The feral goats of kielderhead moor: a preliminary investigation

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THE FERAL GOATS OF KIELDERHEAD MOOR: A PRELIMINARY INVESTIGATION.

By

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"The precise place in the ecosystem at which each individual plant or animal is situated in relation to its neighbours is of considerable significance in the organisation of the community."

(Dice 1952).

Yearling
Nanny

Fig. 1. A Nanny and Yearling on Kielderhead Moor, January 1972.

During the winter the nannies occupy the rock exposures on the edges of the high moors. They are not found in herds at this time but are either alone or with their kid of the previous season.

This photograph of a nanny and the yearling on the White Crag was taken at dusk at the end of January. The yearling (seen end on to the right of the photograph) is noticeably smaller than the nanny at this time of year.

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1. INTRODUCTION

1. Introduction.

The goat Capra hircus L. was brought to Britain by Neolithic herdsmen (Milner, Goodier and Crook 1968). Since that time it has often escaped to become feral in the wilder parts of these islands, where its reversion to the wild type is rapid (Fraser Darling 1937a).

Goats have long been attributed with magical properties and the reasons why they were kept on Border farms went well beyond the strictly utilitarian. They were reputed

a) to kill adders Vipera berus L.

b) in deep snow to lead sheep to safe ground by breaking a path with their longer legs.

c) to prevent contagious abortion. Often until the 1939 - '45 war a nanny ran with the cows as a supposed preventive measure against contagious abortion. In some herds a billy, having the stronger scent, was considered more efficacious.

d) to be a good guide to the weather. Shepherds still give them the reputation of coming off the high ground before the advent of severe weather.

Goats are still kept on some Border farms, but now they are used as a ready supply of good milk for orphan lambs, bought in calves and to supplement the nourishment farm puppies receive from lactating bitches. Some of these animals still get away to the hill and one Border herd shows by the incidence of short hair and neck toggles (Williams and Rudge 1969) some such recent introductions of fresh blood.

i) THE PROBLEMS

i) The Problems

The present study was proposed to answer the following questions about the population of feral goats present on Kielderhead Moor :-

a) What is the population and herd structure of the Kielderhead goats?

b) What is the home range of the herd or herds?

c) What activity patterns are followed by these animals?

d) Is there likely to be competition between the goats and the sheep which graze over the area?

ii) REVIEW OF THE LITERATURE

ii) Review of the literature.

The ancestry of the goats has been described by Harris (1962). Boyd - Watt (1937) summarised the known distribution of the animal in Northern Britain. This account has been brought up to date by Tegner (1965), Greig (1969) and Whitehead (1972).

Having been confined to remote hills and the western shores and islands the goat has caused little trouble in Britain, although it has been destroyed locally, for spoiling the shooting by its wariness (Boyd - Watt 1937), for preventing the regeneration of forests (Ritchie 1920) and competing with sheep for scarce pasture (Boyd - Watt 1937). In most parts of the world where it has been introduced the goat has however raised serious problems in habitat conservation. The history of introductions has been best covered in New Zealand (Thomson 1922 and Wodzicki 1950). Here the feral goat is classified as a noxious pest. Its damage to vegetation has led to the loss of indigenous species, habitat destruction, gullying and erosion (Turbott 1948, Atkinson 1964, Howard 1956 and Sykes 1969). On St. Helena it has left a once luxuriantly forested island a barren and rocky waste (Ritchie 1920). Islands such as New Zealand, Hawaii and St. Helena, where the flora has evolved free from the competition of herbivorous ungulates, are peculiarly vulnerable to the depredations of goats (Yocum 1967). Milevic (1953) and Ashby (1966) have discussed the conservation problems in the Mediterranean area which are posed by the too large flocks of domestic goats.

Population studies have been undertaken in Japan (Asahi 1960), New Zealand (Williams and Rudge 1969, Rudge and Smit 1970) and in Scotland (Greig 1969).

Fraser Darling (1937a) examined some aspects of the behaviour of

feral goats. Scott and Stewart (1946) examined dominance and leadership. Collias (1956) compared the maternal - infant behaviour of sheep and goats. Crook (1969) studied the social organisation of feral goats in Snowdonia. McTaggart (1971) introduced a fresh study of comparisons in the behaviour of Soay sheep and feral goats. Rudge looked at mother - kid behaviour (1970) and is now concerned with the relationship between the reproductive pattern (1969) and the social system within the population (pers. comm.).

The concept of home range (Burt 1943, 1949, Dice 1952, Jewell 1966) has given an understanding of movements confined to only a small part of the habitats that are fully suited for an animal's existence and over which it is potentially free to roam (Riney and Caughley 1950, Asahi 1960, Geist 1960, Grubb and Jewell 1966 and Milner, Goodier and Crook 1968).

There is a very considerable agricultural literature on domestic goats which has not been considered here. Where it is relevant it is mentioned elsewhere in the text.

Fig. 2. The Distribution of the Goat Herd on the Borders

The map shows the position of the study area in relation to the position of the other Border herds.

Table 16. Food Preferences Expressed as a Percentage of the Faecal Pellett Analysis. Sheep (Combined Figures for the Chattlehope and Bateinghope Hirsels).

Weeks ending	Calluna	Empetrum	Vaccinium	Festuca	Eriophorum	Trichophorum	Rubus	Cladonia
28 /iv / 72								
5 / v / 72	66				34			
12 / v / 72								
19 / v / 72	66			24	10			
26 / v / 72	56			20	24			
2 /vi /72	56			30	7	4	3	
9 /vi / 72	31		2	24	12	31		
16 /vi /72	20			24	10	46		
23 /vi / 72	13		7	7	20	53		
30 /vi / 72	24		7	11	20	33	5	

Fig. 2. The Distribution of Feral Goat Herds on the Borders.

iii) THE STUDY AREA

iii) The Study Area.

The study area (fig. 2.) occupies the high ground forming the watershed between the valleys of the Rede and the Kielder. The geology of the area has been most recently described by Clough (1889). Anvil shaped in cross section, a plateau of fell sandstone overlies the cement stone which forms the lower slopes. The whole is overlain with blanket peat except at the steep edges formed by the fell standstone. Where the fell sandstone falls away to the cement stone there are exposures of rock large enough to be named such as the Girdle Stone, White Crags, Oh Me Edge, High Countess etc. (Fig.3.).

The high ground is drained by burns flowing eastwards to the Rede and westwards to Kielder. Their courses are steep and often rocky; where they leave the upper fell sandstone they form gorges and waterfalls as they drop to the lower cement stone. As the level of the ground begins to slope away at the sources of the burns the peat is severely dissected forming haggs often 3 metres deep.

Much of the area below 300 metres has been given over to forestry plantations, of spruce Picea sitchencis and lodgepole pine Pinus contorta. The remainder of the low ground is sheep pasture largely of grasses Festuca ovina, Anthoxanthum odoratum, and Nardus stricta, and of soft rush Juncus effusus. The ground above 300 metres is a wilderness of cotton grass and heather. Carter Fell, on the Border, is the highest point in the study area but much of the moor is only a little below its 350 metres.

The vegetation of the high moor shows a considerable degree of homogeneity. It could be considered a Calluneto - Eriophoretum (McVean and Radcliffe 1962). It is species poor and consists of :-

Betula pubescens Ehrh.

Calluna vulgaris (L.) Hull.

Empetrum hermaphroditum Hagerup.

E. nigrum L.

Erica tetralix L.

Vaccinium myrtillus L.

Anthoxanthum odoratum L.

Deschampsia flexuosa (L.) Trin.

Festuca ovina L.

Nardus stricta L.

Eriophorum angustifolium Honck.

E. vaginatum L.

Trichophorum cespitosum (L.) Hatm.

Drosera rotundifolia L.

Galium saxatile L.

Oxalis acetosella L.

Pinguicula vulgaris L.

Rubus chamaemorus L.

Campylopus flexuosus (Hedw.) Brid.

Dicranum scoparium Hedw.

Hypnum cupressiforme Hedw.

Plagiothecium undulatum (Hedw.) B., S. & G.

Pleurozium schreberi (Brid.) Mitt.

Sphagnum palustre L.

S. papillosum Lindb.

Cladonia coccifera Willd. Rev. Gordon

C. impexa Harm. Graham

C. uncialis Web.

Parmelia physodes Ach.

Omphalina ericetorum (Fr. ex Fr.) Lange.

The name of plants are as described by Clapham, Tutin & Watburg (1962), Dahl (1968), Smith (1921) and Watson (1968).

The moor is largely Calluna and Eriophorum with some Vaccinium and Trichophorum. The Calluna is ten to eleven years old but only low growing. On the steep edges Vaccinium myrtillus becomes prominent. South of Limestone Knowe on to Grey Mare's Knowe and the Grun, as the ground slopes away, Trichophorum cespitosum takes over from the Eriophorum and the Calluna looks thin and wasted. The green, grassy appearance this gives to the southern end of Carter Fell is the probable reason why they are called knowes. The very northern edge of Carter Fell has similar vegetation. Betula pubescens grows in the steep cleughs leading to White Kielder. There is very little grass on the high moor except in some very small patches around the Girdle Stone, the White Crags and similar places, places where sheep in summer spend their nights and which are consequently heavily manured. This appears to have improved the soil in these small areas as worms were present and on one a mole Talpa europaea L. had thrown up mounds.

Although the winter 1971 - 72 was not severe it was followed by a late, cold spring and a cool, wet summer until the end of July. On the top of the moor it was the beginning of May before fresh Calluna and Vaccinium growth was seen. The Eriophorum began to flower about the same time but there was little vegetative growth until the beginning of June, by which time Rubus chamaemorus had begun to grow and flower. Trichophorum cespitosum did not begin to grow on the high moor until the end of the first week in June.

During the winter there was some snow cover but always the western edges were blown clear by the wind. The top of Cross Cleugh leading to the Bateinghope Burn and the cleughs leading to the Chattlehope Spout were green with Sphagnum through the winter when they were not covered with snow. Many of the peat haggs have extensive patches of Sphagnum.

2. METHODS

i) VISITS.

2. Methods

i) Visits

Visits to the moor were made once a week between Christmas and the end of March and almost daily from the end of April until the end of July when once weekly visits were resumed.

The initial searches were made by sweeps across the moor on fixed compass bearings. This method was also used when hill fog, a common occurrence, made navigation difficult on the practically featureless moor. Once the range of the goats began to become apparent it was usually possible to find the animals by walking to where they had last been seen the night before and then examining the areas where they might have gone between first light and the time that observation on the moor was resumed. Three all night visits were made but in each case full cloud cover and rain made the night too dark for observation.

ii) OBSERVATION OF GOATS

ii) Observation of Goats.

Although with care it is possible to approach goats very closely (sec. 3. vi.b.) it is better to make observations from a distance to minimise the risk of disturbance, and the consequent interference with their normal behaviour. This of course is true for most mammals (Fogden 1971). For this reason most observations were made with the use of a 6 x 30 binocular and a 15 - 60 x 60 telescope mounted on a tripod.

Camp was made below the moor in the forest in order not to interfere with the free range of the goats.

iii) IDENTIFICATION

iii) Identification.

The majority of the feral goats on Kielderhead Moor are peat coloured, but with practice it is possible to make use of some individual characteristic such as a marking or a horn shape to make identification possible. Drawings were made of the animals and entered on cards, which were carried in the field. In order to make the goats more familiar they were given names, as names were found much easier to remember than the use of numbers. It has seemed reasonable to continue this use of names in this paper.

Table 1. The animals mentioned in the Text.

Although in the course of field work all animals were individually distinguished it has not been found necessary to mention every animal in this paper. The use of familiar names was found useful as an aid to memory and adopted in preference to an anonymous system of identification by number or letter. The animals mentioned by name in the course of this study are listed below:-

a) Males.

Robin. a large white billy with dark brown markings along the back and sides. He was the only billy with scimitar curved horns and was also unusual in only having long hair on the hind quarters. He spent the winter with the Chattlehope billies on Wool Meath and the summer with the Chattlehope nannies.

Skull a peat coloured beast with the facial markings in white of a skull. He spent the winter with the Bateinghope billies and the summer with the Bateinghope nannies.

Bill — a mature billy which spent the winter with the Bateinghope billies. In the summer he wandered with another billy around Carter Fell maintaining a loose association with the Bateinghope herd on those occasions when he happened to be near them. He was a peat coloured animal with a completely white face. He had a pronounced fringe hanging over the eyes. He had a very fine spread of horns.

Ben — a young billy which by the summer was considered to be a mature animal. A close inspection showed three notches on his horns (Sec. 2. v.). It spent the winter with the Bateinghope herd and the summer in close association with Bill.

Duncan — a young billy from the Chattlehope herd of billies. Entirely peat coloured he had no distinguishing mark and could only be recognised by familiarity. He was not seen again after the winter. (Fig. 6).

George — a yearling billy from the Bateinghope herd of nannies. He spent the winter with his mother on the White Crag (Fig. 1.). She disappeared at the end of the winter. He was a uniform peat colour until after the moult when his beard grew very black and his fringe which extended over the temples grew tawny. By the beginning of September 1972 his horns had started to thicken at the base and flatten anteriorly. He was still only the size of a nanny (Sec. 3. ii.).

b) Females

Nancy — the largest of the nannies, she was a light grey and extremely shaggy. Throughout the study she was always found on a flow below Limestone Knowe.

Jessie — a white nanny heavily marked with tan. Her right horn was broken or frayed off several inches shorter than the left. She spent the winter on the Castle (Fig. 3.) but was not seen in the summer.

Pat — a peat coloured animal with a large white patch on her left flank. Her face was distinctively streaked with white. During the winter she was in the gorge of the Black Cleugh. (Fig. 3.). In the summer she was a member of the Chattlehope herd.

Demeter — a small, peat coloured animal with the sole distinguishing features of tawny coloured ears. She spent the winter at the head of the Bateinghope Burn (Fig. 3.) where she was observed giving birth. Her summer was spent with the Bateinghope herd.

It would be better for all beasts to be individually marked but so far they have proved difficult to capture. The animals captured on Roan Fell were driven down the hill with dogs straight into a fold in the farm yard. During the course of their rush down hill the nannies and the kids cleared a wire fence, later measured and found to be 1 metre high. They were caught by hand as they leapt the rails and placed in a byre. This did not prove possible on Kielderhead Moor where the animals manage to get on to inaccessible rocks.

The quality and intensity of light continually changes making some dark colours particularly difficult to recognise, but with practice this difficulty is overcome. The colour black in a kid changes to a dark peat colour by the age of two months, although it is of interest that this is not so in some of the short haired animals at Hindhope where the black retains its intensity even in some adults.

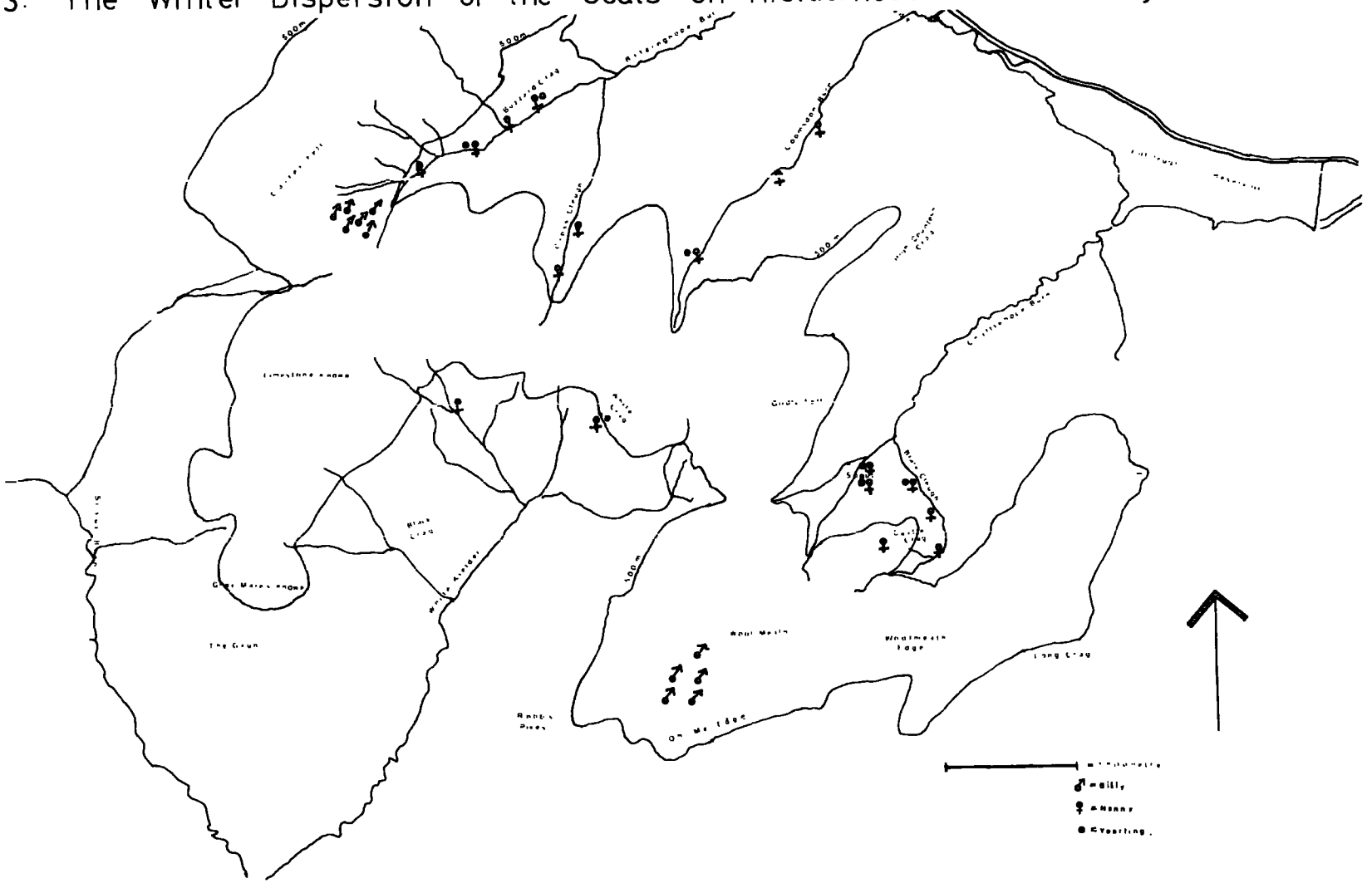
Fig. 3. The Winter Distribution of the Goats in the Study Area of Kielderhead Moor: (January - March 1972).

The nannies were dispersed on the broken, rocky ground at the edges of the fell sandstone or in the gorges cut by the burns. Some were accompanied by yearlings whilst others were on their own.

The two groups of billies ranged much more widely than the nannies. They stayed as all male herds and the two herds were not seen to meet or mingle at any time during the winter.

The yearlings remained with their presumed mothers throughout the winter.

Fig. 3. The Winter Dispersion of the Goats on Kielderhead Moor: January – March 1972.



iv) SEX DIFFERENTIATION.

iv) Sex Differentiation.

Billies may be recognised from the nannies by the considerable growth of hair around the neck merging with the beard. Nannies look thin necked, even when compared with males in moult when much of the neck hair is lost for a time. The billies also have a tufty fringe hanging between the eyes, which is visible at short range. This fringe first grows at the end of their first year after the moult. Before this time it is only possible to sex the kids when the females are observed urinating or some of the young males show precocious sexual behaviour in their play.

The horns of the Kielderhead goats are of two types; a) those horns which rise in a vertical plane and arch over the neck in a long scimitar - like curve. These horns have a sharp anterior keel: and b) those horns which curve upwards, backwards and outwards in an incipient spiral. These horns have a sharp inner keel and a broad anterior edge giving the horn a triangular cross section. (Fig. 6).

The majority of the females carry the scimitar shaped horns while the majority of males have the broad, spreading horns but there are some exceptions which make it unsafe to use the horns as a reliable guide to the animal's sex.

There is also some variation in size. The really large animals are usually billies. Only one of the females studied is very large and shaggy. It takes four years for a billy to reach its full size, if the method of aging by counting the notches on the horns of adult animals is reliable (Pino 1952) (Fig. 6.).

v) AGE.

v) Age.

Four age classes may be easily recognised in the field:-

a) Adults or fully grown animals.

b) Young males which are older than yearlings but have not yet grown to full size and maturity.

c) Yearlings which were half grown at Christmas when the study began (Fig. 1.), and did not resume their growth until the end of March. They then grew rapidly until by the middle of June they were indistinguishable in size from the adult nannies although not as large as the mature billies.

d) Kids.

At very close range it is possible to see notches on the horns of adult animals. It is suggested these are annual marks (Pino 1952). Similar marks have not been found on the horns of the domestic goats which have been examined in this study at Chattlehope Farm and Twizlehope Farm.

vi) RANGE AND ACTIVITY.

vi) Range and Activity.

6 inch to the mile tracings of maps of the area were carried on each visit and the positions of individual goats marked on it; at each hour if individuals were under continuous observation; or where they were found if the area was being searched for all the animals. A record of the activity of each animal was made at the same time.

During the summer the southern herd which kept more nearly together and often fed in the saucer to the south east of the Girdle Stone and above the Chattlehope Spout, were usually much easier to observe than the northern herd which were often dispersed widely and hidden in the haggs of the Bateinghope hirsel. However the reverse was true if the animals were being sought initially by the observer before beginning a period of observation. The southern herd, often in a close formation could remain hidden in a long hagg and traverse a considerable distance without one goat being seen by an observer. The loosely dispersed nature of the northern herd usually meant that an odd animal would be seen if they were in the area being searched. In this study these two herds are called the Chattlehope herd and the Bateinghope herds after the hirsels on which these animals are found.

vii) FOOD PLANTS.

vii) Food Plants.

The most reliable method of food analysis is by the examination of stomach contents. This requires the sacrifice of a number of animals and was therefore not considered suitable for this study.

When animals were observed feeding a note was made of their food plants, although it is not always possible to see exactly which plant is being consumed when an animal's muzzle is dropped into mixed vegetation or when it is being observed from a distance. Faecal pellets were therefore collected for analysis as a further method of identifying the food plants.

The faecal pellets of goats, sheep and roe deer Capreolus capreolus L. (which are all living on the moor to some extent at least) are all similar, and though often separable when fresh, the degree of overlap in their appearance after a few hours did not allow of their use as an index of abundance of these animals. For the same reason, when pellets were collected from sheep and goats for food analysis it was necessary to collect faeces which were seen voided to eliminate any possible source of confusion.

Pellets were boiled in 10% NaOH and stored in 70% alcohol until stained with saffranin and fast green or with haematoxylin. Stained material was mounted in Canada balsam and spread evenly over a 7.5 x 5.0 c.m. slide. It was then examined under the high power of the microscope and compared with reference slides of epidermal macerations. The tissues of known plant material for these reference slides were fixed in formalin ascetic acid, cut into small pieces and digested in concentrated Nitric acid. The recognisable material from 15 ocular areas of each slide prepared from the faecal pellets was counted. 15 ocular areas were considered to be an appropriate number as no significant difference in composition

was found in repeated estimations on new counts from the same material. The counts were grouped with other material collected in the same week and percentage occurrences calculated of one plant in relation to all the plant material recognised and counted. The raw data was examined statistically by the application of χ^2 tests.

The relative occurrence estimates have been assumed to agree with the real diet composition, although Hansson (1970) shows that with rodents at least, the most common item is under represented and the most uncommon items are over represented. Some plant material has a very delicate epidermis and such material might not show up well in animal droppings. No attempt was made to estimate the actual volume of plant material eaten.

In spite of these shortcomings in the method of food analysis it was considered sufficiently reliable to use as a comparative method between sheep and goats as any errors inherent in the method would be likely to be the same for both species.

3. RESULTS.

i) THE WINTER RANGE OF THE GOATS OF THE STUDY AREA OF KIELDERHEAD MOOR, JANUARY - MARCH 1972.

3. Results.

i) The Winter Range of the Goats of the Study Area of Kielderhead Moor, January - March 1972.

When the study began in January the sexes were separated. The billies were in two herds and the nannies were scattered singly or as couples composed of a nanny and a yearling, presumably the nanny's kid of the previous season still running with her.

The Chattlehope group of billies (Table 3), a party of five, were found around Wool Meath, usually on Oh Me Edge or the western slopes of Wool Meath but never as far west as Rob's Pikes (Fig. 3). The Bateinghope billies (Table 3), a group of six, lived on the southern half of Carter Fell above the 500 metre contour (Fig. 3).

The nannies occupied the broken ground with large exposures of rock which occur on the edges of the high moor where the blanket peat cover has eroded away. The Chattlehope nannies were spread along the gorge of the Black Cleugh and below Chattlehope Spout (Fig. 3). The Bateinghope nannies occupied similarly, but more widely distributed, broken ground; the gorges of the Bateinghope and Coomsdon Burns, the White Crag (Fig. 1) and Buzzard Crag below Carter Pike except for one animal, the large grey nanny, Nancy, which was always to be found on and around a flow below Limestone Knowe.

This dispersion was maintained until after kidding towards the end of March.

ii) KIDS AND KIDDING.

ii) Kids and Kidding.

The gestation period of the goat is 151 days (Asdell 1964). The goat is a seasonally polyoestrus animal with a cycle of 21 days beginning in September, reaching its greatest intensity in October and then tapering off (Asdell 1964). As the kids were born in the third and fourth weeks of March, the rut must have taken place in October.

A birth was observed on the 21st March. The description from the field note book reads :-

"I walked WNW to the top of the Bateinghope Burn. On the north side in a peat hagg above the gorge was a nanny in a peculiar position. She was crouched with her tail against a heather bush. I approached and still she did not run away. Her eyes were half closed and I thought at first she was dying. Then under her muzzle I could see a stillborn kid and I realised she was dropping another. Seven minutes later she turned and licked the second kid which bleated several times and kicked its hind legs vigorously as though trying to stand up. Its fur appeared to dry very quickly under the influence of its mother's licking. The kid was black with a white topknot and a white blaze across the right cheek. It did not prove possible to discover its sex. After nine minutes it stood up and followed, rather unsteadily, its mother up the side of the burn for a few metres. There the mother lay down with the kid standing by her side.

I withdrew as I thought I had caused enough disturbance. I carried the stillborn kid away with me. It did not appear to have been licked and was still wet when I came off the hill an hour and a half later.

During the birth the nanny made no sound but crouched with her head and neck held low and her hind hooves level with and outside the

front hooves. Her hind quarters were held low to the ground but I could not see what was happening as her tail was hidden in the Calluna bush. During the time I watched she made no obvious muscular movement. The kid appeared to just come. As the nanny moved away she trailed afterbirth from her birth canal."

Table 2. The Measurements of the Stillborn Kid.

Base of the tail to top of skull	37	cms.
Base of tail to tip of nose	40.5	cms.
Net weight	1550	g
Sex	Male	

A count of the horn notches of this nanny, suggested that she was six years old. She was seen again on other occasions but as she did not have her kid with her it must have succumbed. It is of interest that in an investigation into factors affecting multiple births Moulick et al (1966) observed maximum litter size from nannies aged between 61 and 73 months. Ahmed and Tantawy (1960) showed the great influence of birth weight on the mortality rate, 1.5 Kg. being the statistically significant weight for survival, and Eaton (1952) showed little difference in the length and weight of foetuses due to single, twin or triplet pregnancies.

In New Zealand Rudge (1970) reports that kids are only hidden for the first four days of their life. This would not appear to be

the case on Kielderhead Moor, where observations suggest the kid remains with the mother for the first few days of its life but is hidden afterwards until about six weeks old. It is this behaviour which gives nannies the reputation of bad mothers with shepherds, who are used to the constant attention given by ewes to their lambs.

One example of such observations concerned a very young kid watched for two hours between 1200 and 1400 hours on 21st March. During this time it suckled four times for durations of five, eight, five and two minutes before 1245, when the mother lay down to ruminate. Whilst the mother cudded the kid sometimes lay down for up to five minutes, walked slowly over to a piece of vegetation and investigated it with its mouth, walked round its mother or just stood at its mother's side.

On another occasion on 26th April when the kids were four to five weeks old the Chattlehope herd was watched from 0900 hours. No kids were seen until 1652. Before the kids were seen one nanny left the herd which was lying down and quietly ruminating above the Spout at 1645, and circled the moor between the Girdle, Wool Meath and the Castle at a fast walk bleating continuously. The nanny concerned was Pat, a peat coloured nanny with a large white patch on her left flank. At 1652 her own kid, which was almost wholly white, appeared with three others from a peat hagg and ran up to her. They scurried around Pat's hind quarters for two or three minutes apparently all attempting to suckle. Their tails were briskly waving and Pat made no apparent move to drive any of the kids away. She stood still with her nose turned to the tails of the kids clustered around her udder. This was the only behaviour seen which was at all reminiscent of the "creche"

behaviour of the moufflon Ovis ammon Schreiber (Pfeffer 1967). After three minutes three of the kids ran over to the rest of the herd which had resumed feeding at 1645 but were still almost a kilometre away above the Spout. Her own kid continued to suckle. As soon as the other three kids reached the group above the Spout they ran to their mothers and suckled. They did not cluster around one nanny again.

Very soon after this when the kids were about six weeks old the kids were observed to remain with their mothers in a loose association and even though they might be out of sight of her because of the lie of the land which is tussocky and hagged, they seemed well aware of her position. In stalking the Bateinghope herd, always much more difficult to approach, it often happened that a kid, or two kids feeding together, would be stumbled over before they were seen by the observer. Whenever this happened the startled kid would immediately run to its mother although she had probably been out of sight for some time. If however a nanny was accidentally put to flight and then a kid was later disturbed the kid would run to where its mother had been and then stop, bleating (the first time any sound would have come from either the kid or the nanny), with no idea which way to run.

During this period the kids were observed to suckle for short periods at any time of the day. They are much more gentle with their mothers than lambs or calves. They do not indulge in the vigorous bunting at the udder which will often lift a ewe's hind quarters off the ground. A kid's horns at this stage are sharp and point straight up, unlike a lamb's which curl over

at the top. This is probably the reason for the kid's more gentle approach.

From the 6th June when the kids were about eleven weeks old no kid was seen to suckle in the day time although observations were sometimes continued until darkness made further work impossible. Yet two nannies caught and examined on Roan Fell, on 5th July at 1700 hours had extremely full bags from which milk was easily expressed. Since no kids were observed to suckle in observations lasting all day on Roan Fell, on Hindhope Law on 28th June, Bewcastle Fell on 2nd July, or at the College Burn on the 19th July, it seems likely that after the kid reaches the age of ten weeks it only suckles in the night or in the early morning.

The kids grew rapidly during spring and early summer. By the middle of June they were as large as the yearlings had been when first observed in late December. There appears to be a severe check to the growth of the kids from the middle of June and at the beginning of September there was little, if any, observable gain in the size of the kids, apart from a slight increase in the length of the horns which were now beginning to show a curve. The yearlings had appeared to remain stationary in size through the winter, but had resumed growth at the end of March at about the same time the kids were born. The yearlings were then seen to grow rapidly until by the end of June they were indistinguishable in size from the adult nannies although not as large as the mature billies.

From the age of six weeks the young billies were occasionally

observed to show precocious sexual behaviour, persisting in attempts to mount their contemporaries until a nanny lowered her neck in threat and the episode ended. In domestic goats the testes and epididymides develop rapidly from the age of 30 to 40 days until 140 to 150 days when they are almost fully mature. Spermatozoa appeared at 88 - 95 days. In young female domestic goats conception may occur at six months of age (Asdell 1964).

iii) THE SUMMER RANGE OF THE GOATS OF THE STUDY AREA OF KIELDERHEAD MOOR, APRIL - AUGUST 1972.

iii) The Summer Range of the Goats of the Study Area of Kielderhead Moor, April - August 1972.

It has been seen that during the winter the nannies did not group together whereas the billies maintained a herd structure throughout this period. By the last week in March a change in herding behaviour could be observed. All those nannies with kids a few days old were by that time feeding above the areas where they had spent the winter and were loosely associated in groups of threes and fours.

At this time the billy herds broke up and only two billies could be found on the moor; Skull (table 1) from the herd which had fed on Carter Fell all winter was now feeding with the Bateinghope herd of nannies, and Robin (table 1) from the winter herd of billies on Wool Meath was feeding with the Chattlehope nannies in the saucer of ground above the Spout and below the Girdle and the Castle (Fig. 4).

By the end of April the goats of Kielderhead Moor were in two distinct herds which were to remain stable for the rest of the summer. The Chattlehope nannies with their yearlings and kids were always to be found with Robin on the moor to the south of the Girdle Stone. They did not go below the Spout as they had done during the winter or across to the east bank of the Black Cleugh. They were most often found on the north east slope of Wool Meath down to the Spout (Fig. 4).

The Bateinghope nannies with their yearlings and their kids were in a looser association spread over more ground, although they would bunch up if they were disturbed. They wandered over more ground, showed less concentrated use of particular areas and were more likely to fragment than the Chattlehope herd. Skull was only away from these nannies for a period of three days when he followed Bill and

Ben (table 1) out over Black Crag to Grey Mare's Knowe and back over Limestone Knowe to the far side of Carter Fell before returning to the main herd via the head of the Bateinghope Burn and Cross Cleugh. This was a favoured route of Bill and Ben, the two billies which returned to the Bateinghope herd in the middle of May (Section 3. vi.), but were only in the loosest association with them, going away for days at a time. When this occurred they could usually be found by a search with the telescope of the ground from the White Crag over to Grey Mare's Knowe or a walk over Carter Fell to the Carter Burn.

Only Nancy (Table 1), the large grey nanny which had spent the winter on the flow below Limestone Knowe did not associate with the herd unless they, or components of the herd, were feeding on the flow with her. On these occasions she fed with them as an apparent member of the herd, but as the rest of the animals moved away she remained on the same ground she had occupied all winter. She was an extremely wary animal, and difficult to approach although not difficult to watch as she was easy to find and observe from a distance through the telescope. When disturbed she invariably moved down into the steep gorge of the unnamed cleugh which began in the flow and ran down into the White Kielder. When the rest of the Bateinghope herd were with her they invariably followed her in any headlong rush to the safety of the gorge. Although Nancy always led the rest in this way she led them in no other way.

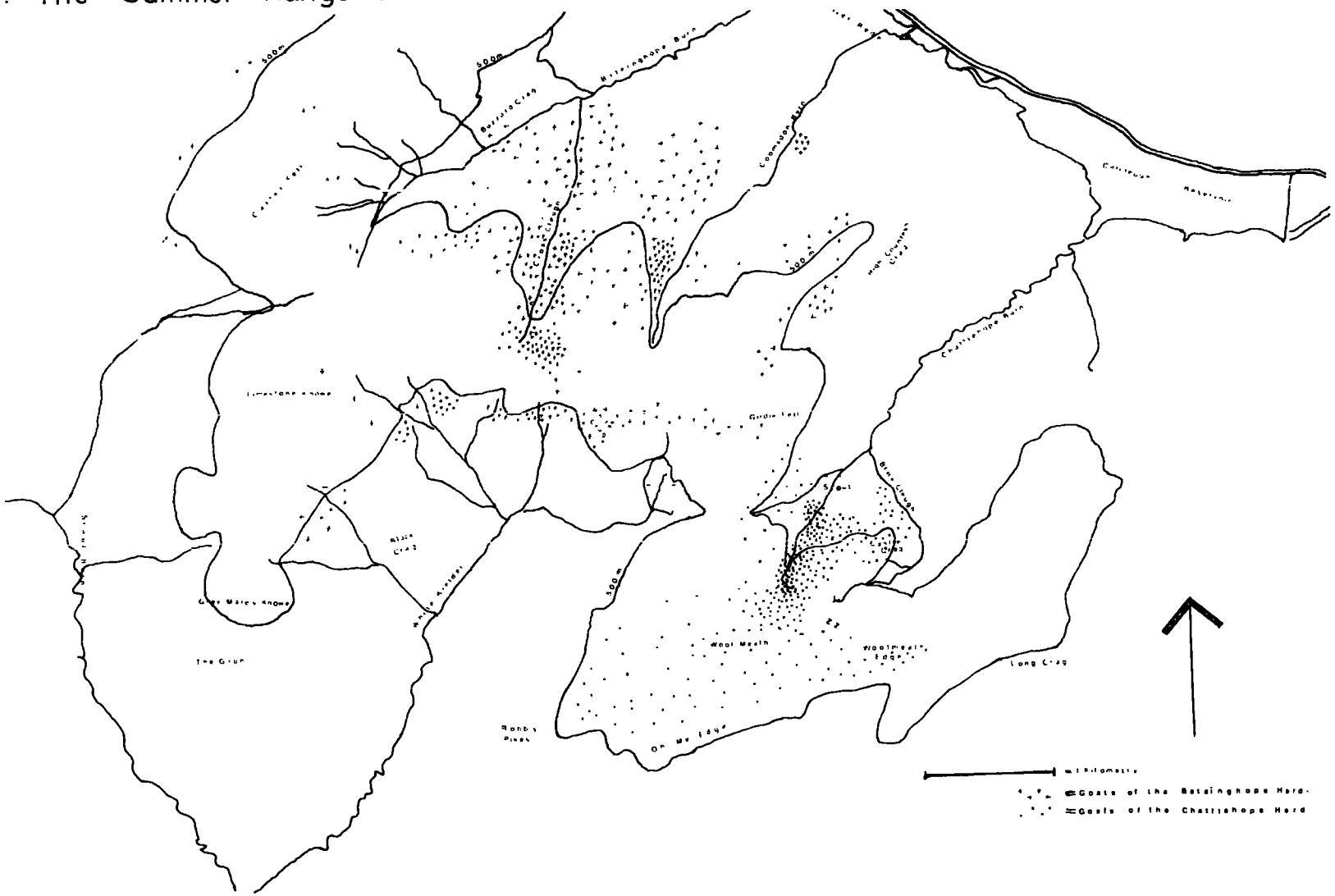
The Bateinghope herd sometimes broke up into two loosely associated groups, something the Chattlehope goats did not do. An example taken from a field map on 16th May illustrates the phenomenon. The whole herd commenced feeding at first light by the Ordnance Stone above the head of the Coomsdon Burn where they had been left at dark on the previous evening. The whole herd moved, feeding steadily, to the Cross Cleugh. By 1100 hours four of the nannies and Skull were

Fig. 4. The Observed Summer Range of the Goats on Kielderhead Moor, April - August 1972

One record in five of records taken from the field maps has been marked, indicating both the range of the animals and the areas on which the goats were most often found.

The goats on Chattlehope and Bateinghope respectively remained as two distinct herds throughout the summer. Although both sometimes ranged up to the edge of Girdle Fell where their ranges abutted, on no occasion were the two herds there together.

Fig. 4. The Summer Range of the Goats on Kielderhead Moor: April – August 1972.



feeding about a kilometre down the Cross Cleugh while the rest had gone out of sight over the shoulder towards Buzzard Crag. A search later in the afternoon found two nannies and a yearling feeding below Buzzard Crag. Before the rest could be found these animals were disturbed by the observer stumbling over two kids feeding in a peat hagg. The disturbed animals moved off down the Bateinghope Burn. They must have turned south lower down the burn as later in the same day the whole herd were together again feeding over the shoulder between Cross Cleugh and the Coomsdon Burn. On other occasions two groups originating in this way might remain separate for up to three days before joining up again, unless they were disturbed in which case they usually bunched together, although they might have been a kilometre or more apart before they were disturbed and had no contact for over a day.

On these occasions there seemed to be no preferential associations evident such as were exhibited by Bill and Ben who were always together, or by Robin and Pat and her white kid (Table 1), who although not apart from their herd were usually in close proximity unless the kid was playing with another kid in the group. The only other associations shown were those between the nannies and the yearlings and the nannies and kids.

iv) THE LATE SUMMER DISPERSION OF THE GOATS OF KIELDERHEAD MOOR.

iv) The Late Summer Dispersion of the Goats of Kielderhead Moor.

At the beginning of August the Forestry Commission began to erect a five strand high tension boundary fence along the ridge of Carter Fell along the Border which at this point follows the line of the high ground of Carter Fell. By the third week in August the fence was in position as far as a point on the north slope of the Grun. The fence was one metre high and its purpose was to keep sheep on their own hirsels and out of the plantations of trees.

The Chattlehope and Bateinghope herds maintained their summer range (Sec. iii.) until the 23rd August when the two herds were found on Limestone Knowe (Table 5). They were together as one herd and formed a much closer association than was the normal practice with either herd. The area of ground they were on was the flat ground above Grey Mare's Knowe and below the high point of Limestone Knowe just on the English side of the new boundary fence.

With the goats of Chattlehope and Bateinghope were 8 strange billies which had not previously been seen during the course of the study. They were fully mature animals with large spreads of horns. These billies were with the amalgamated herds but not of them. They were watched for five hours between 1430 and 1930 hours on the 23rd and in that time they spent four hours grazing as a group of animals along the boundary wire. The eight ruminated for almost an hour between 1600 and 1700 hours. Skull and Robin, the herd billies and George, who must now be considered a young billy, were with the nannies. Bill and Ben could not be found. Nancy was not with the herd but was looked for and found on the path home on her usual place not very far from the main body of the herd on the flow below and to the south of Limestone Knowe.

During the five hours of observations Robin cudded at the same time as the 8 strange billies. The only other animals to ruminate during the observation period were three nannies. Skull and George persistently walked through the herd sniffing at the genital area of the nannies. Most of the nannies just moved away rather more quickly than a normal grazing walk but occasionally a nanny would lower her hind quarters, lift her tail and urinate while both Skull and George would hold their noses to the stream of urine. Skull showed no irritation at the close proximity of George. During the whole period Skull kept his tail erect showing his unusually dark perineal skin. George held his tail in a position just below the horizontal, a common position for kids to carry their tails but not previously noticed in yearlings. Occasionally as a nanny walked away from the attentions of the two billies Skull would stand and stretch his neck at the same time lifting his upper lip and projecting it forward. The peregrination of Skull and George through the herd kept the nannies and kids continually on the move in a milling movement. In a normal period of observation one would have had to move one's position several times in a five hour stretch to keep the animals under observation for that time. This was not necessary on this occasion.

Neither Robin nor the 8 strange billies interacted with the nannies.

v) FOOD PREFERENCES EXHIBITED BY THE GOATS OF KIELDERHEAD MOOR.

v) Food Preferences Exhibited by the Goats of Kielderhead Moor.

Because of the mixed nature of the vegetation; there being few if any pure stands of a single species apart from the Sphagnum found growing in large blocks on some of the flows, it was often difficult to be sure what the goats were eating by direct observation (Sec. 2. vii). On some occasions in the winter billies were seen standing in very wet conditions apparently eating nothing but Sphagnum. On other occasions they seemed to feed exclusively on the tips of heather C. vulgarsis. On these occasions the herd of billies would cover a large area of ground fairly quickly walking at a fast pace between each bite. As the examination of feeding preferences was made to establish the amount, if any, of competition with sheep only one collection of faeces was made, from the Wool Meath herd of billies, throughout the winter as no sheep were up on the high moor and therefore no competition was taking place. This collection showed remains of Sphagnum and Calluna. No other pellets collected in the course of the study showed Sphagnum again.

The sheep, Scotch Blackface cross Swaledales are retained on the lower ground through the winter where they are fed hay to supplement their grazing. Lambing began in the last week of April and the greater part of it was over by the end of the first week of May. From this time the sheep began to feed higher and the hay supplement was stopped.

The sheep are in two hirsels called the Chattlehope and Bateinghope hirsels looked after by two shepherds. In the evening shepherds rake their animals to the higher ground. During the day the sheep feed towards the lower ground showing a preference for the grassier swards growing on the better drained slopes off the blanket peat which envelopes the high moor. Blackfaces are preferred on this type of ground because of their hardiness and their preference for feeding widely over the

ground and not collecting in knots of more than five or six (Fraser Darling 1937b) unlike lowland breeds which flock and feed together as a tight unit.

The sheep were not present on the high ground occupied by the goats, until after the completion of lambing. They were taken from the moor for the week which ended 12th May and were again removed from the moor at the end of June for clipping. The adverse weather made this a protracted labour and the sheep did not return until the middle of July. Fig. 5 shows the composition of the food of the goats and sheep present on the high moor during this period of the summer. The composition is expressed as a percentage of the occurrence of the plant material in the faecal pellet analysis. The tables of percentages of the relative occurrence of the plant material have been placed in the appendix.

It is not surprising that the sheep and goats eat the same plants as the moor is species poor. Until the beginning of July both species were eating similar proportions of Calluna. The amount of Cladonia in the goat pellets however suggests that they were biting more of the Calluna stem off, than the sheep as it is the lower parts of the heather stem on which the Cladonia grows. The sheep would appear to be eating the tips of the heather only as no Cladonia was found in any of the sheep samples analysed.

Because of the lateness of the spring it was the end of the first week in June before most plants were growing well. The results from the analysis of the sheep pellets reflect the greater choice available to them after this time. There was a considerable increase in their intake of Trichophorum after this time and a corresponding fall in the proportion of heather eaten. The goats at all times appeared to consume a larger proportion of Calluna than the sheep, but as the fresh growth

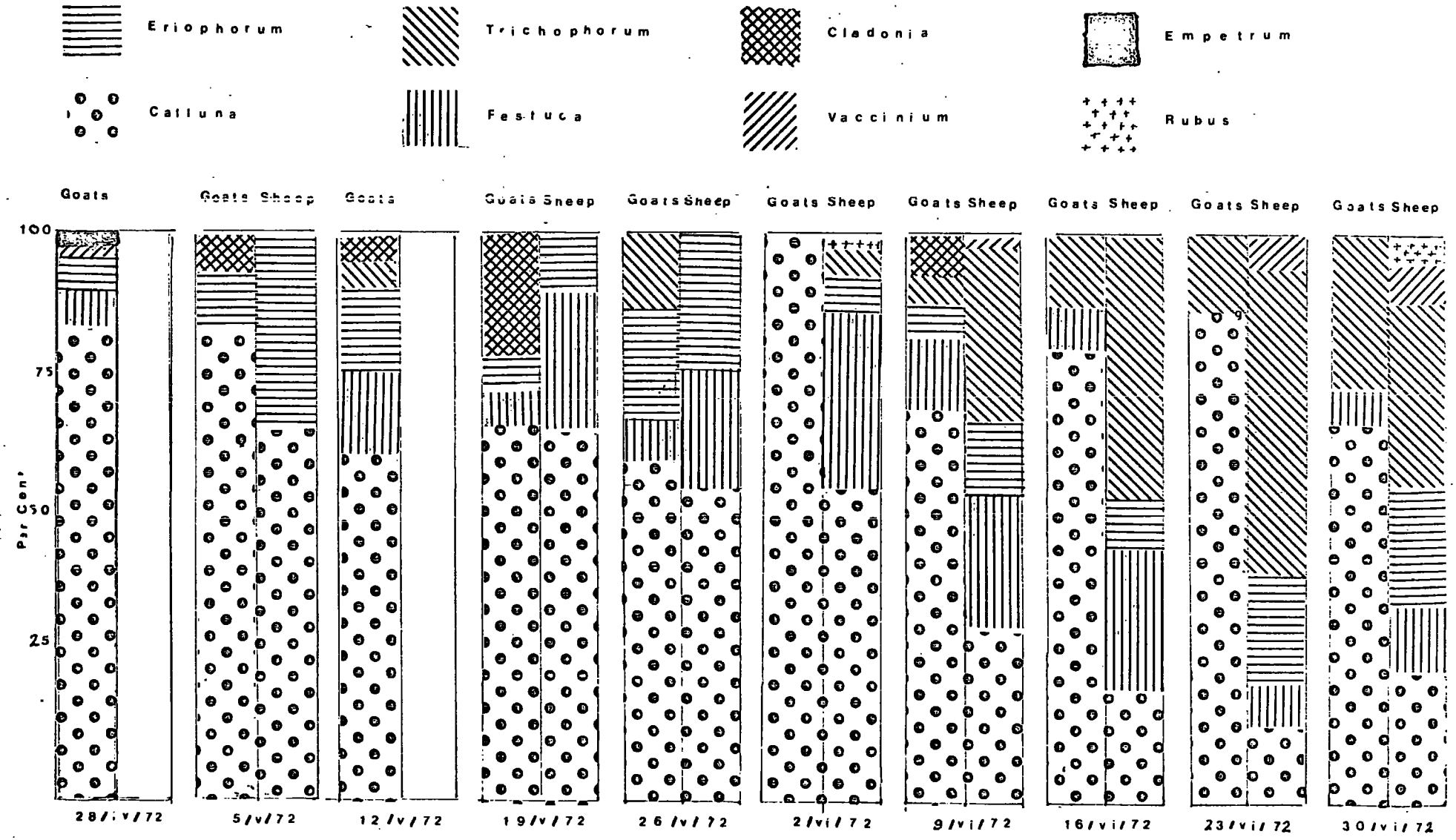
of Trichophorum became available they also ate a larger share of this plant. The sheep ate a constant proportion of Eriophorum whereas the proportion decreased in the goats until by the end of June they were apparently eating none at all. It is of interest that no Rubus chamaemorus appeared in either animal's diet until a small amount was recorded in sheep at the end of June, by which time its period of growth and flowering was over. Taylor (1971) states that flowering of this plant coincides with the lactation period of hill sheep and that these animals crop the flowers, which are beneficial because of their high nutrient content. Although reference material was made of Cloudberry flowers no evidence of their forming part of the diet of either sheep or goats at this flowering stage was found in this study.

χ^2 tests were applied to the raw data of the faecal pellet analysis and no significant differences were found between the sheep and goat results until the weekending 2nd June when $P < 0.01$. The results for the remaining weeks of 9th, 16th, 23rd and 30th June were highly significant, $P < 0.001$.

Fig. 5. Food Preferences Expressed as a Percentage of the Faecal Pellet Analysis.

The histogram represents the proportions of the food eaten by the goats and the sheep on Kielderhead Moor.

Fig. 5. Food Preferences Expressed as a Percentage of the Faecal Pellet Analysis.



vi) BEHAVIOUR

vi) Behaviour

From this study it would appear that feral goats are as shy and wary an any wild animal and their reactions to external stimuli just as sensitive. The goats have been found to have acute senses of sight, smell and hearing.

a) Sight

On many occasions it was found that goats would sight the observer at about 1 Km. distance. They would continue to feed or ruminate without however taking their eye off the approaching observer, and would allow the observer to approach within 300 metres without taking flight, but keeping the observer under constant surveillance. If the observer were lost to view for a moment they would show a certain agitation and try to reach a point from where the intruder could be seen. Approached a little closer they would wait until the observer dropped from sight again when they themselves would take the opportunity of disappearing. Fraser Darling (1937a) reports the same reactions.

If in the course of a stalk the goats are approached by the observer in the prone position and he is then seen the goats will approach closer to see what this strange creature is. This sense of curiosity would be their undoing if they were being poached. Pfeffer (1967) records the same sense of curiosity in mouflon.

Ovis ammon.

b) Smell

If one has successfully stalked goats and is lying concealed within a distance of 100 metres and the wind changes direction to blow towards the goats one may see them lift their heads, sniff the air and immediately take flight. This sudden smell of a human being causes more instant alarm than the sudden view of an approaching observer. If the wind is blowing strongly and noisily it is possible to approach to within two or three metres of an individual goat before it will become aware of one's presence when it will expel air sharply through the nostrils making a snorting, whistling call which appears to alarm the whole herd. Either this sound does not carry very far or it is only made when danger is very close as it is only heard in the course of such close stalks or when an animal is inadvertently discovered under a peat hagg before the observer is aware of its presence.

The goats themselves have a strong smell easily sensed by a human nose. The billies smell especially strongly.

On three occasions when observation was carried on until it was too dark to see the goats, they were continuing to feed until sight was lost of them. It is probable that the smell of vegetation plays some part in their continued feeding after dark. Ashby (1972) has reviewed the problems of sleeping and grazing in ruminants after dark.

The nanny while being suckled stands with her head turned to the kid sniffing its perineal region while at the same time the kid briskly waves its tail. It would seem from this that a sense of smell plays a part in the identification of her kid.

On no occasion were adults seen to sniff each other until 23 rd

August when Skull and George spent the whole observation period sniffing at the genital areas of the nannies (Sec. 3. iv.).

c) Hearing

Goats have a good sense of hearing. On many occasions while observing goats they were seen to become aware of the presence of a shepherd and his dogs on the moor before the observer had heard his calls or whistles to his dogs. These sounds always sent the goats into the nearest hagg and along its line until they were gone completely from that part of the moor. Their use of haggs as lines of escape often made it extremely difficult to see where they went.

The goats of Kielderhead Moor appeared able to discriminate dangerous sounds from non-dangerous sounds to which they had become habituated. On perhaps 10 occasions on every day aircraft of the R. A. F. would skim low over the moor travelling from North to South. The sudden roar of their jets almost invariably startled the observer without appearing to disturb the goats at all. Similarly Army helicopters from Otterburn often flew low over the moor without causing the least sign of apprehension, yet on the visit to Roan Fell a single helicopter flew over and caused an immediate stampede of the goats being watched at that moment. Not being so near the Army camp at Otterburn they are perhaps not so used to helicopters and they did not appear to be in the direct flight path of R. A. F. training flights as Kielderhead always appeared to be.

The distant booms and crumps from the Army range caused no concern neither did thunder directly overhead during a heavy storm in June yet the first crackle of firing from the grouse butts below the High Countess put to flight goats being watched at the head of the Bateinghope Burn. It is of interest in this respect that Riney and Caughley (1952) advocate the use of low powered rifles fitted with silencers to control the herds of goats in New Zealand so that the disturbance of the rest

of the herd can be kept at a minimum. They found shooting with high powered rifles caused the goat herds to become excessively wary.

d) Activity

The feral goat is a herbivore which spends the greater part of the day feeding, and in the intervals when it is not it is usually lying down ruminating. Some animals occasionally spend part of the ruminating period standing but it would spend at least some of the time lying down. Goats were not seen to sleep although on three occasions they were found to have moved very little during the period of total darkness.

Table 3. Numbers of animals ruminating in hourly periods in a) the Chattlehope and b) Bateinghope Herds.

a) Chattlehope	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
W.E. 28/iv/72	0	0	0	1	8	3	0	0	7	2	0	0	0	0
5/ v/72	0	0	0	3	8	2	1	0	10	5	1	0	0	0
12/v/72	0	0	0	2	16	3	2	0	7	14	2	1	0	0
19/v/72	0	0	0	1	10	9	0	0	6	7	3	0	0	0
26/v/72	0	0	0	5	16	4	0	0	13	10	5	0	0	0
2/vi/72	0	0	0	3	3	5	0	0	9	7	8	1	0	0
9/vi/72	0	0	0	4	4	5	0	0	10	6	6	0	0	0
16/vi/72	0	0	0	7	10	9	0	0	5	8	5	0	0	0
23/vi/72	0	0	0	16	10	7	0	0	6	11	12	0	0	0
30/vi/72	0	0	0	12	13	6	0	0	5	8	7	0	0	0
7/vii/72	0	0	0	10	14	2	0	0	6	6	6	0	0	0
14/vii/72	0	0	0	7	12	5	0	0	7	7	8	0	0	0

Table 3. continued

b) Bateinghope	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
W.E. 28/iv/72	0	0	0	3	3	1	1	1	2	0	0	0	0	0
5/ v/72	0	0	0	1	7	0	1	0	1	3	1	1	0	0
12/ v/72	0	0	0	2	3	5	0	2	3	7	0	2	0	0
19/ v/72	0	0	0	3	5	5	0	0	1	8	3	2	0	0
26/ v/72	0	0	0	5	1	2	1	1	5	7	2	1	0	0
2/vi/72	0	0	0	0	2	1	1	3	5	2	1	0	0	0
9/vi/72	0	0	0	3	2	2	1	1	4	5	3	1	0	0
16/vi/72	0	0	0	2	1	3	2	1	3	4	3	1	0	0
23/vi/72	0	0	0	3	4	3	1	1	4	5	2	1	0	0
30/vi/72	0	0	0	4	4	3	0	1	2	5	4	2	0	0
7/vii/72	0	0	0	5	5	6	0	0	1	7	6	3	0	0
14/vii/72	0	0	0	5	4	4	1	1	4	3	6	1	0	0

Table 3 indicates the total numbers of goats observed ruminating during hourly periods in any one week. The lower numbers for Bateinghope (Table 3b) do not necessarily mean that this herd spent less time cudding than Chattlehope. It was just more difficult to observe as many animals at one time with this herd even when they were up together in one group and not broken up. The convex nature of the shoulders of ground between the Bateinghope Burn, Cross Cleugh and Coomsdon Burn where the animals spent a considerable part of their time only gave the observer a severely circumscribed field of view.

No animals were ever seen ruminating in the morning before 1100 hours. However less time was spent with animals under observation in this morning period as it was often spent in searches for the goats which could not always be found easily. Again no animals were observed to ruminate between 2000 hours and the fall of darkness. All the animals which were observed in these two periods of early morning and late evening grazed steadily for the whole time.

The Chattlehope herd cudded in two periods, between 1100 and 1400 hours and between 1600 hours and 2000 hours. They often but not always spent the first ruminating period in the flow just below and to the NE of Wool Meath having spent the morning grazing and travelling in that direction. The later ruminating period would often be spent above the Spout. There is an increase in the numbers of Chattlehope goats cudding in the earlier 11-12 period in June (Table 3) which can perhaps be explained by the lengthening day and the earlier dawn at this time of year.

The Bateinghope herd cudded over a longer period and some animals could sometimes be seen cudding between 1400 and 1600 hours a period when only one animal from Chattlehope was observed ruminating. However the Bateinghope herd peak cudding times were similar to the Chattlehope's falling between 1100 and 1400 hours and between 1600 and 2000 hours. The

Bateinghope herd always wandered wider than the Chattlehope herd and showed less faithfulness to a favoured area to ruminate although probably larger numbers of goats were counted ruminating at the head of the Coomsdon Burn on the northern slope, which again faced NE as did the flow below Wool Meath, than any where else on the Bateinghope hirsel.

Greater numbers of goats were observed grazing than in any other activity. There is a difference in the way sheep graze and the way goats graze. Goats cover considerably more ground in a period of grazing than do sheep which feed steadily away at a patch of vegetation before moving slightly to graze another. Goats take one bite and then move a pace or two before taking another bite. This is particularly noticeable in the winter when the billy herds watched feeding used to move at a fast walk across the moor taking a bite here and there as they went. The nannies at this time did not move far but again they moved between bites. On those occasions (Sec. 3. vi. b.) when observations were carried on until it was too dark to see the goats they were continuing to feed until sight was lost of them. However on these occasions the animals were picked up at first light in the same spot where they had been left a few hours earlier which suggests they had not fed long but had rested and ruminated for the greater part of the dark hours. Whether they are able to rest all the hours of darkness during the winter is not known. It would seem unlikely that they would be able to eat sufficient food during the short day-light hours. Sheep make and follow paths in single file. No goats were ever seen following a path. They moved on a broad front.

Kielderhead Moor has no suitable plants for browsing except for the few birches in the cleugh leading to White Kielder. No animal was ever seen eating this although they were only observed to go there when they had been disturbed from the flow below Limestone Knowe. Goats at the College were observed to take a leaf or two from the hazel trees

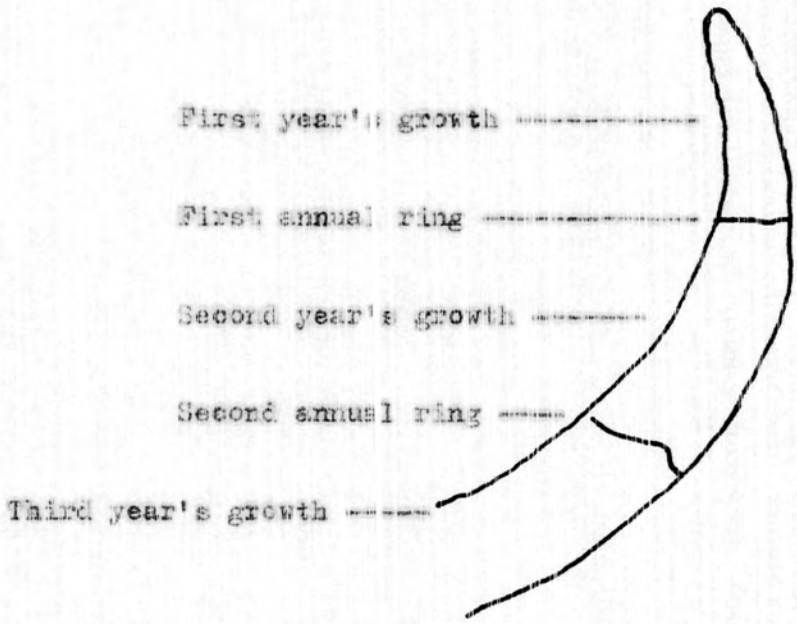
which they passed through on their way up hill from the College Burn after drinking.

Kielderhead Moor is a wet place. No goat would have to walk far to drink, and no particular drinking places were observed.

In spite of the fact that the goats are extremely shaggy and could be expected to carry many ectoparasites, little time seemed to be spent in grooming. The goats appeared to have no difficulty in reaching any part of their body to scratch. They scratched the forward part of their body with their hind hooves and the rear part with their horns (Fig. 6). Flies and midges were never a problem at any time during the summer, possibly because the weather was cool, wet and above all extremely windy. No Tabanids were seen on the moor during the course of the study.

Fig. 6. The Ageing of Feral Goats by an Examination of their Horn Rings.

The photograph shows a billy scratching its back with its horns. The two annual rings which indicate the animal is in its third year can be seen clearly.


First year's growth
First annual ring
Second year's growth
Second annual ring
Third year's growth

e) The Social Systems.

Zuckerman (1932) has suggested that sociality has its roots in the physiological and psychological processes of reproduction. This is an aspect of goat ecology on which Rudge (pers. comm.) is working in New Zealand where they breed throughout the year and there is, consequently, no clear distinction between male groups and female groups alternating with a defined rut, as there is on Kielderhead Moor.

From Christmas when the study started until the end of March when the kids are born the nannies remain solitary or in company with their kids of the previous season on the broken, rocky ground which surrounds the moor (Fig. 1.). It is to this type of ground that the summer herds go if they are persistently disturbed, here they bunch closely together and face round to the intruder. Dogs which have faced them before have to be encouraged to approach them again and the goats are perfectly capable of keeping them off with their horns.

Once the nannies have given birth to their kids they leave the small, sheltered area in which they have spent the winter and go up to the high moor. The basic structure of the herd is the maternal relationship between the nanny, her kid from the previous season and the new born kid. This is commonly seen in many herbivorous ungulates (Morton and Cheatum 1946, Fraser Darling 1950, Verheyen 1955, Burkhart 1958, Player and Feely 1960, Kiley - Worthington 1965, and Pfeffer 1967). This basic unit of the family group is the basis of the hefting system practised on hill pastures in this country which has its origin in the need of the lamb to follow its mother (Hunter 1964). This basic structure was maintained throughout the winter.

By the end of March two distinct female herds were present on Kielderhead Moor. Each herd had one adult male with it in addition to any yearling males which were present. This herd structure was retained

all through the summer until 23rd August when as described in Sec.3.iv both herds came together at the beginning of the period of the rut.

Male herds were maintained from the beginning of the study at Christmas all through the winter. There were two herds of five and six (Table 5). They maintained separate ranges (Fig. 3.) through the winter. Except for the two billies Robin and Skull, which remained with the female herds during the summer it is not known what happened to the male herds in the summer, as they disappeared from the moor after Easter. Two, Bill and Ben, returned later and spent the summer in a loose association with the Bateinghope female herd. They were often away for several days at a time and on one occasion Skull, the Bateinghope billy accompanied them during one of these journeys afield (Sec. 3. iii). On visits to Roan Fell a group of 2 mature males and 6 young males were seen away from the three female groups one of which had no billy with it (Table 8) and to the College two billies were seen away from the nannies (Table 9). It is thought that the group of females at the College was an assemblage of female herds as they were observed coming away from drinking together at the College Burn. The herd of mature billies (Sec. 3. iv) which appeared on Limestone Knowe on the 23rd August had not been observed before in the course of the study but there is no reason to doubt that they had been together all summer as those people who observe goats in the course of their daily activities such as foresters, shepherds and members of the hunt all speak of wandering billies, and, during the period of the rut of single, vagabond billies which they all refer to as having been "banished" from the herd. In my walk along the Border I was not fortunate enough to come across billies far away from the main herds (Fig. 2), but the herd at Bewcastle had no billy and none could be found although kids were present (Table 7).

From this information it seems that the social structure of the

goats of Kielderhead Moor could be represented as in Fig. 7.

The social tendency of the goats which results in a group cohesion and the formation of herds would appear to be expressed in an allelo-mimetic reaction, the imitative behaviour of a strong following reaction. If a goat walked purposefully away others were seen to lift their heads and follow. Only in case of alarm was any sound made. No contact was maintained by bleating, the way it is in sheep, except on those occasions when a kid lost its mother or a nanny was looking for her kid (Sec. 3. ii.). The social signal would appear to be that animals walking purposefully away lift their tails exposing the perineal skin, which in most animals was pink. In some cases defaecation took place during the first few steps. The imitative behaviour of the following animals would result in group synchrony. Group synchrony could be seen well in the numbers of animals ruminating at the same time (Table 3).

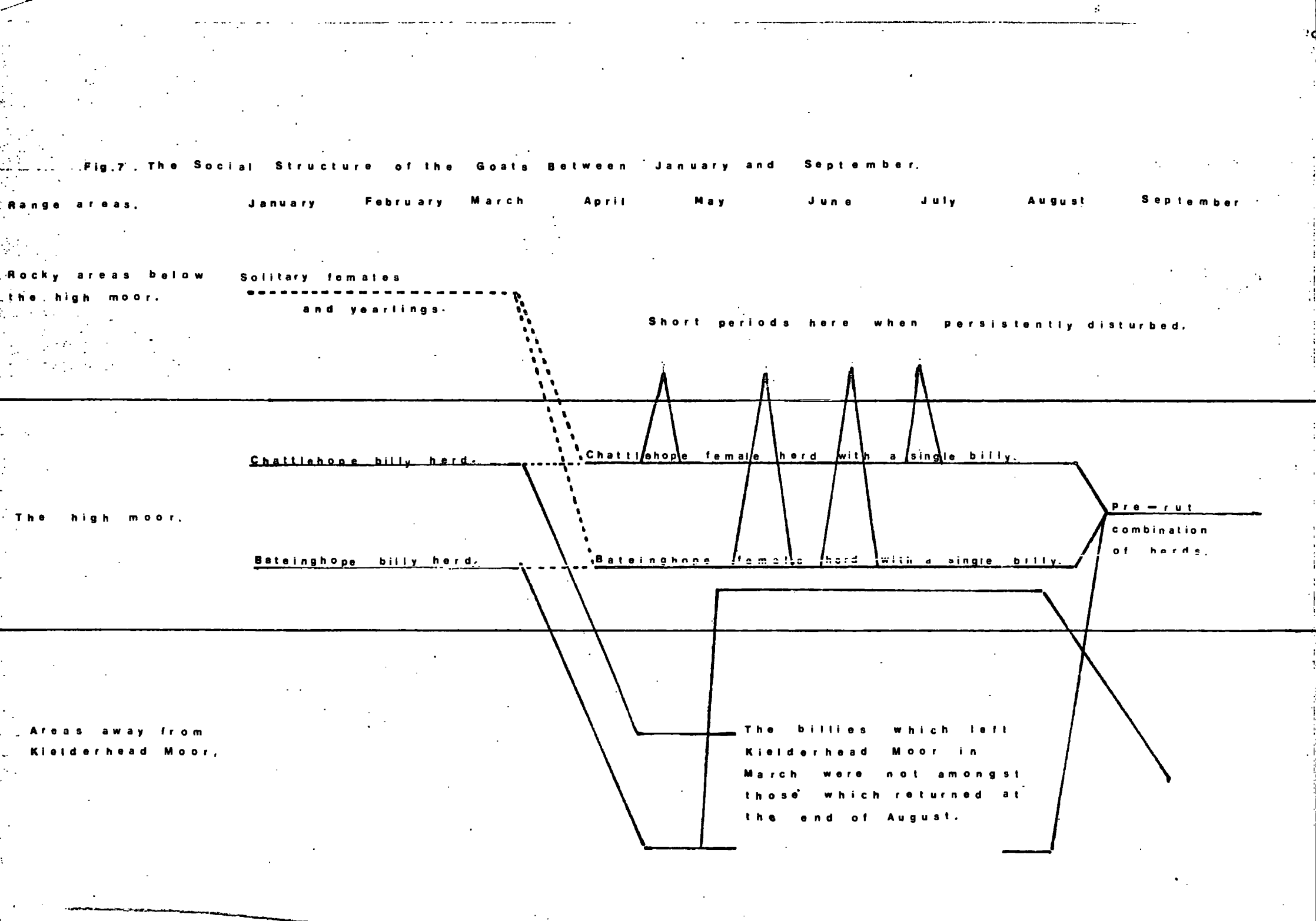
Scott and Stewart (1946) found no correlation between dominance and leadership in a study of a flock of goats and none was observed in this study. If when Bill and Ben were disturbed by the observer and in their hurry to escape Ben came too near Bill, Bill would turn and give Ben a severe blow in the ribs with his horns. This was never seen to be returned. Similarly some nannies would do this if in the general melee of an escape another animal crowded them. If a nanny were disturbed by the play of another nanny's kid she would lower her neck in threat at the offending kid which was always seen to desist from what it had been doing. Kids would play sometimes by rearing up and clashing their horns together for up to ten minutes at a time without either animal appearing to attempt to gain advantage of the other. During the winter when the billy herds were being searched for, conditions of visibility were usually bad and attention was often drawn to the herds by the considerable amount of time the young immature billies spent in rearing up and

clashing their horns together, again without appearing to attempt to gain an advantage over each other. No mature billies were ever seen to indulge in this head clashing although if when disturbed by the observer the herd rushed away and other animals crowded them they would stop and give the offending animal a blow in the ribs. It is possible that during these bouts of horn clashing both as kids and as immature billies a social heirarchy is established. No nannies were seen rearing and clashing horns although this of course does not mean that they never do it. Dominant animals were considered to be those animals which were seen to strike another in the ribs with their horns without the blow being returned. Leadership was not apparent in any animal except perhaps in Nancy who always led the rush to safety from below Limestone Knowe (Sec. 3. iii.). Fraser Darling (1937a) states that the billies lead the way and the nannies send their kids in front of them. This was not found to be the case in this study but the differences may be caused by the differences in the type of ground on which they were observed in the two studies.

Fig. 7. The Social Structure of the Goats Between January and September.

On Kielderhead Moor male herds are separate from the female herds until the pre rut period. Female herds form after the birth of the kids in March and are accompanied by a single herd billy.

Fig.7. The Social Structure of the Goats Between January and September.



vii) POPULATION

vii) Population.

Goats are present along the high ground of the Scottish Borders. (Fig. 2). Herds have been found at College Burn, Hindhope Law, Kielderhead Moor (the study area), Bewcastle Fell and Roan Fell. There are possibly other groups of animals on some of the other high hills of the area but they were not discovered during this study. Herds of billies may be found at any time anywhere along the Borders and solitary vagabond billies may be seen during the time of the rut. (Sec. 3. vi.e.) In the course of this short study the only strange herd of billies observed was the herd which joined the Kielderhead goats on the 23rd August.

Goats are also to be found along the high ground of the counties of Dumfries and Kirkudbright to the west but no attempt was made to locate and count any of these herds in the limited time available for this study.

Two distinct types of scenery are to be found along the high ground of the Borders; a) the rounded grassy knowes of the igneous complex found in the Cheviots on the Lower Old Red Sandstone and found on the intensely folded Hawick Rocks of the Silurian and b) the high, heather covered plateaux of the Carboniferous (Fig. 1). The College and Hindhope are grassy knowes on lavas. Roan Fell is a similar grassy knowe but on greywacke and shale. Bewcastle and the study area of Kielderhead Moor are of the second type, a high tableland of blanket peat overlying sandstones. There are obvious differences of nutritional levels in these areas. On the knowes of Roan Fell, Hindhope and the College the Cheviot sheep are reared whilst on the peat covered grounds the hardier and smaller cross Swaledale Scotch Blackfaces are preferred. The nannies in the herds on the grassy areas appear larger than the nannies from the peat covered areas. The nannies from Roan Fell, (Table 9), Hindhope

and the College observed in this study are taller, leggier and carry less hair than the small, shaggy females from Bewcastle and Kielderhead.

Table 4. The size of female goat herds in summer.

Chattlehope	11*		
Bateinghope	20*		
Bewcastle	10		
Roan Fell	19*	17*	6
College	26**		
Hindhope	14*	4	

* Female herds with a single billy present.

** It is possible that the group at the College were a combination of herds as they were observed going back uphill from drinking. Three billies were present.

There are no obvious differences in billies from any of the areas. Once the billies are mature animals they are all very similar in their size and the amount of hair they carry. On Roan Fell a number of twins were successfully reared this year. (Table 9). The College herd also has some twins (Table 10). Mr. G. Laing informs me that on Roan Fell some female kids come into season in their first October. If they become pregnant however he finds that they die during their first winter. (Domestic sheep come into season on the areas where the goats live in their first Autumn but these hoggets are normally prevented by their shepherds from breeding until they are in their second year.) In none of the other herds on the Borders do kids come into season in their first Autumn (T. Elliot, Hindhope and Mrs. G. Elliot, College pers. comm.). As the herds at the College and on Roan Fell are culled in some years their differences in levels of fecundity, fertility and age of recruitment to the breeding population are possibly not solely caused by the differences in nutritional levels on the moors and knowes.

Table 5. Population of Kielderhead Moor, January 1972.

	Chattlehope	Bateinghope	Totals
Mature males	1	2	3
Young males	4	4	8
Females	6	11	17
Yearlings	3	4	7
Totals	14	21	35

Table 6. Population of Kielderhead Moor, July 1972.

Mature males	1	3[a]	4
Young males	0	0	0
Females	5	8	13
Yearlings	2[c]	3[b]	5
Kids	3	6	9
Totals	11	20	31

a The additional mature male in the Bateinghope herd was not an animal from elsewhere. It was Ben (Table 1), one of the young males of this herd which could now be considered a fully mature Male.

b Two of the yearlings became identifiable as nannies. The third grew a tufty fringe on its forehead after the moult identifying it as a billy (George of Table 1).

c Identified as nannies.

Table 7. Population of Kielderhead Moor, late August 1972.

	Amalgamated herd on Limestone Knowe.	Solitary nanny above White Kielder	Totals
Mature males	10[a]	0	10
Young males	1	0	1
Females	16[b]	1[c]	17
Kids	9	0	9
Totals	36	1	37

a The total of ten mature males is composed of Robin and Skull, the two herd billies and eight strange billies. Bill and Ben had left the moor. (Table 1 and Sec. 3 iv.)

b The females' totals include two female yearlings from Chattlehope and two female yearlings from Bateinghope which are indistinguishable from the adult nannies at this stage.

c The single nanny is Nancy (Table 1 and Sec. 3 iv).

Table 8. Population of Bewcastle Fell, July 1972.

Mature males	0
Young males	0
Females	6
Yearlings	0[a]
Kids	4
Totals	10

These animals were in one group on Christianbury Crag.

a It is not known if any of the animals listed under females were yearlings.

No billies or other groups of animals were found.

Table 9. Population of Roan Fell, July 1972.

	Herd 1	Herd 2	Herd 3	Herd 4	Totals
Mature males	2	1	1	0	4
Young males[a]	6	0	0	0	6
Females[a]	0	7	6	2	15
Yearlings[a]	0	0	0	0	0
Kids	0	11	10	4	25
Totals	8	19	17	6	50

a Presumably some of the nannies and young males were yearlings but by July it is too difficult to be certain.

Table 10. Population of College Burn, July 1972.

Mature males	3
Young males	
Females	23
Yearlings	
Kids	
Totals	26

This herd proved impossible to count fully in the time available. The cover provided by the gorse Ulex europaeus L. along the banks of the burn, the hazel Corylus avellana L. on the lower slopes and the bracken Pteridium aquilinum (L.) Kuhn higher up made counts of kids totally unreliable.

Table 11. Population of Hindhope Law, July 1972.

	Herd 1	Herd 2	Totals
Mature males	4	0	4
Young males	0	0	0
Females	5	4	9
Yearlings[a]	1	0	1
Kids	4	0	4
Totals	14	4	18

a Yearlings are difficult to recognise in July, but one female kid was born to this herd in 1971, none in 1970 and three in 1969 (T. Elliot, pers. comm.) The mortality was not known.

Table 12. Weights of Goats caught on Roan Fell, 6 / vii / 72.

Nanny	51.8 Kg.	Nanny	45.4 Kg.
her two kids :-		her two kids:-	
male	17.7 Kg.	male	23.2 Kg.
female	15.4 Kg.	female	21.3 Kg.

The first nanny showed eight notches on her horns whilst the second showed six (Pino 1952). An examination of their teeth by Mr. G. Laing accustomed to ageing sheep by an examination of the eruption and wear of their teeth, suggested that this was a reasonable indication of their age. Their teeth were also compared with the teeth of domestic goats present on the farm. This second check also suggested that nine and seven was a reasonable indication of their ages. (Fig. 6.)

b) Mortality

Emigration and mortality are difficult to distinguish. It is difficult to ascribe the disappearance from a population of an animal as death unless the body is found. No dead adult animals were found during the study although the whole moor was crisscrossed countless times during the course of the study, both randomly and on fixed

compass lines in search and observation of the goats. The only corpses seen were on the 21st March 1972 of a stillborn kid and of the remains of an apparently fresh born kid being fed on by two ravens Corvus corax L on the broken ground below Oh Me Edge.

On the 1st May 1972 a careful all day search produced six kids in the Bateinghope herd. Demeter, the nanny which had been observed giving birth to the twins (Sec. 3 ii), one of which had been stillborn did not appear to have a kid and none of the kids was marked in the same way as the one which was seen born. She was never seen again with a kid. On the following day a similarly careful count was made of the Chattlehope herd. At the time they had four kids. One of these later disappeared. It is difficult to be certain of the date but it was definitely not there by the beginning of June. No traces of it were found.

The nanny which was absent from the Chattlehope herd (Tables 3 and 4) after the winter was not seen after 21st March 1972. She was well marked and distinctive. Named Jessie she was white with tan markings (a unique colour on this moor) and her right horn was several inches shorter than the left (Table 1). All through the winter she could be found on the Castle (Fig. 3).

Three nannies disappeared from the Bateinghope herd before the middle of May. It is difficult to be certain when they went, they were not distinctively marked and had not been individually distinguished.

Of the four billies present on Kielderhead Moor during the winter only four have been seen since 21st March 1972. But two of these Bill and Ben disappeared for a while, returning to the

Bateinghope herd on 18th May 1972 after an absence of nearly eight weeks. They would appear to have gone right away from the moor during this time. This pair occasionally wandered away from the herd throughout the rest of the summer for several days at a time and on one occasion were accompanied by Skull (the Bateinghope herd billy) for three days, the only occasion Skull was not with the nannies all summer, but on these occasions they could always be found over the top of Carter Fell or on the further northern slope of the Fell (Fig. 4 and Sec. 3. iii).

Two yearlings, one from each herd, disappeared at the same time. They were both young billies judging by the tufty fringe they were beginning to grow.

A report in the Evening Chronicle of 6th March 1972 suggested that goats were to be taken from certain unspecified Border herds and taken to Game Parks "in the interest of conservation". In the event it transpired that three were sent to Lowther Wildlife Park from the College Burn herd (Mrs. G. Elliot pers. comm.) of which two have survived, and one, a mature billy, was sent to Hindhope. It is still there and included in table 11. If one considers all disappearances from the population as deaths and assumes no further deaths in the autumn of 1972 one can express the population counts in tables 5 and 6 in terms of an adult goat's further expectation of life by the formula $\frac{2 - m}{2 \times m}$ where m = the proportion of adult annual mortality (Lack and Schifferli 1948, Lack 1954).

Table 13: The Adult Goat's Further Expectation of Life at Kielderhead Moor.

	Chatillehope	Bateinghope	Combined
Males	0.8 years	1.5 years	1.0 years
Females	5.5 years	3.1 years	3.7 years

It is by no means certain however that all disappearances from the population represent deaths. It would seem from the evidence of the appearance of the eight billies at the end of August, the return of Bill and Ben after an absence of eight weeks in the spring and their disappearance at the end of August, and the reports of wandering herds of billies from local people in a position to see them that it is perhaps unlikely that all the missing billies had died. The nannies are however much more likely to remain static. There have been no disappearances of nannies followed by reappearances and there are no reports of strange herds of nannies seen anywhere on the Border. For these reasons the estimates of further expectation of life in table 13 would seem reasonable for the females but be an underestimate for the males.

c) Fecundity, Fertility and Recruitment.

In the study of population dynamics it is useful to distinguish fecundity, fertility and recruitment to the adult breeding population.

Fecundity may be considered as egg production, or in mammals as the production of fertilised ova. Without sacrificing the nannies after the rut this is an impossible statistic to achieve directly. Although some ova may be lost after fertilisation and implantation an indirect attempt to estimate this figure may be made by a visual examination of the nannies in winter for pregnancy. (Although shaggy animals, nannies which are not pregnant have a hollow appearance along the spine between the ribs and the pelvis. Pregnant nannies appear

swollen in this position by January. By February pregnant animals appear swollen sided, often unevenly, when viewed from the rear as the animal moves away from the observer.) Where, as at Kielder twins are rare, this gives an estimate of the number of kids born to the nannies. From this their natality rate may be calculated which, although not the same thing as there is the possibility of abortion during pregnancy, gives an indication of their possible rate of increase.

Of the three nannies present at Chattlehope throughout the winter three had yearlings with them. The other three could have lost their 1971 kids or not had one that year. Only one, Jessie, did not look pregnant throughout the winter. Her ragged horn gave her an appearance of being old but she was an extremely wary beast and always managed to frustrate attempts to get close enough to age her by counting her horn notches. It may be assumed that she was post reproductive. From these six nannies five kids were born, the one whose remains were eaten by the ravens and the four counted on 2nd May 1972. The Chattlehope group therefore had a natality rate per individual nanny of 0.83.

Of the eleven nannies present at Bateinghope throughout the winter four had yearlings with them and appeared pregnant. Of the rest only Nancy, the very large grey nanny which was always found to the east of and below Limestone Knowe, did not look to be in kid. The rest appeared to be pregnant. The remaining ten nannies could be expected to have eleven kids (including the nanny Demeter which gave birth to the twins). Three of these nannies disappeared before they were found with kids, leaving seven animals which had eight kids (the six counted on 1st May 1972 and the twins). The Bateinghope group therefore had a natality rate per unit time per individual nanny of 0.73. The combined Kielderhead Moor herd of 17 nannies could have been expected to have 16 kids. In the event they had

13 kids, an observed natality rate of 0.76.

Fertility may be considered as the number of viable young successfully produced. In mammals there may be a heavy infant mortality soon after birth. In this study the number of viable young produced is considered as the number of kids still alive at three months, the age when suckling in daylight stopped. The fertility rate / year / individual nanny at Chattlehope where three of the five kids from six nannies survived was 0.5 and at Bateinghope where six of the eight kids from 11 nannies survived was 0.54. From the combined herd of 17 nannies which gave birth to thirteen kids nine kids survived to this age, a fertility rate of 0.53.

Recruitment is the additional increment to the breeding population. This includes an element of immigration and emigration, the extent of which is becoming apparent on Kielderhead Moor with the influx of eight strange billies and the disappearance of the winter billy herds and the two billies (Sec. 3. iv and Table 7.). There is probably a sexual disparity in the age at which the sexes are recruited to the breeding population which could not be discovered until the full rut, which occurs after this study is ended. In September young nannies of eighteen months are indistinguishable from adult nannies and it is to be expected they will enter the breeding population at this rut. Young billies are identifiable until about the fourth year to judge by the notches on the horns. They are no doubt mature sexually well before this age but whether they are able to enter the breeding population will not be known until the rut. Skull ignored the presence of George when he was investigating females on 23rd August. Whether he would if a female had been found to be receptive is not yet known. Reports of foresters and shepherds suggest that herd billies banish other billies from the herd at the rut. If this is so young billies are unlikely to enter the breeding population before they are fully

mature animals. This cannot be ascertained until a rutting season has been watched. However for the purposes of this study recruits to the breeding population will be considered to be the yearlings born in 1971 and still alive and present in the herd at the end of the field work in September 1972. Immigration and emigration will not be considered.

Five yearlings of the 1971 cohort were still present on the moor at the end of the study. If 17 females was the total number of nannies present in the herd in 1971 the recruitment rate / year / individual nanny was 0.33 on Chattlehope, 0.27 on Bateinghope and 0.29 on the whole moor. Of these five yearlings four were nannies and one a billy.

Table 14. The Fecundity (estimated), Natality, Fertility, and Recruitment to the Adult Breeding Population on Kielderhead Moor, 1972.

	Chattlehope	Bateinghope	Combined
Fecundity	0.83	1.00	0.94
Natality	0.83	0.73	0.76
Fertility	0.50	0.54	0.53
Recruitment	0.33	0.27	0.29

The statistics for the other herds along the Borders are unknown but the figures from Roan Fell are good enough to allow the fertility rate to be derived. There were 25 kids alive in July from 15 nannies (presuming no loss of nannies from the number present at the beginning of winter. No cull had taken place that winter, G. Laing pers. comm.) which gave a fertility rate of 1.67. For Hindhope they allow the fertility rate of 0.11 and the recruitment rate of 0.11 to be calculated.

4. DISCUSSION

4. Discussion

Goats have been present on the hills of Britain for so long that they must have survived there even when wolves Canis lupus L. were present in this country and it is of interest that Mech (1970) speaking of goats and bighorn sheep says " they are apparently better equipped to escape the wolves than the forest game species." Crook (1969) reports the goats of Snowdonia returning to higher ground when they are disturbed. There, the broken, rocky ground is at a higher altitude than the feeding areas. On Kielderhead Moor the reverse is true and it would seem that it is this broken, rocky nature of the ground which is important in the defensive situation. This is a possible explanation for the preference shown by the nanny goats for such ground during the winter when they are pregnant and therefore more than usually vulnerable to any possible predator. An explanation is necessary to explain why they limit their feeding range to such a circumscribed area during the worst time of year climatologically. Even in such a rocky area as Black Clough or the head of the Bateinghope Burn the two or three nannies present there (Fig. 3) would bunch up and present a united front to any disturbance.

The habit of leaving the kid in a hiding place (Sec. 3. ii) for considerable periods after the first three or four days of life seems at first of doubtful survival value but it can perhaps be best explained by the necessity for the nanny to build up her resources after the long winter. In the first few days of the kid's life when it is suckled frequently (Sec. 3. ii.) the nanny does not move far but once the suckling periods are more broadly spaced it is advantageous for the nanny to be able to range widely and as long as there is an adequate and safe hiding place for the kid it is better resting between feeds than trotting long distances after its mother. The ewe's different method of grazing (Sec. 3. vi. d.) whereby she only moves a short

distance makes it unnecessary for her to hide her lamb. The common predator of the moor is the fox Vulpes vulpes L. The Forestry Commission employs rangers among whose duties are the control of foxes. On Kielderhead Moor and in the forest below 40 foxes are killed in most years (T. Bishopson pers. comm.). During the summer a pair of foxes were often seen between the High Countess and the Girdle. They successfully reared a litter of cubs. It is not known how much damage, if any, foxes do to goats. No goat or sheep remains were seen in the prey remains which collected outside their earth. During kidding and while the kid was two or three days old it would seem possible that foxes could be a danger, but it is in this period of the first few days of its life that the kid stays with its mother.

There is a similarity about the size of the female herds, especially if the College figure is ignored, for the reason stated in Table 4, which suggests there is an optimum size to a herd. All the smaller herds are without a herd billy, which suggests that the smaller herds composed of nannies and kids have budded off from a parent herd as numbers have increased with the arrival of the new kids. The majority of the summer female herds were larger than the two winter billy herds which is perhaps an indication of the better feeding available during the summer months. The differences in behaviour observed between the herds of Chattlehope and Bateinghope (Sec. 3. iii.) could be explained by the nature of the ground on which they ranged. The Chattlehope herd were usually in a saucer of ground where it was easy for each animal to keep each other in sight. This herd never splintered into smaller groups and usually they were seen to ruminate together. The Bateinghope herd ranged over ground which was cut into shoulders by the dissection of the burns and cleughs. Vision was often circumscribed and this herd often splintered and animals were to be seen cudding on their own. It is suggested that the size of herds of animals of either sex is a function of the availability of

food and the nature of the ground as it affects the distance over which the animals can see each other.

Wynne - Edwards (1962) suggests that grouping is epideictic behaviour, important in population regulation and this is a possible explanation of the amalgamation of the herds on Limestone Knowe into a herd of 37 (Table 5), a herd much larger than any other seen along the Borders, at the end of August and before the actual rut begins. This large grouping could be expected to make severe inroads on the grazing available on a limited area. It is of interest that this large assembly took place on the one part of the Bateinghope hirsel which allows an extended view in all directions. The saucer between the Spout, the Girdle and Wool Meath would have offered an area of ground with a similar field of view but it is possible that the smaller Chattlehope herd was attracted to the larger herd. The saucer above the Spout had also been more extensively grazed during the course of the summer (Fig. 4). The area of Limestone Knowe had been little used all through the summer (Fig. 4).

From fig. 7 it can be seen that the billies which left Kielderhead Moor at the end of the winter were not the same animals which joined the amalgamated herd at the end of the summer. Incursions of unknown billies have been reported from Snowdonia in intensively watched herds (Milner et al, 1968). The two Bateinghope billies Bill and Ben have also left the moor by the end of summer. There would seem to be considerable genetic potential in a system, where, although the nannies remained faithful to a range, (familiarity would give them an advantage over any predator), strange billies came in at the time of the rut. It is of interest that billies from any of the herds observed on the Borders (Fig. 2) are remarkably alike in size and conformation whereas it would be possible to state which herd most nannies came from as their appearance varies considerably from one area to the next

suggesting that they reflect the differences in the environment between one area and another (Sec. 3. vii.). For example the nannies of Kielderhead Moor are smaller and shaggier than the nannies of any other area. Fraser Darling (1937 a) remarks on how quickly domestic goats revert to the wild form of their area, but Geist (1960) found that the feral state had no apparent effect on the physical type and body size of goats in British Columbia. It will be interesting to see in a few generations time the descendants of the wild goats placed in the comparatively lush environment of Game Parks if there are no further importations. In a study of home range behaviour in hill sheep Hunter (1964) found that rams always mated at random among the various hefts of ewes, yet found that there were consistent differences in the performances of lambs born on the different hefts which if genetically determined could not be from the male parentage and which persisted even when replacement ewes were chosen from only the lambs which performed best.

The advent of the strange billies on 23rd August would seem to indicate the possibility at least that the herds along the Borders are an open system with male animals moving from one part of the Border to another. In a walk along the Border there was much wire but it was in a derelict condition and would cause no hindrance to the free movement of a goat. However Forestry Commission fences are not derelict and while most of them are only a metre high on this part of the Border, a height which goats have been seen to clear (Sec. 2. iii), at least if sufficiently pressed, one can only view with alarm any further proliferation of wire along the high ground of the Borders as it could be expected to interfere with the free movement of these animals. Greig (1969) however states specifically, and publishes a photograph in support of his contention, that even a low fence will retain a goat. This is not the opinion of the farmers and shepherds I have spoken to in the course of this study. On the other hand the

wire surrounding the farm of Hindhope Law on which the Hindhope goats are to be found is in good condition and about a metre and a half high. This would seem to be too high for goats to clear and Mr. T. Elliot, the farmer, considers that the goats are restricted to the area of his farm by this wire and that it is impossible for any other goat to get in. For this reason he imported a new billy this year from his cousin Mr. G. Elliot who farms the College. This billy is included in the total in table 11.

This herd on Hindhope has the very low recruitment rate of 0.11 which is apparently sufficient for it to maintain its numbers (T.Elliot pers. comm.). The goats of Kielderhead Moor appear to be maintaining their numbers. They were reported to be about 25 in 1967 (J. Lockie pers. comm.) and 23 in 1969 (Greig 1969). It is not known if these are winter, summer or rutting figures as from this study there would appear to be possible differences at these times of year. However it seems certain that with a recruitment rate of 0.29 per individual nanny per year they are maintaining their numbers and possibly even increasing. After the severe winter of 1962 - 1963 the Kielderhead Moor population was reduced to 9 animals (T. Bishopson pers. comm.), a position from which it has recovered.

The herds on Roan Fell and the College are both culled in some years. Unfortunately the recruitment rate to these herds is unknown but Roan Fell has the very high fertility rate of 1.67, three times as high as it is on Kielderhead Moor and some of the female kids show the interesting phenomenon of coming into season twelve months earlier than the females in any of the other herds.

Goats can be troublesome to a farmer. An individual was shot by a shepherd for persistently breaking a stone dyke (T. Elliot pers. comm.).

At the College the only source of water on all this naturally well drained estate is the College Burn. Here the goats are difficult to keep out of the lower fields, which are retained for hay during the summer, on the goats' passage to and from the water. They have also proved difficult to keep out of a new forestry plantation on the estate. It is only on this estate where the goats are forced to come low enough to clash with the farmer's natural interests, by the shortage of water higher on the hills that this problem arises in such an acute form. It is for this reason that the goats are culled in some years to keep their numbers at about 30 (Mrs. G. Elliot pers. comm.). They are not considered a problem on Roan Fell but are cropped as a source of food in some years for the hounds kept at Twizlehope (G. Laing pers. comm.). On neither farm are they culled in every year.

Although the sheep of the Chattlehope and Bateinghope hirsels are not on the moor during the winter and it could be said that there is therefore no competition between the sheep and the goats, the goat must obviously be eating food during the winter, which if not eaten, would have been available to the sheep in the spring when they came up on to the high moor. In the early part of the summer the sheep and goats are eating very similar proportions of the plants present on the moor. Later on in the season there is a divergence with the sheep eating less Calluna while the goats eat less Eriophorum but as the Trichophorum becomes available both animals include this plant in their diet. However it is the spring which is commonly the critical period in a pastoral regime in climates such as are customary on hill grazing in this country. It is then that the shepherd is looking for the early bite. The winter of 1971 - 1972 was not severe. If it had been it is doubtful if the lower pastures would have stood up so well to the long period of the winter under the constant grazing pressure of all the sheep even with the supplemantary feeding the sheep received. The fact that there is little apparent clash with the shepherding interests on Kielderhead

Moor is because of the light stocking rate which Mr. W. Hedley the farmer practices. This would seem to be the case on all the Border farms, visited in the course of this study, where there seems to be a tradition of good shepherding with a careful husbanding of the grazing. It is probable that stocking rates have evolved over a long period of time to suit the severe winter conditions common along the high ground of the Borders.

From this it would seem that the goats are still present on the high hills of the Borders because the farmers are favourably disposed towards them. It is this fact which bodes well for their continued success in a part of Britain which they have occupied for so long.

5. CONCLUSION.

5. Conclusion.

Many mammals live in dense cover and are so hidden that they are difficult to observe. Some are so swift that they present almost insuperable difficulties in keeping them under any prolonged observation. The feral goat would seem to be an ideal animal for further study in a habitat which it has occupied for so long, and to which it has become ecologically so well adapted.

In a further study of the goats it would be interesting to establish the degree of interchange in the herds along the Borders. It would be essential to capture and mark, probably with ear tags, animals from all the herds. If coloured tags were used one colour could be allocated to each herd enabling an observer to recognise in the field the area from which an animal had originated. Goats from the College, Roan Fell, and Hindhope would be comparatively easily rounded up but the beasts from Kielderhead Moor and the Bewcastle Fell animals on Christianbury Crag would present difficulties which it would be essential to overcome. It is possible that deer nets could be used to trap the animals and prevent them getting on to rocks where it is impossible to deal with them. As feral goats show annual marks on their horns, it would be possible to construct life tables for the various herds. More study of the problems posed by fences to the free movement of the animals would be necessary than the limited time available for this study allowed.

There seem to be considerable differences in fertility in different herds. It would be interesting to discover in what way, if any, culling affects the recruitment rate to each herd. With two herds out of five being culled an experimental approach to the problem would be possible with the cooperation of Mr. G. Elliot and Mr. G. Laing.

The physical differences in the nannies suggest problems of

nutrition in these animals which would repay further study.

The further elucidation of the social structure and behaviour of these animals would be considerably eased if all animals could be satisfactorily marked and watched over a longer period of time. From this short study one can see how well adapted their behaviour is ecologically. It would be worthwhile in a further study to look for differences, if any, in the behaviour of the herds living in different areas and in different habitats.

6. SUMMARY.

6. Summary.

1. Nannies remain solitary, or in the company of their yearlings through the winter. After the birth of their kids in March two female herds are formed. Two male herds present during the winter leave at Easter except for a single billy from each which remains as a herd billy with each of the two female herds. Two other billies return later in the summer and maintain a loose association with one of the female herds. The two female herds maintain separate ranges until the end of August when they combine into one large herd. A strange herd of billies joined the combined herd at this time in a pre - rut assembly.

2. The observed winter and summer dispersion of the females are described.

3. The population of feral goats on Kielderhead Moor is described. The population is maintained with a recruitment rate of 0.29 / nanny / year. Females have a further expectation of life of 3.7 years.

4. The population of herds present at the College, Hindhope, Bewcastle Fell and Roan Fell are described.

5. The behaviour of the goats is described.

6. An investigation of the food consumption of the goats and sheep present on the moor suggests that the main competition between these animals is concentrated in the spring and early summer at a time when it is sometimes most important for a farmer to find the early bite for his sheep.

7. The continued presence of the goats on the high ground along the Borders would seem to depend on the fact that the farmers are favourably disposed towards them. The possible proliferation of wire

along the Borders could interfere with the free movement these animals enjoy at the present and could present a threat to their continued wellbeing.

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9. APPENDIX.

Table 15. Food Preferences Expressed as a Percentage of the Faecal Pellet Analysis. Goats (Combined figures Chattlehope and Bateinghope.)

Weeks ending	Calluna	Empetrum	Vaccinium	Festuca	Eriophorum	Trichophorum	Rubus	Cladonia
28 / iv / 72	84	2	2	7	5			
5 / v / 72	83				10			7
12 / v / 72	61			14	15	5		5
19 / v / 72	67			6	6			20
26 / v / 72	60			7	20	13		
2 /vi / 72	100							
9 /vi / 72	70			12	6	5		7
16 /vi / 72	80			7		13		
23 /vi / 72	87					13		
30 /vi / 72	67			6		17		