved. For adoption to take place familiarization of the cow with the foundling calf is essential. The initial rejection of the foundling by the cow changes towards tolerance or even adoption with time. The relationship was stabilized by 3 months post partum.

The behaviour of the calf on introduction and later is important.

With experience dams become more permissive towards other calves.

Given an understanding of these effects, a system to ensure adoption of a second calf by beef cows has been established and tested. Such a system results in a highly profitable low labour and capital intensive method of raising cattle at grass.

Chapter 9. Behavioural problems of cattle. The behavioural problems of cattle as a result of extensive or intensive management are outlined. It is found that their development is dependent on many environmental factors. Stress; infertility; stereotypies, (including inter-suckling and hair licking); crowding and aggression; environmental complexity; learning; stockmanship and feeding are discussed in relation to environmental variables.

Chapter 10. Ecology and socio-biology of cattle. It is suggested that cattle are social because of wide dispersion of food and the importance of protection in numbers. It is argued that although there are other effects of domestication on behaviour; the effect of domestication on social organization is very small. Dominance hierarchy is relatively unimportant in maintaining the social structure, much more important is affiliative behaviour developing bonds between peers and generations. The hider type of behaviour of calves (Chapter 6) is discussed and reasons suggested for it. Functional reasons for the frequent association of similar sex or age groups and groups having similar physiological needs (e.g. pregnant females) are also outlined. Finally, the importance of learning in the day to day life of cattle is underlined.

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LE SOMMAIRE

LE COMPORTEMENT DU BETAIL ALLAITANT (BOS TAURUS)

M. Kiley-Worthington et S. de la Plain

Chapitre 1. L'origine et l'évolution du bétail et les méthodes de recherches.

On discute l'évolution du bétail (Bos taurus) de l'Auroch par rapport au comportement. On considère l'effet de la domestication sur le comportement. On décrit les troupeaux et comment on les maîtrise, les méthodes de recherches, les aspects de comportment marqués et l'analyse statistique des données.

Chapitre 2. Le monde du bétail.

On présente l'anatomie et la physiologie des recepteurs et du cerveau en ce qui concerne le comportement caractéristique de l'espèce.

Chapitre 3. La communication.

On décrit les manifestations visuelles et on discute leurs causes. On discute la possibilité de la communication tactile, olfactive et gustative. On décrit les cris du bétail relatif au niveau de la motivation. On discute la portée fonctionelle de toutes ces manifestations. On cite les manifestations du comportement sexuel en exemple de la corrélation des manifestations visuelles, tactiles, olfactives, auditives et gustatives.

Chapitre 4. La naissance du veau.

On décrit les indices de l'approche de la parturition. On détaile le comportement de douze vaches et de leurs veaux pour les premiers trois heures après la parturition.

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Chapitre 5. L'évolution du comportement de la vache et du veau.

On décrit et on fait l'analyse quantitative du comportement social de la vache et du veau. L'activité sociale fut aggressive, sexuelle et filiale. Cette dernière catégorie fut la plus fréquente. La plupart du comportement social se passa entre les vaches et leurs veaux. Il y eut des différences significatives entre les vaches en ce qui concerne leur rapport avec leurs veaux et ce rapport changea en relation avec l'âge de la vache et avec la lactation. On décrit l'analyse quantitative de l'ontologie du rapport social et du comportement en ce qui concerne l'allaitement. La plupart des rapports des vaches et des veaux avec le reste du troupeau fut avec les bêtes du même âge. On montre les différences individuelles du rapport social entre les vaches et les veaux.

Chapitre 6. L'organisation sociale du troupeau.

On analyse les données au sujet des voisins les plus proches et au sujet de toutes sortes d'actions réciproques. Les vaches ne s'approchèrent pas aussi près de leurs voisines que les veaux (ceux-ci fréquentèrent de préférence les veaux). On remarqua des différences individuelles entre les vaches en ce qui concerne la distance entre elles et leurs veaux et les préférences d'association avec les membres du troupeau. Ainsi le troupeau se divise en groupes.

Parmi le bétail en pâture on remarqua plus de comportement cohésif (le frottage mutuel, le lèchement, le contact amical) que de comportement aggressif (les coups de tête, les menaces, le retrait). De ces données, on avance l'opinion que les relations de dominance sont moins importantes que les relations filiales pour le bétail en pâture.

Chapitre 7. Le train quotidien et l'utilisation de la pâture.

On démontre l'influence du milieu et de la distribution de la

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nourriture sur le temps passé en activités diverses et sur la distribution de ces activités pendant la journée. Dans cette étude le bétail en pâture manga plus souvent se coucha plus souvent que les bêtes à l'étable qui passèrent plus de temps debout. Cependant on ne remarqua pas de changements significatifs du comportement des veaux élevés dans l'étable. Le cycle quotidien d'activités fut influencé par la distribution de la nourriture supplémentaire, par le surpeuplement, par la longeur des jours et par le temps.

Le bétail se servit de certaines parties du champ pour certaines fonctions. Il y eut, par exemple, des regions où les bêtes cherchèrent l'abri, des chemins, des endroits préférés pour boire et pour paître. On ne remarqua aucune préference pour des champs individuels. Certaines vaches se trouvèrent plus souvent à la périphérie du troupeau et d'autres se trouvèrent généralement en plein milieu. Les veaux utilisèrent la pâture de la même façon que leurs mères, mais peu de temps après.

Chapitre 8. L'adoption totale et en partie du bétail.

La reconnaissance du veau de la part de la vache s'établit pendant les premières minutes après la naissance par le moyen d'indications visuelles et olfactives. Pour faciliter l'adoption, l'essentiel est que la vache s'habitue au veau introduit. La vache qui rejette le veau introduit au début peut changer après peu de temps jusqu'à ce qu'elle le tolère ou même qu'elle l'adopte. Le comportement du veau introduit a de l'importance. L'expérience rend les vaches plus tolérantes à l'égard d'autres veaux. Fondé sur ces observations on a dévéloppé et vérifié un système qui assure l'adoption d'un second veau par la vache. Le résultat de ce système est une méthode d'élevage du bétail en pâture très rémunératrice, peu coûteuse, avec peu de travail et de fonds.

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Chapitre 9. Les problèmes de comportement du bétail.

On décrit les problèmes du comportement du bétail qui résultent des méthodes d'élevage extensives ou intensives. On trouve que l'évolution des problèmes dépend de plusieurs facteurs du milieu. Ainsi c'est par rapport à ces facteurs qu'on discute le stress, l'infécondité, les stéréotypies (y compris tetter sans discernement n'importe quelle vache et lécher la peau), la capacité d'apprendre, l'élevage et l'alimentation.

Chapitre 10. L'écologie et la socio-biologie du bétail.

On suggère que la sociabilité du bétail résulte de la dispersion de la nourriture et de l'importance d'être nombreux pour se protéger. Bien qu'il y ait d'autres effets de la domestication sur le comportement, on avance l'opinion que l'effet de la domestication sur l'organisation sociale est très discret. La hiérarchie fondée sur la dominance est peu importante pour maintenir l'édifice social; plus importantes sont les actions filiales qui rendent plus forts les liens entre les animaux du même âge ou de la même famille. On discute le comportement de veaux qui se cachent (Chapitre 6) et on en suggère des motifs. On avance des opinions aussi sur les motifs fonctionnels pour l'association des bêtes du même sexe ou du même âge et des bêtes ayant les mêmes besoins physiologiques (les vaches pleines, par exemple). A la fin on souligne l'importance pour les bêtes d'avoir l'occasion de faire un apprentissage.

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ZUSAMMENFASSUNG

DAS VERHALTEN IN MUTTERKUH-RINDER-HERDEN (BOS TAURUS)

M. Kiley-Worthington und S. de la Plain

Kapitel 1. Die Herkunft und die Entwicklung des Rindes; angewandte Methoden.

Die Entwicklung des Rindes (Bos taurus) aus dem Auerochsen wird aus ethologischer Sicht diskutiert. Der Einfluss der Domestikation auf das Verhalten wird erörtert. Beschrieben werden die beobachteten Verhaltensweisen sowie die statistische Analyse.

Kapitel 2. Die Welt der Kuh.

Wichtige Information wird dargelegt für das Verständnis des artspezifischen Verhaltens als Ergebnis von Anatomie und Physiologie der Rezeptoren und des Hirns.

Die Bedeutung dieser Eigenschaften für das Verständnis des Verhaltens wird diskutiert.

Kapitel 3. Kommunikation.

Optische Signale werden beschrieben und ihre Ursachen erörtert. Ausserdem werden taktile, geruchliche und geschmackliche Kommunikationsmöglichkeiten diskutiert. Akustische Ausdrucksweisen werden beschrieben und in Beziehung zu allgemeinen Stimmungslagen gebracht. Die funktionelle Relevanz dieser Kommunikationssignale wird diskutiert.

Das Zusammenspiel optischer, akustischer, geruchlicher, taktiler und geschmacklicher Kommunikationssignale wird exemplarisch am Sexualverhalten beschrieben.

Uebersetzung: V. Reinhardt

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Kapitel 4. Die Geburt des Kalbes.

Die Anzeichen der bevorstehenden Geburt werden beschrieben. Neben einer genauen Analyse der Geburt wird das Verhalten zwischen Kuh und Kalb während der ersten drei Stunden post partum dargelegt.

Kapitel 5. Die Verhaltensentwicklung der Kühe und ihrer Kälber.

Das Individual- und Sozialverhalten der Kuh und des Kalbes werden beschrieben und quantitativ analysiert.

Das Sozialverhalten bestand aus aggressiven, sexuellen und freundlichen Aktivitäten. Freundliche Interaktionen nahmen den breitesten Raum ein. Die meisten Sozialaktivitäten tauschte die Kuh mit ihrem "eigenen" Kalb aus. Hinsichtlich der mütterlichen Fürsorge gab es signifikante individuelle Unterschiede, die sich mit dem Alter und der fortschreitenden Laktation veränderten. Auf Grund einer quantitativen Auswertung wird die Ontogene des sozialen Kontaktverhaltens und des Saugverhaltens beschrieben.

Kontakt zu anderen Herdenmitgliedern beschränkten sich in erster Linie auf Tiere der eigenen Altersgruppe. Sowohl Kühe als auch Kälber zeigten hier individuelle Unterschiede.

Kapitel 6. Die soziale Organisation der Herde.

Nachbarpartner - Ergebnisse und andere soziale Interaktionen werden untersucht. Kälber tendierten dazu, näher bei ihren Nachbarpartnern zu sein (sie zeigten eine signifikante Präferenz für Kälber) als Kühe. Es gab individuelle Unterschiede im Mutter-Kalb Abstand. Auch Kühe zeigten auffallende individuelle Präferenzen und Abneigungen gegenüber anderen Mitgliedern der Herde. Dies erlaubte die Unterteilung der Herde in Untergruppen.

Während des Weidens zeigten die Tiere wesentlich mehr freundliches Verhalten (z.B. gegenseitiges Reiben, Lecken, Berühren und Beriechen) als aggressives,abweisendes Verhalten

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(Drohen, Stossen, Vermeiden und Ausweichen). Aus den Daten wird die Schlussfolgerung gezogen, dass Dominanzbeziehungen beim Weiden eine geringere Rolle spielen als freundliche Interaktionen.

Kapitel 7. Der Tagesablauf und der Gebrauch der Weide.

Es wird gezeigt, dass die Umgebung und die Verteilung des Futters einen Einfluss nimmt auf die Gesamtzeit mit der die verschiedenen Aktivitäten ausgeübt, und wie die einzelnen Aktivitätsphasen über den Tag verteilt werden. So verbrachten in dieser Studie weidende Kühe mehr Zeit mit Fressen und Liegen als im Stall gehaltene Kühe; die letzteren stehen dafür mehr. Das Verhalten der Kälber hingegen zeigte keine signifikante Abhängigkeit von Weide- bzw. Stallhaltung.

Der circadiane Aktivitätsrhythmus wurde erheblich beeinflusst von den Fütterungszeiten, Bestandsdichte, Tageslänge und dem Wetter.

Bestimmte Areale der Weide wurden von den Rindern für bestimmte Funktionen verwendet (z.B. Unterstände, Reibplätze, bevorzugte Weide- und Trinkplätze). Innerhalb der Untersuchungskoppel zeigten die Rinder keine generelle Bevorzugung für irgendein Areal. Bestimmte Kühe hielten sich gewöhnlich am Rand der Herde auf, während andere regelmässig im Zentrum anzutreffen waren. Die Kälber zeigten die gleichen Bewegungsmuster wie ihre Mütter, denen sie etwas verzögert folgten.

Kapitel 8. Ammenverhalten und Adoption bei Fleischrindern.

Innerhalb weniger Minuten nach der Geburt erkennt die Mutter das eigene Kalb. Geruchliche und optische Merkmale werden von der Mutter anfänglich als Erkennungszeichen verwendet. Damit ein Waisenkalb von einer Kuh adoptiert wird,ist es wichtig, dass sich die Kuh zunächst an das fremde Kalb gewöhnt. Im Laufe der Zeit macht die anfängliche Abweisung des zugesetzten Kalbes

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durch die Amme einer Toleranz oder sogar einer Adoption Platz. Die Reaktion des fremden Kalbes spielt eine wichtige Rolle. Erfahrene Kühe werden gegenüber fremden Kälbern duldsamer. Unter Berücksichtigung dieser Gegebenheiten wurde ein System entwickelt und getestet, das die Adoption eines zweiten, fremden Kalbes durch Fleischrindkühe sichert. Ein solches System stellt ein höchst profitable Methode dar, mit wenig Arbeit und geringem Kapitaleinsatz Rinder auf Weiden aufzuziehen.

Kapitel 9. Verhaltensprobleme bei Rindern.

Die Verhaltensprobleme, die Rinder aus extensiver oder intensiver Haltung erwachsen, werden dargelegt. Es wird gefunden, dass die Entwicklung von Verhaltensproblemen von vielen Umständen abhängt. "Stress", Unfruchtbarkeit, Stereotypien (eingeschlossen Scheinsaugen und Haarlecken), Crowding und Aggression, Vielfältigkeit und Umwelt, Lernen, die Fähigkeit der Tierhalters sowie die Fütterung werden in Beziehung zu Umweltfaktoren diskutiert.

Kapitel 10. Oekologie und Soziobiologie des Rindes.

Es wird vermutet, dass Rinder wegen der grossen Futterverbreitung und wegen der wichtigen Schutzfunktion, die von vielen Tieren ausgeht, sozial sind. Es wird die Behauptung aufgestellt, dass der Einfluss der Domistikation auf die soziale Organisation sehr gering ist, obgleich es noch andere domestikationsbedingte Verhaltenseinflüsse gibt. Die Dominanzhierarchie spielt eine relativ untergeordnete Rolle für den Zusammenhalt der Sozialstruktur. Viel wichtiger ist das freundliche Verhalten, aus dem sich Sozialbindungen zwischen Gleichaltrigen und zwischen den Generationen entwickeln. Das Ablegeverhalten der Kälber (Kapitel 6) wird diskutiert und Gründe vorgeschlagen. Ausserdem wird die funktionelle Bedeutung häufiger Assoziationen zwischen Tieren des gleichen Geschlechtes, ähnlichen Alters und ähnlichen physiologischen Ansprüchen (z.B. tragende Kühe) besprochen. Abschliessend wird die Wichtigkeit des Lernens im Tagesablauf der Rinder dargelegt.

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