The Feeding Ecology of the Fallow Deer (*Dama dama* L.) in the New Forest

by

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ABSTRACT

FACULTY OF SCIENCE

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FEEDING ECOLOGY OF FALLOW DEER (DAMA DAMA L.)

IN THE NEW FOREST

by John Edward Jackson.

Annual, seasonal and local variations in the diet of fallow deer in the New Forest were determined from November 1970 - March 1973 by analysing rumen contents from 325 dead animals. From April 1971 - October 1972 the feeding habits of 1,551 free-living individuals were studied to determine their diet, feeding preferences, habitat utlisation and behaviour. Faecal pellet group counts were also carried out to show seasonal changes in habitat preference.

Vegetation surveys were performed in order to determine the relative availabilities of different foods which were then related to the observed diet so that feeding preferences could be established. A survey of browsing pressures on woody species of plant was also conducted.

Size, skeletal size, body weights and physical conditions of adult females and of fawns were determined from culled specimens during the three winters (November - February) of the study period and were related to diet. An abundance of acorns and mast in the autumn resulted in increased body weights and fat deposits.

Feeding activity, behaviour and factors affecting ~~it~~ them were investigated. Fallow were found to feed at intervals throughout the day, especially during the winter months. Seasonal changes in herd size, types and areas frequented are discussed. Of the various disturbance factors investigated, day visitors and campers were found to have the most detrimental effect on feeding ecology. Relationships between fallow and other large herbivores in the New Forest are outlined.

Future trends in the New Forest and their possible effects on fallow deer feeding ecology are discussed. Methods of habitat improvements are suggested.

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Chapter 1. INTRODUCTION.

Knowledge of the biology of Cervidae has reached an advanced stage in North America, New Zealand and continental Europe. Numerous scientific papers and general descriptive accounts have been published in Canada and the United States in periodicals such as the Journal of Range Ecology and the Journal of Wildlife Management but the species encountered there differ from those found in Europe. In New Zealand, certain species of deer occur which were originally introduced from Europe. However because the general ecology of the two situations differ markedly interpretation of data from there to Europe is often of limited relevance. Although it is not felt appropriate to include here reviews of the literature on work in North America or New Zealand, methods employed on deer research in these places have been used extensively in the present study and full references are given in the text where appropriate.

Considerable research has been carried out on Cervidae in continental Europe, principally on the red deer (*Cervus elaphus* L.) and roe deer (*Capreolus capreolus* L.) which are the two most numerous and widely occurring species. They also assume considerable economic importance in hunting and forestry. The other species found, namely reindeer (*Rangifer tarandùs* L.), elk (*Alces alces* L.), sika (*Cervus nippon* Temminck), fallow (*Dama dama* L.), muntjac (*Muntiacus muntjak* Zimmerman), chinese water (*Hydropotes inermis* Swinhoe) and white-tailed deer (*Odocoileus virginianus* Zimmerman) have also been studied to varying degrees but in less detail. Of these, the distribution of the last three species, which have resulted from recent introductions and escapes, is very limited in Europe at present (van den Brink 1967).

Scientific research on red deer has been done throughout most of Scandinavia and northern Europe and many aspects of their biology and management have been investigated. Feeding habits and nutrition have been studied, for example Ahlen (1965) in Scandinavia, Baicher (1969) in Bulgaria, Baskin (1965) in Russia, Bubenik & Casnocha (1963) in Czechoslovakia, Dzieciolowski (1967a,b, 1970b,c,d) in Poland, Hegg (1961) in Switzerland and Rijcken (1965), Eygenraam & Pieters (1966), Jensen (1968), Prins (1968), Prins & Geelen (1968), and van de Veen (1973) in the Netherlands.

The smaller roe deer has also been studied extensively and works on food, feeding and nutrition include those by Hegg (1961), Juon (1963), Dragoev (1964), Brüggeman, Giescke & Kärst (1965), Klötzi (1965), Kolev (1966), Siuda, Zurowski & Siuda (1969) and Klein & Strandgaard (1972).

Fallow deer have been studied principally in Germany, often in relation to forestry, hunting and management (Ueckermann 1956, 64; Ueckermann & Hansen 1968) although Heidemann (1971) studied their territories and behaviour.

In Great Britain, scientific work on deer has only been initiated in the last fifteen years. Red deer have and are being studied principally in Scotland, notably by the Nature Conservancy on the Isle of Rhum and in Glenfeshie, and by Edinburgh University in South Ross, although work is also being done in Western Eire. Aspects investigated include food and feeding habits (Charles & McCowan 1967; Charles, McCowan & East, in prep.; Staines 1970, in prep.; Colquhoun 1971; Miles 1971), reproduction (Lincoln, Youngson & Short 1970; Lincoln 1971; Mitchell & Lincoln 1973), condition (Mitchell 1971), winter mortality (Anderson 1972), effects on regeneration of vegetation (Holloway 1967; Miller 1971), population dynamics (Lowe 1969) and ageing (Mitchell 1967; Lowe 1967).

Roe deer biology has also been worked on by various authors. Diet has been studied by Cumming (1966), Robertson (1967) & Hosey (pers.comm.), territory and behaviour by Gibson & MacArthur (1965), Robertson (1967), Davies & Davies (1968) & Bramley (1970), reproduction by Short & Hay (1965), Short & Mann (1965), Chaplin, Chapman & Prior (1966) & Chapman & Chapman (1971), diseases and parasites by Dunn (1967) & McDiarmid (1968), supernumerary teeth by Chaplin & Atkinson (1968), damage to forestry by Thomsom (1966) and general biology by Prior (1968), Delap (1970) & Chard (1970).

Sika deer have been studied in detail in the Poole Basin by Horwood (1966,71) and Horwood & Masters (1970), and muntjac in the Home Counties by Dansie (1970).

The genus Dama contains two species; the common fallow deer, Dama dama L., and the Persian fallow deer, Dama mesopotamica Brooke, the latter species being nearly extinct. The common fallow deer has been widely introduced into many parts of the world and is now found in all continents except Asia (Uloth 1971; Dansie & Wince, 1971) but is believed to have originated from areas of Europe bordering the Mediterranean and from Asia Minor.

This species of deer is widely distributed in the British Isles having been recorded in all English counties, half of those in Scotland, seven in Wales and in all but five Irish Counties (Whitehead 1964; Cadman 1966; Chapman & Chapman 1970). The majority of present herds are formed from descendants of park animals which have escaped and turned feral but stocks of ancient origin still exist in Epping, Savernake, Rockingham and the New Forests.

In recent years much basic information has been gathered in Great Britain on various aspects of fallow deer biology. Studies have included those on dental characteristics, abnormalities and eruption patterns (Chapman & Chapman 1969,70a,73), reproduction (Armstrong, Chaplin, Chapman & Smith 1969; Chapman & Chapman 1970b), skin structure

(Jenkinson 1972), haemoglobin types (Maughan & Williams 1967) and parasites & diseases (Thompson 1967; Batty & Chapman 1970). Little is known of the feeding ecology of fallow deer in the British Isles and descriptions of the diet are limited to brief accounts in general works, few of which enter into any detail and even fewer are based on systematic scientific studies.

A thorough knowledge of the feeding habits of a particular species of deer in different situations is fundamental if its biology is to be fully understood and used in its management. An adequate food supply is essential if deer are to survive in a given habitat but the quality and quantity of the available foods there should also be considered as these are known to affect the animals' body weight, condition, skeletal size, growth rate, reproductive potential, antler size and the winter mortality (Einarsen 1946; McEwan, French, Magruder, Swift & Ingram 1957; Adams 1960; Ransom 1967; Segelquist, Ward & Leonard 1969; Mitchell 1971; Klein & Strandgaard 1972; Reimers 1972). An understanding of the feeding habits is also essential when considering optimum stocking rates, improvement of deer habitat and the causes and methods of prevention of damage to forestry, agricultural and horticultural concerns.

The present research programme was initiated to provide basic information on the food and feeding habits of this species of deer in an area of multiple land use, namely the New Forest.

Chapter 2. THE NEW FOREST.

2.1. General Description.

2.1.1. Introduction.

It is generally believed that the New Forest was first designated as a royal hunting forest by William the Conqueror sometime between 1066 and 1086 (Fitzgerald 1966; Tubbs 1968; Conservation of the New Forest 1970). From then until the late seventeenth century it was used primarily for the preservation and pursuit of deer after which timber became increasingly important economically and considerable areas were enclosed for forestry purposes under the provision of Acts of Parliament of 1698, 1808, 1851, 1877 and 1949.

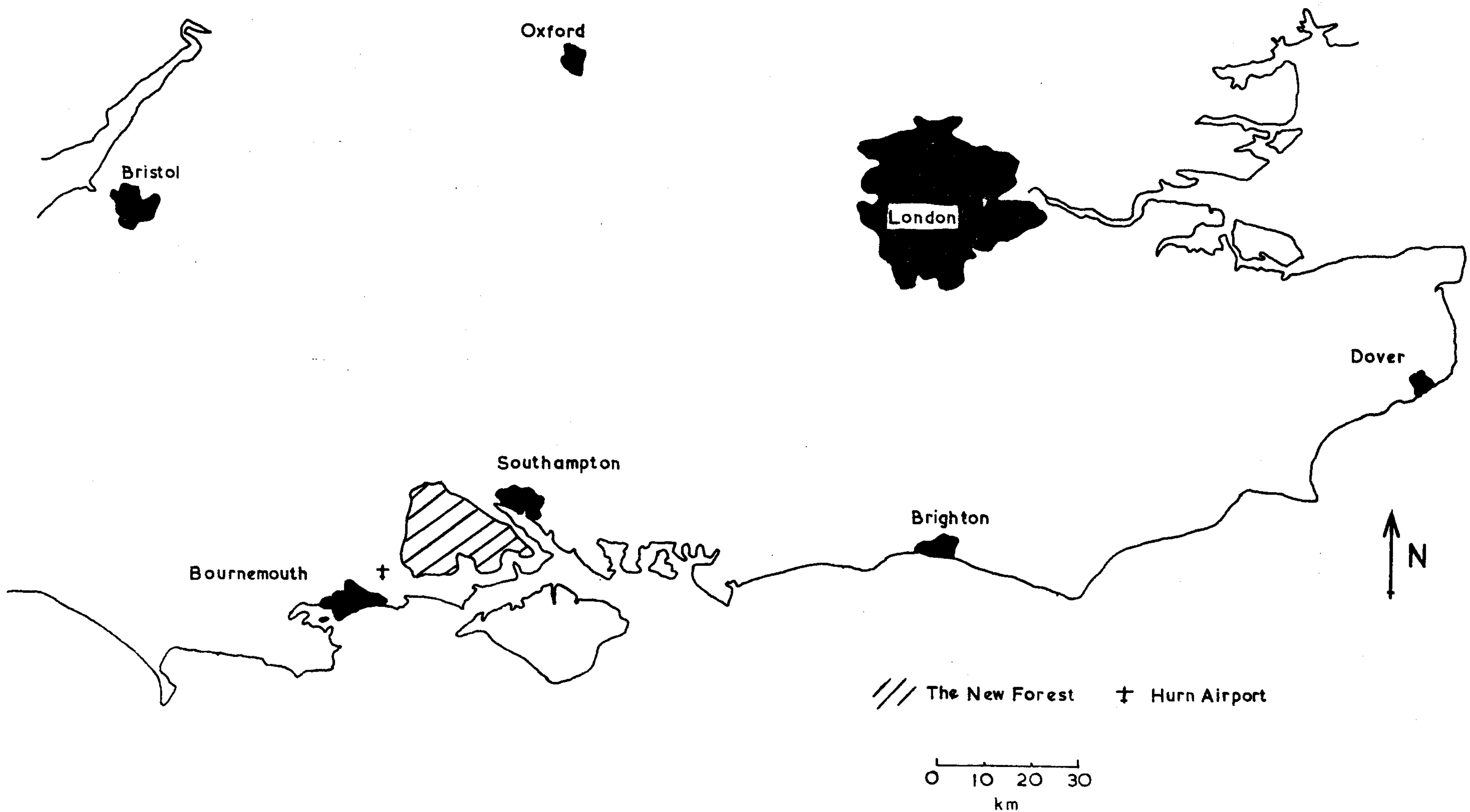
It is situated in south-central England (Figure 1) and is roughly triangular in shape, being some 20 by 25 km. It consists of a series of plateaux which in the north have been eroded by streams into a series of wide valleys separated by ridges whilst in the south they form expansive undulating plains which slope away gently towards the sea. The highest point is 127 m. (418 feet) above sea level and is located in the extreme north of the New Forest and the lowest is below 30 m. (100 feet) in the extreme south.

The New Forest lies between the Solent, in the east, and the River Avon, in the west, in a syncline of the chalk known as the Hampshire Basin and filled with deposits of gravels, sands and clays from the Tertiary era (Tubbs 1968; Tavener 1969; Conservation of the New Forest 1970).

2.1.2. Climate.

Metereological data from within the New Forest is not available and so recordings made at the Weather Centre at Hurn Airport, five miles to the southwest, have been used. Its location can be seen in Figure 1.

Figure 1 Geographical Location of the New Forest



It might be expected that conditions there would be slightly drier and warmer than those experienced on the higher ground in the north of the Forest but similar to those encountered on the southern half. Peterken (1965) also considered that records from Hurn were acceptable for giving a climatological description of the New Forest in his study on the ecology of holly (Ilex aquifolium).

a) Temperature.

The mean maximum and minimum temperatures for each calendar month for the 25 year period from 1946 to 1970 were available. These are presented in Figure 2 together with the same readings for each month of the study period from November 1970 until March 1973. The seasonal pattern shown is typical of Britain but it should be noted that the midwinter temperatures are still relatively mild, January and February being the coldest months with a mean maxima of 7.0 & 7.3°C. and minima of 1.7 & 1.2°C. respectively. Summers are warm, July and August being the hottest months with mean maxima of 20.9 & 20.6°C. and minima of 11.4 & 11.3°C. respectively.

The mean number of days each month when the grass minimum temperature at Hurn fell below 0.0°C. was calculated and taken to represent the frequency of occurrence of ground frost. The results for the cumulative period from 1951 to 1973 and for each month of the study period are presented in Table 1. Ground frosts were of extremely infrequent occurrence between June and August and are not included here. They were common between November and April and could be expected on one day in two from December to March.

b) Snow and Sleet.

From 1951 until 1973 data was available from Hurn Airport on the number of days each month that snowing or sleeting were noted and on how many occasions snow was actually lying on the ground at 09.00 hours

Figure 2 Monthly Mean Maximum & Minimum Temperatures at Hurn

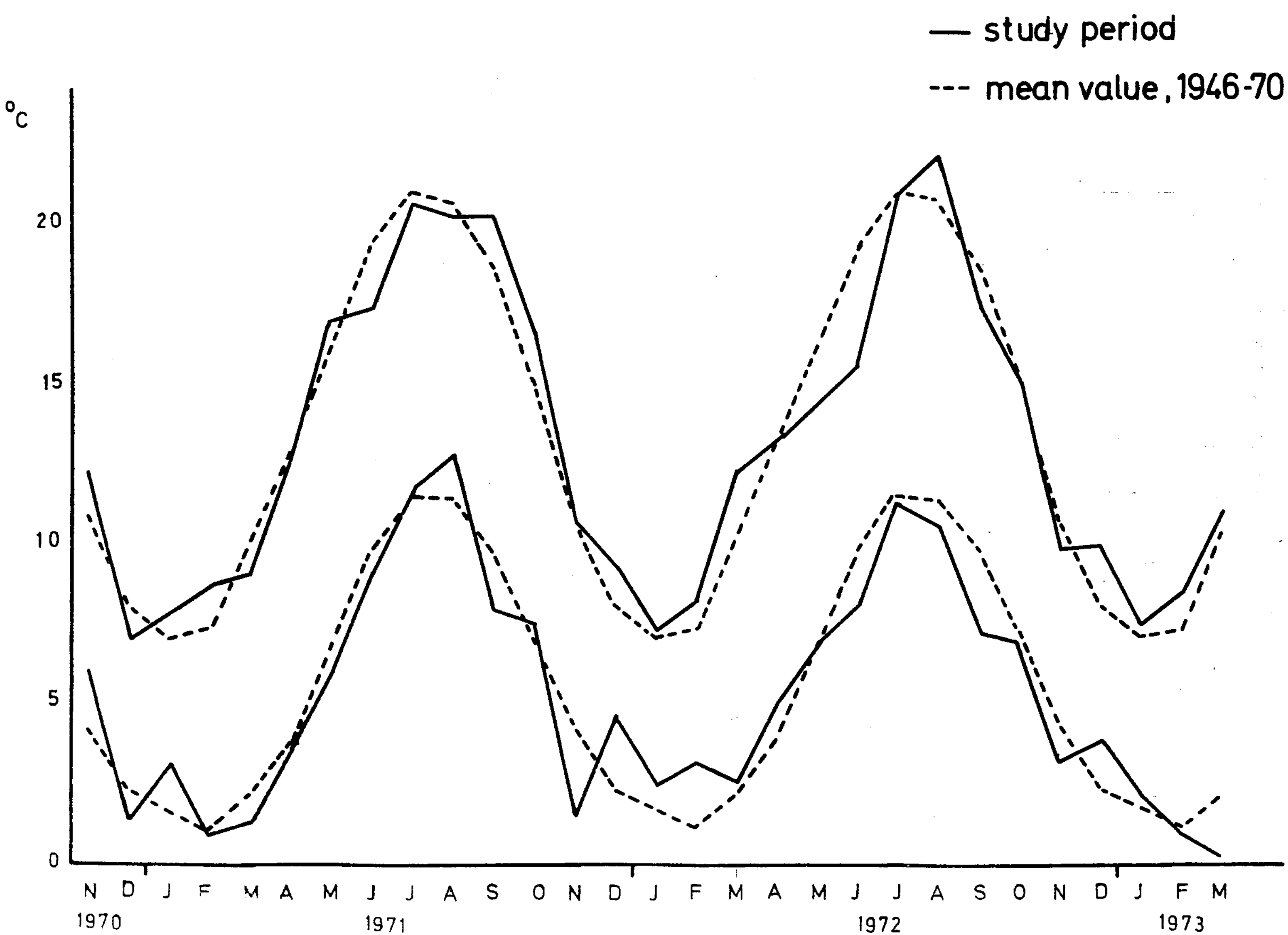


Table 1. Occurrence of Ground Frost at Hurn Airport

Month	Number of Days with Ground Frost 1951-73	1970	1971	1972	1973
January	14.5		8	10	11
February	15.9		16	9	19
March	15.1		17	17	22
April	12.8		13	9	
May	6.6		11	5	
September	1.6		4	4	
October	5.7		14	9	
November	11.6	8	17	13	
December	13.6	19	7	11	

Table 2. Occurrence of Snow and Sleet at Hurn Airport

Month	1951-73 a	b	1970 a	b	1971 a	b	1972 a	b	1973 a	b
January	3.0	2.2			0	0	0	0	0	0
February	2.7	1.7			2	0	0	0	5	1
March	2.7	0.4			5	0	3	0	0	0
November	0.5	0.1	0	0	0	0	1	1		
December	2.1	0.8	6	4	0	0	0	0		

Column a : number of days on which snow/sleet recorded

Column b : number of days on which snow lying at 09.00 hrs G.M.T.

G.M.T. The monthly means for this period and for each month of the present study are given in Table 2 for November to March. Outside these dates snow or sleet was exceptional. Snow and sleet can be seen from Table 2 to be rare in this area and seldom to settle or persist for long.

The three parameters of temperature, days with ground frost and days with snow or sleet can be taken as indicators of the mildness or severity of the weather especially during the crucial winter period from November until March. When the data for the three winters 1970-71, 1971-72 & 1972-3 are examined it can be seen that although certain months such as December 1970, November 1971 and March 1973 were harsher than average most others were as mild or milder than might be expected. Thus during the course of the study period from November 1970 to March 1973 the winter weather was not abnormally harsh and sustained conditions of low temperature, frost and snow cover were not experienced.

c) Rainfall.

The values for the mean monthly rainfall, the extreme maxima and minima, and the mean number of "rain days" (when more than 0.2 mm was recorded) and "wet days" (when more than 1.0 mm was recorded) for Hurn Airport are given in Table 3 together with the results for each month of the present study and for the summer of 1970. Figure 3 shows graphically the mean monthly precipitation values for the twenty year period 1951-70 compared with those recorded from November 1970 until March 1973. The total annual rainfall for the years 1951 to 1972 are given in Table 4.

The data presented here are in agreement with Young (1935) in that the average annual rainfall in the New Forest is approximately 840 mm (33 inches) and that two thirds of this falls between October

Table 3. Rainfall Records from Hurn Airport

	1951-70					1970			1971			1972			1973		
	mm.			mean rain	mean wet		rain	wet		rain	wet		rain	wet		rain	wet
Month	mean	max.	min	days	days	mm.	day	day	mm	day	day	mm	day	day	mm	day	day
January	86	155	11	15	11				128	20	16	107	22	19	47	11	8
February	57	157	1	12	9				23	8	5	109	19	16	16	6	4
March	57	107	1	12	10				66	12	7	101	16	12	15	7	5
April	49	118	4	13	9				55	6	5	61	15	10			
May	58	125	13	13	9	35	7	4	28	10	7	79	26	17			
June	50	106	7	11	8	25	6	6	131	11	9	57	18	11			
July	52	106	10	11	8	46	13	11	12	6	5	33	8	7			
August	70	132	17	13	10	49	11	7	53	13	10	25	4	3			
September	83	149	13	14	10	78	12	10	9	4	3	30	6	3			
October	89	259	3	14	10	21	12	7	45	8	7	26	7	5			
November	104	248	21	15	12	217	20	18	58	14	6	96	18	12			
December	86	200	18	18	13	32	14	8	32	10	6	126	19	15			
Annual	839			161	119	882			638	122	86	849	178	130			

Rain day ; more than 0.2mm recorded

Wet day ; more than 1.0mm recorded

Figure 3 Monthly Rainfall at Hurn

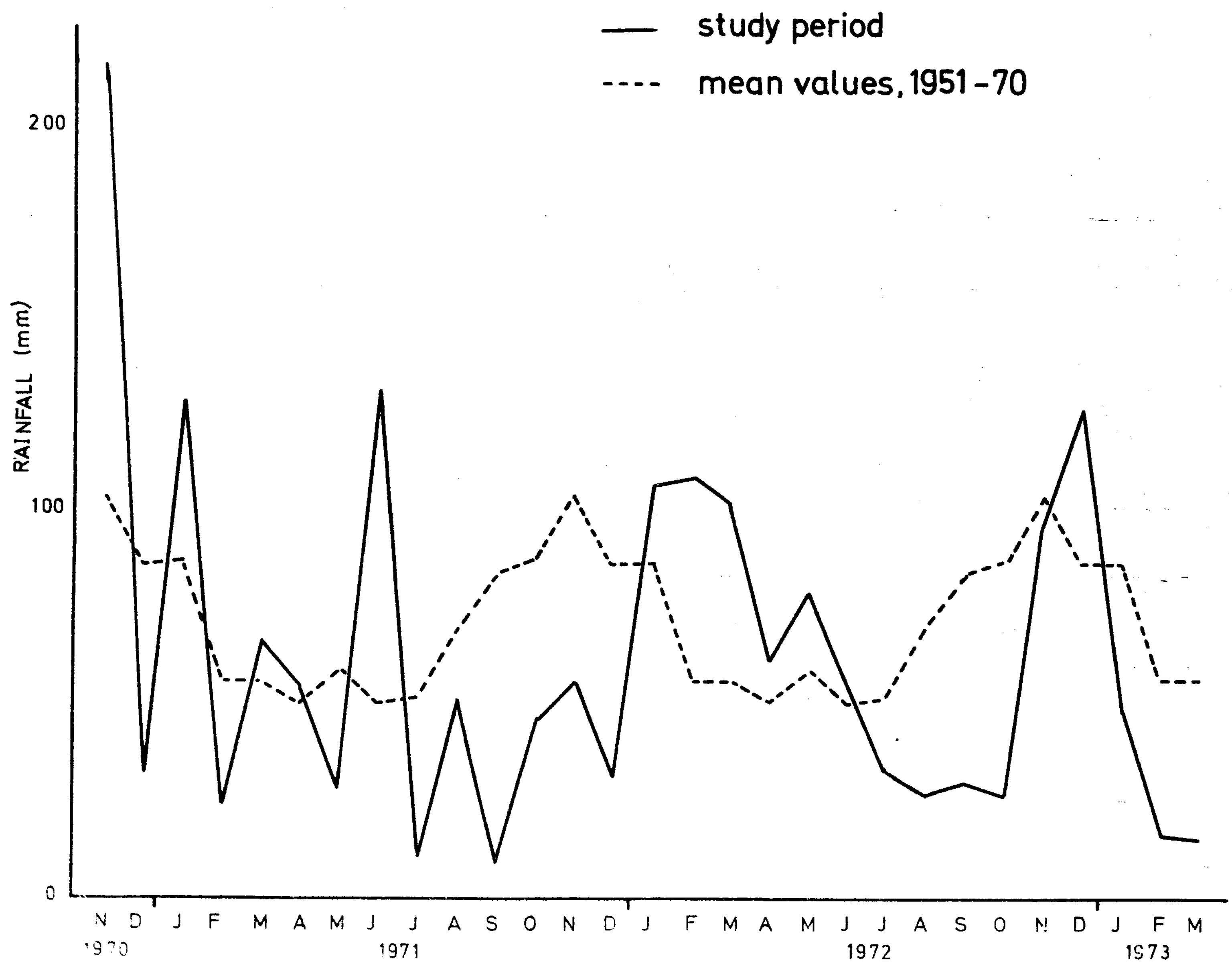


Table 4. Total Annual Rainfall at Hurn Airport, 1951-72 (in mm.)

Year	Amount	Year	Amount
1951	1098	1962	675
1952	751	1963	923
1953	556	1964	634
1954	849	1965	848
1955	753	1966	994
1956	760	1967	922
1957	736	1968	858
1958	928	1969	816
1959	855	1970	822
1960	1253	1971	638
1961	755	1972	849

20 year mean (1951-70)-839mm

and March. Freeman (1963), using readings obtained by the Forestry Commission from Deerleap Inclosure (Map I, 54) and Holmsley (Map I, 90) from 1948 to 1960, found that the driest month was April (48 mm) and the wettest November (123 mm). The mean annual rainfall was 957 mm, considerably higher than that obtained from Hurn over a longer period. In Table 4 it can be seen that the annual rainfall values do fluctuate considerably, the minimum recorded at Hurn being 556 mm in 1953 and the maximum 1253 mm in 1960. The same large monthly fluctuations are evident in Table 3.

Peterken (1965) gives a graph of the monthly precipitation and potential evaporation for ten sites in the New Forest for the period 1936-56. He concluded that, between April and August, evaporation exceeds rainfall and states that the New Forest tends to become very dry in late summer. Cadman (1962) supports this.

The results for the duration of the present study show that although ample rainfall occurred during the three winters, the summers of 1971 and 1972 were exceptionally dry (Figure 3). The situation in 1971 was better than in the subsequent summer as heavy rain fell in June, the effects of which were still evident into July. It was noted that during August, September and October grassland became very dry and the plants withered especially on areas with porous soils in exposed situations. The summer of 1970, prior to the commencement of this work, was also dry but not exceptionally so (Table 3).

2.1.3. Recreational Use.

The resident human population in the New Forest is very low compared with most parts of Great Britain (Conservation of the New Forest 1970) being concentrated in the villages of Burley, Fritham, Lyndhurst and Minstead and those adjacent to the boundary such as Ashurst, Blackfield, Brockenhurst, Dibden, East Boldre and Sway (Map I).

However both day visitors and campers are now numerous in the New Forest, particularly during the summer and their overall numbers increase annually (Conservation of the New Forest 1970). This is shown in Figure 4 which gives the figures supplied by the Forestry Commission for the number of camper-nights (one person camping for one night) spent in the New Forest over the past fourteen years. Up to 1971 the numbers increased greatly each year but since then they have stabilised at about 600,000 camper-nights per annum. This stabilisation has resulted from the restriction of camping to a limited number of sites (Figure 5) whereas previously people could stay where they chose on the open Forest. The camping season extends from the beginning of April until October and the numbers present fluctuates being greatest at weekends, bank holidays and during July and August (Conservation of the New Forest 1970).

The number of day-visitors to the New Forest is more difficult to determine. However it was estimated that for instance from October 1968 to September 1969, 3.5 million day visits were made of which 0.75 million were during the winter period and 1.25 million during the main holiday period of mid July to the end of August. Primary factors affecting the numbers of visitors are the day of the week (peak levels occurring only on Sundays and bank holidays), weather (the better the weather the greater the level of use) and to a lesser extent the main holiday period. A high percentage of use occurs between 1400 and 1900 hours G.M.T. with a peak around 1600 hours. Between 80 and 90 percent of day-visitors are in the New Forest for less than three hours (Conservation of the New Forest 1970).

In the past two years public vehicular access on the Forest has been restricted but few points are more than one mile from a parking place. It is therefore evident that during the whole year, but especially at weekends, bank holidays and during the peak holiday period

Figure 4 Location of Camp Sites in the New Forest

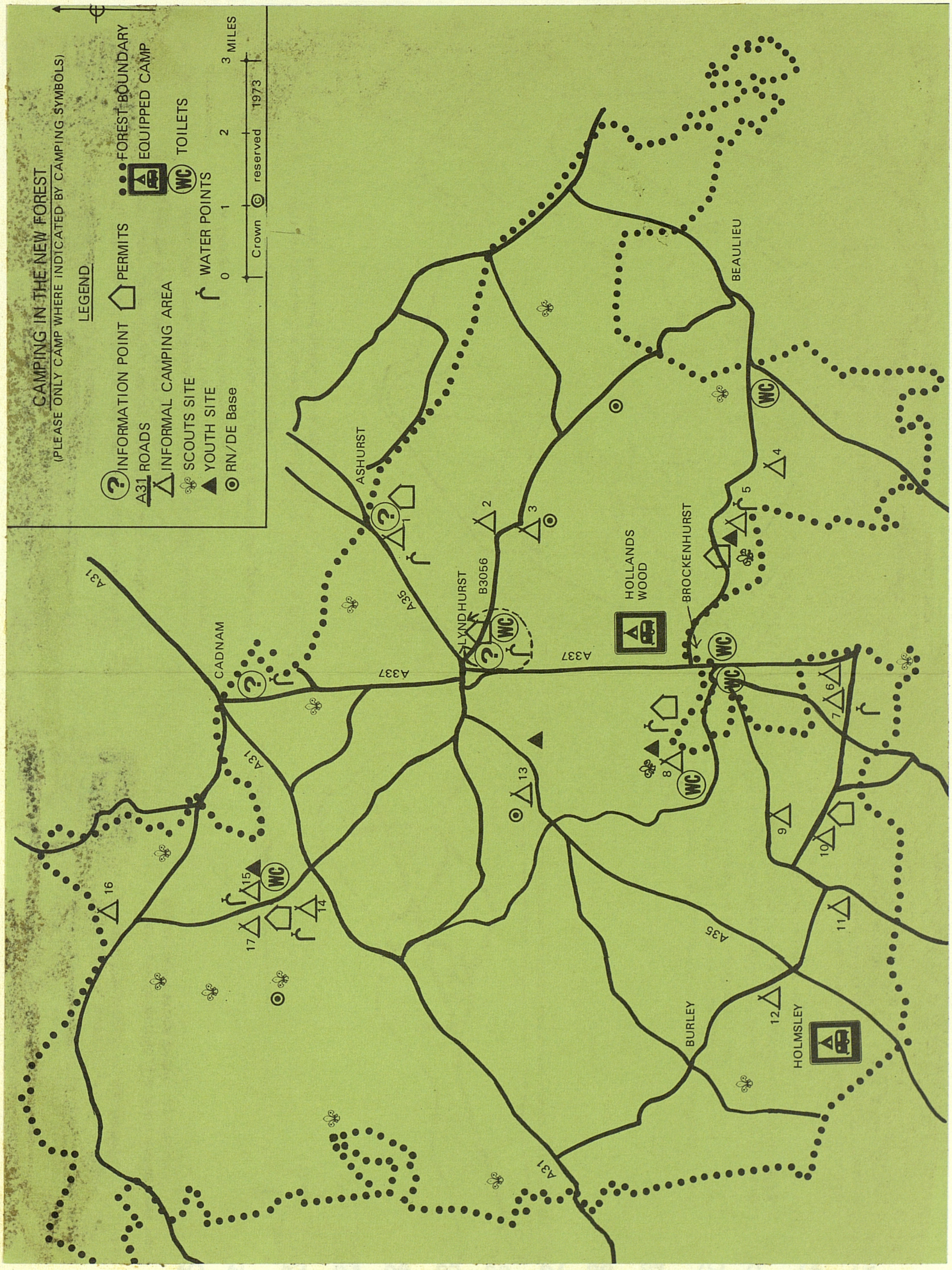
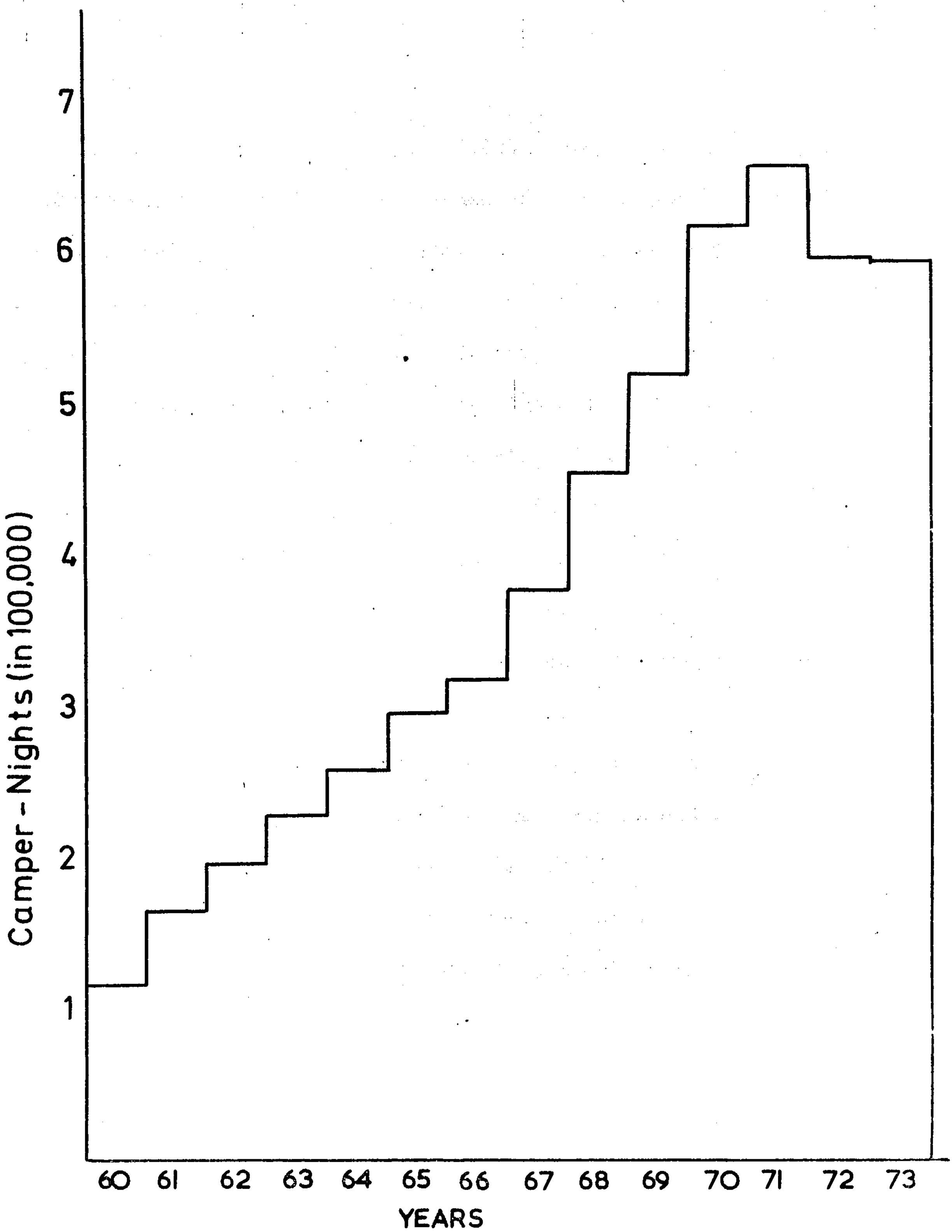


Figure 5 Number of Camper-Nights spent in the New Forest, 1960-73



large numbers of people use the New Forest and considerable disturbance results across the whole area.

2.1.4. Land Use.

Largely as a result of being subject to various management practices extending over many centuries the New Forest today still retains complex and unique patterns of land use and administration. These result in there being encompassed within its boundaries a complex mosaic of semi-natural vegetation, plantations and agricultural land.

The Crown land is 27,135 ha (67,000 acres) in extent of which 18,020 ha (44,500 acres) are unenclosed or "open forest" and 7,960 ha (19,650 acres) are designated as statutory Inclosures which may be fenced for the purposes of growing timber. Adjacent to the boundary are a further 1,420 ha (3,500 acres) of unfenced, privately owned land known as "manorial wastes" over which common rights exist with the vegetation resembling that of the nearby open forest. Such areas are found for instance at Hale Purlieu and Ibsley & Rockford Commons (Map I; 1,15,24). Private enclosed land occurs within the Forest, notably at Burley, Fritham, Lyndhurst and Minstead (Map I). Much of this land is used for pasture as are the majority of the agricultural areas adjacent to the boundary. A further 962 ha (2,376 acres) of Crown Freehold land also exists which is used for forestry, residential and also agricultural purposes such as the fields leased to local farmers and smallholders at New Park Farm, Burley Lodge and Denny (Map I; 71,83,61). The overall distribution of the land types can be seen in Map I, the open forest being subdivided into woodland and other types of vegetation.

2.1.5. Vegetation.

The New Forest is now the largest area of semi-natural vegetation in lowland Britain. For the purposes of the present study the vegetation is best treated by considering that found on the open forest to be distinct from that in Inclosures.

2.1.5.1. The Open Forest.

The vegetation on the open forest has been mapped by Mr. Colin Tubbs, Assistant Regional Officer, The Nature Conservancy, Lyndhurst, using aerial photographs and ground surveys. He recognised four main habitats which were subdivisable into thirteen vegetational types. These are summarised in Table 5 and the descriptions given below are drawn mainly from Tubbs (1968).

A. Woodland.

Deciduous woodland is dominated by the oaks (*Quercus robur* & *Q. petrea*) and beech (*Fagus sylvatica*) commonly with understoreys of yew (*Taxus baccata*) and holly (*Ilex aquifolium*). Sweet chestnut (*Castanea sativa*), sloe (*Prunus spinosa*) and hawthorn (*Crataegus monogyna*) are often present and occasionally ash (*Fraxinus excelsior*), whitebeam (*Sorbus aria*) and sycamore (*Acer pseudoplatenus*) may be locally abundant. Rowan (*Sorbus aucuparia*) and crab apple (*Malus sylvestris*) are found scattered throughout the New Forest. The birch (*Betula pendula*) is common, particularly along the margins of woodland.

A feature of the unenclosed woodlands is their impoverished ground flora which Tubbs (1968) believes is a result of grazing by deer and domestic stock. The dwarf shrub bilberry (*Vaccinium myrtillus*) is widespread in the New Forest although irregular in its distribution. Some 3,240 ha (8,000 acres) of deciduous woodland exist on the open forest of which 2,025 ha (5,000 acres) are found on clay soils, 1,010 ha (2,500 acres) on sands & loams, and 200 ha (500 acres) on gravels.

Besides being common as an understorey in deciduous woodland, holly may also form almost pure stands, roughly circular in shape, known

Table 5. Habitat and Vegetation Types on the Open Forest.

Habitat	Vegetation Type	No.	Area (ha)		% of total area (18,020ha)	
A Woodland	Deciduous woodland	1	3,240		18	
	Holly hats	2	200		1	
	Scots pine	3	690		4	
	Carrs	4	-		-	
B *Calluna* moorland	*Calluna*	5	5,900	7,290	33	38
	Calluna with gorse	6				
	Calluna with bracken	7				
C Grassland	Reseeded areas	8	490		3	
	Lawns	9	350		2	
	Acid grassland	10	4,455		23	
	Acid grassland with gorse	11				
	Acid grassland with bracken	12				
D Wet heath & bog		13	2,835		15	
	Gorse dominated	6&11	1.575		9	

as "hats" or "holms" (Peterken 1965). These cover some 200 ha (500 acres).

Scots Pine (Pinus sylvestris) was first introduced into the New Forest as a timber tree in the late eighteenth century and by the mid nineteenth self-sown trees had begun to rapidly colonise areas of Callunetum on the unenclosed land. However large expanses have now been eradicated, mainly by the use of controlled burning, and the extent of this type of woodland has now diminished considerably. The figures for the area of Scots Pine on the open forest in recent years illustrate this clearly:-

1937	4,455 ha	(11,000 acres)
1944	1,620 ha	(4,000 acres)
1963	690 ha	(1,700 acres)

Carrs are small extremely wet wooded areas associated with slow moving streams draining extensive valley bogs. These are usually dominated by alder buckthorn (Alnus glutinosa), although occasionally willow (Salix spp.) and birch may replace it, and show a characteristic flora including species such as the sedge Carex paniculata, the dwarf shrub bog myrtle (Myrica gale) and the bogbean (Menyanthes trifoliata). Although forming a distinctive vegetation type, carrs are never extensive and cannot be considered important in terms of area.

B. Calluna moorland.

Plant associations in which Calluna vulgaris, the heather or ling, is dominant extends across 7,290 ha (18,000 acres) of the open forest. It is often associated with purple moor grass (Molinia caerulea) and cross-leaved heath (Erica tetralix) on wetter clay soils, and with bell heather (Erica cinerea) and dwarf gorse (Ulex minor) on more porous substrates.

Tubbs (1973) states that 5,900 ha (14,570 acres) of this habitat are pure Calluna. The larger gorse (Ulex europea) may be locally dominant as may bracken (Pteridium aquilinum) and other plants may be practically excluded.

The practice of burning Callunetum, especially where it is being colonised by Scots Pine is described subsequently.

C. Acid grassland.

This habitat is characterised by the grasses Agrostis setacea, the bristle bent, and Molinia caerulea, the purple moor grass. The exact proportions of these two species in the sward vary with locality but it should be remembered that although this habitat covers approximately 4,460 ha (11,000 acres) a large, but unknown, percentage of this is dominated by Ulex europea and by bracken, often to the total exclusion of the grasses especially with the latter species.

The gorse on acid grassland, and to a lesser extent on Calluna moorland, may form extensive areas known as "brakes" which total some 1,575 ha (3,890 acres) (Tubbs 1973).

Reseeded areas and lawns are generally much richer pastureland than that of bristle bent and Molinia. Lawns are areas of natural grassland dominated by the grasses Agrostis tenius, the brown bent, and Festuca ovina, the sheeps fescue, found over 325-365 ha (800-900 acres) on either clay soils in close association with deciduous woodland or on deposits of alluvium in valleys. The reseeded grasslands total 490 ha (1,200 acres) and are established on a variety of sites and soil types. Many were originally heathland ploughed since the end of the second World War and sown with a variety of grasses although the same species now dominate as in the natural lawns. Certain of these areas are treated with lime in connection with pasture improvement schemes.

D. Wet heath and bog.

Wet heath and bog extends across 2,835 ha (7,000 acres) of the open forest and is characterised by the accumulation of peat. This habitat type, although particularly extensive in the south, is widespread over the whole of the New Forest. In drier sites Molinia is prominent as is Erica tetralix; as conditions become wetter, bog asphodel (Narthecium ossifragum), sundews (Drosera spp.) and cotton grass (Eriophorum augustifolium) are found grading into communities dominated by the bog mosses Sphagnum spp. in waterlogged situations.

Carrs may be found in the centre of valley bogs and are described under habitat A.

The habitat and vegetation types present on the open forest are illustrated in Plates 1-6.

The natural vegetation on the unenclosed Crown land is managed or used in a variety of ways. The New Forest Act of 1949 provided that the Forestry Commission should ensure that "the grazings shall be kept sufficiently clear of coarse herbage, scrub and self-sown trees" and this is achieved by the use of controlled burning of selected areas of heathland. Since 1960 the total area burnt has been reduced from approximately 1215 ha (3,000 acres) a year to 324 ha (800 acres) in 1973. Cutting of heather is now tending to replace burning; it is baled and used as a seperator between the clay subsoil and the gravel fill in roadmaking (Tubbs 1973). Burning is carried out in March each year and the figures for the extent of controlled burning and cutting for the last four springs are as follows:-

1970	326 ha	(804 acres)
1971	372 ha	(920 acres)
1972	426 ha	(1053 acres)
1973	324 ha	(801 acres)

Plates 1-6, illustrating the range of vegetation types on the Open Forest.

Plate 1. Mature deciduous woodland, Mark Ash Wood (Map I 39, III 3). Note the absence of scrub and ground flora.

Plate 2. Holly "hat" north of Fritham, also showing <u>Calluna</u> in the foreground with acidic grassland in the middleground.

Plate 3. Lawn with deciduous woodland in the background, Denny Wood (Map I 61, III 4). The area is used as a camp site from April until September.

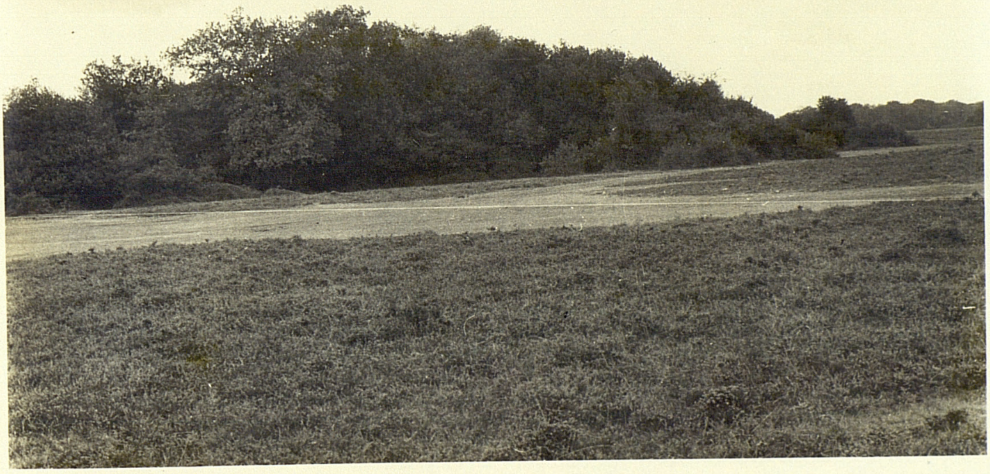


Plate 4. Reseeded grassland, Backley Plain (Map I 33, III).
Note the close-cropped sward.

Plate 5. Extensive *Calluna* moorland west of Backley, also showing scattered regenerating Scots Pine (left) and valley bog.

Plate 6. Valley bog at Shatterford Bottom (Map II 5), with *Calluna* moorland in the middleground and Denny Wood in the background.

This has the effect of maintaining a complex of areas of differing ages of heather and initially after burning new growth of Molinia may be produced. However this practice is generally detrimental to the gorses Ulex europea & U. minor (Tubbs 1973).

During late November and early December, permits are issued to local merchants to cut holly on the majority of unenclosed areas which is then sold as decoration for Christmas. Most of the material is cut where the trees grow in scattered clumps, such as hats or holms, rather than where they form a continuous understorey in deciduous woodland as they fruit better in the former situations (Peterken 1965; Peterken & Lloyd 1967) and only branches with berries are of any value to the dealers. Inevitably certain material is cut without berries and is usually left on the ground, thus making it readily available to deer, ponies and cattle.

2.1.5.2. Inclosures.

Areas enclosed for forestry purposes, known in the New Forest as Inclosures, account for one third of the total acreage of the Crown land and are situated throughout the area (Map I). The areas planted with each main tree crop within Inclosures are shown in Table 6. From this it can be seen that a variety of softwoods (conifers) have been planted but that Scots Pine (Pinus sylvestris L.) predominates with smaller amounts of Douglas Fir (Pseudotsuga menziesii Franco) and Corsican Pine (Pinus nigra Arnold variety maritima Melville), the latter having been introduced extensively only in recent years. Oaks (Quercus spp.) are the main hardwoods. The situation in plantations is the opposite of that woodland on the unenclosed land, conifers predominating in the former and hardwoods in the latter.

From the age class data (Table 7) supplied by the Forestry Commission it can be seen that the majority of the present softwoods have been planted since the 1st World War and most hardwoods prior to this. The ratio of the area of conifer to hardwood planted in a particular period (Table 7) shows that since 1880 softwoods have been in the majority. This was resulting in a change from broadleaved to coniferous woodland in the older Inclosures as mature oak and beech were felled and the compartments replanted with softwoods. However in May 1971, following a visit to the New Forest, the Minister of Agriculture issued a policy statement forbidding the felling of hardwoods and replacement with softwoods. It also made provision that felling in deciduous woodland on the open forest should be done only on small sites in order to encourage regeneration and that within Inclosures no area greater than one acre should be felled in order to encourage a diverse age structure.

The majority of Inclosures were established on the more fertile soils but the most recent ones such as Ipley, Marchwood & Markway (Map I; 56,104,87) are on poorer former heathland areas. The present policy of the Forestry Commission in the New Forest is to avoid fencing new plantings against deer unless absolutely necessary.

Within each enclosed area a variety of both species and ages of trees normally exist, as can be seen from Maps II, III & IV, and although one class of crop may be locally extensive a general patchwork or mosaic effect is obtained and deer have access to several different adjacent stand types. This is in marked contrast to the conditions in certain recent forests in Britain where extensive even-aged monocultures exist. In many cases in the New Forest a particular stand may be comprised of a mixture of species. It can be seen from Table 8 that about 25 percent of all conifers and 40 percent of broadleaves are found in mixed cultures.

The forestry working plan in plantations is such that each Inclosure is subject to various operations every five years. Many of these,

Table 6. Areas of Different Tree Crops within Inclosures

Species	Area(ha)	% total area
Scots Pine	1835	23
Corsican Pine	974	12
Lodgepole Pine	57	1
European Larch	129	2
Japanese Larch	148	2
Douglas Fir	996	13
Norway Spruce	426	5
Sitka Spruce	112	1
Other Conifers	356	5
All Conifers	5130	65
Oak	1926	25
Beech	651	8
Other Hardwoods	137	2
All Hardwoods	2714	35
Total Area	7844	

Table 7. Age Class Distribution of Trees in Inclosures

Planting Year	Conifer Area(ha)	Conifer %	Hardwood Area(ha)	Hardwood %	Area Ratio Conifer:Hardwood
1966-72	997	19	52	2	19.2:1
1956-65	999	19	151	6	6.6:1
1946-55	1154	23	152	6	7.6:1
1936-45	489	10	31	1	15.8:1
1926-35	530	10	174	6	3.0:1
1916-25	460	9	49	2	9.4:1
1906-15	34	1	11	1	3.1:1
1896-1905	59	1	25	1	2.4:1
1881-95	27	1	1	8	27.0:1
1861-80	247	5	252	9	1:1
pre1860	136	3	1820	67	0.1:1
Total	5130		2714		

Table 8. Areas of Conifer, Hardwood and Mixed Stands in Inclosures

Type	Area(ha)	% total area
Pure Conifer	3803	48
Mixed Conifer	1327	17
Pure Hardwood	1633	21
Mixed Hardwood	1081	14
Total	7844	

notably felling, thinning, weeding and brashing result in the provision of often large quantities of foliage being made accessible to deer: this would otherwise have been above their normal browsing height.

In the New Forest the vegetation can be seen to consist of a wide variety of vegetation types both on the open forest and within the Inclosures which form a complex patchwork across the whole region. Within or adjacent to these areas are also varying expanses of agricultural land, smallholdings and private gardens which complete the vegetational mosaic.

2.1.6. Commonable Animals.

Common rights are attached to most of the properties in the New Forest. Amongst these are the right to graze "commonable" animals (ponies, cattle and donkeys) on the open forest throughout the year and to turn out pigs during "pannage" in autumn and early winter to feed on the acorns and beech mast. The ultimate responsibility for the care of these animals rests with the Verderers, a body of ten people consisting of the Official Verderer, appointed by the Sovereign, five elected by the Commoners, and one each appointed by the Ministry of Agriculture, Forestry Commission, the local planning authority and the Countryside Commission.

The numbers of stock in the New Forest during the last three years and for selected dates before that are given in Table 9. This does not include stallions (which at present number about 120), foals of that year and calves of less than four months of age as no marking fees are paid on such animals and their exact numbers are not known. It is evident that during the past three years the numbers of ponies and cattle turned out has remained constant but have increased greatly since 1955, the pony population having doubled in the last fifteen years. All animals are owned and some are given supplementary feed during the winter or are taken off the Forest until the following spring.

The numbers of pigs at pannage varies greatly from year to year and is a reflection on the amount of acorns and mast available. In the autumn of 1970 and 1971 large numbers were turned out, as the crop was good, whereas in the following year production of acorns and mast was minimal and very few pigs were released.

The New Forest pony is recognised as being one of the seven wild breeds in Britain. Their origin is unknown but they are of ancient stock and were present in pre-Norman times being mentioned in their early code, "Constitutiones de Foresta". Their behaviour and social organisation have been described by Tyler (1972).

2.2. The Deer.

The main administrative body in the New Forest is the Forestry Commission which assumed this role in 1923 under the Transfer of Woodlands Act. Amongst their many and varied responsibilities is that of wildlife management which is effected by a Head Forester supported by a staff of fifteen Head Keepers, Keepers and Rangers. At present the whole Forest is divided into the ten beats shown on Map I, each being the responsibility of one keeper.

It is within this vegetationally diverse area, subjected to man's influences in various ways, that the fallow deer (*Dama dama*) have been studied in detail.

2.2.1. The Fallow Deer.

The fallow deer present in the New Forest are of ancient origin, their introduction being variously attributed to the Phoenecians, Romans & Gauls and have existed continuously since then (Whitehead 1964; Cadman 1967a; Tubbs 1968). Deer are free to move in and out of the Forest, there being no boundary fence, and a certain degree of interchange with feral animals in nearby parts of Hampshire and Wiltshire has undoubtedly occurred.

Some interesting data have been published on the population size of fallow deer in the New Forest in the past although it must be remembered that the censusing of wild woodland deer is very difficult as has been shown for both this species and the smaller roe deer, Capreolus capreolus L., in Denmark (Andersen 1953). Such counts invariably tend to underestimate the true population.

Early censuses from before 1800, when deer were actively preserved, gave the population as fluctuating between four and eight thousand head but heavy winter mortality occurred in certain years (Whitehead 1964). By 1850 the figure had fallen to two thousand. In 1851 the Deer Removal Act was passed which provided provision of funds for the removal of all deer from the New Forest within two years. The population was decimated but never exterminated; the numbers began to increase slowly and were estimated by Lascelles (1915) in 1892 as being some 200-250 head. In 1949, Hook believed the population to be 450 animals (Fitzgerald 1966). Modern censuses are compiled each April by the keepering staff for each beat for all species of deer, using the methods described by Cadman (1967a,b). It is on these returns that the annual cull is based. The total fallow population for the New Forest for the past three years was estimated as:-

April 1971	866
April 1972	1035
April 1973	914

The numbers present on each of the ten beats shown in Map I are given in Table 10 for the 1973 census where it can be seen that fallow deer are now found over most of the Forest with the exception of beats South 4 & 5 where few are present. Distinction is made in Table 10 between "male-deer" - bucks older than two years together

Table 9. Numbers of Commonable Animals on the New Forest, 1955-72

Year	Cattle	Ponies	Donkeys	Total	Pigs
1955	2164	1123	10	3297	
1960	2977	1735	8	4720	
1965	1972	2327	7	4306	
1970	1668	2814	13	4495	1622
1971	1601	2742	16	4395	1849
1972	1940	2982	39	4961	100

Table 10. Numbers and Distribution of Fallow Deer in the New Forest, April 1973

Beat	Male-deer	Small-deer	Total
North 1	28	87	115
2	18	72	90
3	13	53	66
4	58	105	163
5	31	63	94
South 1	26	82	108
2	20	78	98
3	35	126	161
4	2	13	15
5	0	0	0
Total	231	679	910

Table 11. Numbers of Fallow Deer Killed in Road Traffic Accidents in the New Forest, November 1970-March73

	Months											
Year	J	F	M	A	M	J	J	A	S	O	N	D
1970											0	2
1971	3	8	2	4	1	4	1	0	1	2	2	2
1972	4	3	3	5	3	1	1	5	1	3	10	2
1973	1	6	3									

with any yearling males (prickets) accompanying them - and "small-deer" - does, yearling does, fawns of either sex and all prickets excepting those in male-deer herds. This distinction is discussed in greater detail in section 7.3.

The shooting of deer in England and Wales is controlled by the 1963 Deer Act. This imposes close seasons for female deer between March 1st & October 31st and for male fallow between May 1st and July 31st. However unlike the situation in Scotland, where under the Deer (Amendment) (Scotland) Act (1967) it is possible under special licence to shoot deer out of season for scientific purposes, no such provision is made in this country.

In practice in the New Forest, small-deer are culled from the beginning of November to the end of February. Male-deer are generally taken in March & April and again in August & September, when the pressure of work on the keepers is less as no small fallow are culled at this time.

A small number of fallow are killed in or as a result of road traffic accidents each year. The monthly figures from November 1970 are shown in Table 11.

Deer have been hunted with hounds in the New Forest since its official recognition in the eleventh century. The history of the various packs are described by Whitehead (1964). Since the 1st World War the one remaining pack, the New Forest Buckhounds, have hunted only fallow bucks. The season starts in early September and continues throughout that month. No hunting takes place in October because of the rut but it commences again in early November and continues until April. The buckhounds hunt on two days per week. Hunting is selective and emphasis is laid on taking injured or sick deer; on quite a number of days the hounds are used simply to break up large herds and move them away from areas where they are doing damage to crops or gardens and are liable to be shot by the landowner if not dispersed (pers.comm. Mrs. Millar, Joint Hon.Sec., New Forest Buckhounds). About ten bucks are taken annually.

A certain amount of poaching occurs and deer are also shot in some localities by the landowners when the animals enter their fields. The exact number of fallow accounted for annually by these two agencies is unknown.

2.2.2. Other Species of Deer.

Roe deer are widely distributed in the Forest, occurring on most beats, and their population in April 1973 was estimated to be approximately 400 animals. The Japanese sika deer (*Cervus nippon nippon* Temminck) are found exclusively on beat South 4 (Map I) having originated from the Beaulieu Manor Estate to the south in about 1908 (Whitehead 1964; Rowland 1967). Their present population consists of about eighty individuals. Less than thirty red deer (*Cervus elaphus* L.) now survive scattered in several locations across the region. Occasional reports are received of sightings of the small muntjac (*Muntiacus reevesi* Ogilby & *M. muntjak* Zimmerman) and Chinese water deer (*Hydropotes inermis* Swinhoe) (Whitehead 1964) but these have not been substantiated.

2.3. Study Areas.

The New Forest, including the privately owned land, covers a total area of over 150 square miles (38,850 ha). It was clear from the outset of this work that the whole of this area could not be considered in detail and that it was therefore necessary to select certain representative localities.

It was proposed that four main lines of investigation would be followed:-

(a) the determination of the diet from culled animals;

(b) the determination of the diet by observing wild animals;

(c) the determination of habitat utilisation by the deer by the technique of faecal counts;

(d) the determination of the availability of different foods in areas where dietary studies were conducted.

Prime consideration in selecting study areas for (a) was therefore given to the number of deer present and the proposed cull in these places. It was shown in section 2.1.5. that a variety of vegetation types occur both on the open forest and in Inclosures. Wherever possible places were selected which showed a representative range of these types. The areas chosen were inevitably somewhat arbitary but consultation with keepers and personal observations do suggest that fallow do show a home range and are therefore fairly permanent within a particular locality. This is also confirmed by Heidemann (1971) working on this species in wooded farmland in Germany. Furthermore he found that their home ranges were smaller in winter. The majority of dead material from the New Forest was collected during winter. Three main study areas were chosen.

Previous personal experience had shown that wild fallow are exceptionally wary animals and that an intimate knowledge of not only their movements and habits but also of the terrain was essential if the observer was to be able to regularly approach and watch them undetected in order to determine their feeding habits. Other authors substantiate this (Page 1962,71; Prior 1965; Lawrence & Brown 1967). It was therefore decided to concentrate direct observational work on only one area which ideally should contain a good population of deer, a wide variety of vegetational types typical of the whole New Forest and also be as free from human disturbance as possible.

The investigation using method (c) was designed to complement the field observational studies and accordingly was carried out in the same study area.

Similarly the vegetational studies to determine the availabilities of different foods were carried out on the study areas chosen with regard to methods (a) and (b). The availability of different forages will vary seasonally and it was felt that two surveys should be done, one in March & April to assess that winter's food and one in August & September for the previous summer's. As will be shown subsequently intensive dietary studies on the three study areas using dead material were restricted to the winter months due to lack of specimens at other times of the year. For this reason only winter foods were assessed on two of the areas; on the third, both winter and summer surveys were carried out as it was also used to determine the diet during the entire year by direct field observation.

Thus in all, three study areas were selected and the types of investigation done on each is summarised in Table 12.

Supplementary data was also obtained for method (a) from dead animals culled on beats South 3 and North 4 outside the three study areas, and from North 5 during the entire duration of this work with the exception of Shave Green Inclosure and Wood (Map I, 50) in the first winter, 1970-71. During August, September & October 1972 all fallow culled on beats South 1 and North 1 & 2 were examined.

Every effort was made to collect material from all animals killed in road accidents in the Forest but especially between March and October. This was the period when few deer were culled and monthly sample sizes were small.

Jaws were obtained from all fawns and yearlings shot on beats North 2 & South 1 between November 1972 and February 1973.

Full notes were also made on any other deer seen in the New Forest besides Area A. Infrequent visits were made to many locations but

Table 12. Research Methods Employed on the Study Areas.

Method	Study Area A	B	C
a) Diet determination from culled deer	X	X	X
b) Diet determination from live deer	X		
c) Habitat utilisation using faecal counts	X		
d) (i) Summer vegetation survey	X		
(ii) Winter vegetation survey	X	X	X

especially to the reseeded areas of Backley (Map I,34; Map III) and Kings Garden in the nook of the south-east corner of Milkham & Roe Inclosures (Map I,22), both of which held large concentrations of small-deer in spring. Visits were also made to the deer sanctuary at Bolderwood Farm (Map I,36; Map III) to observe feeding behaviour and social interactions in the male-deer there.

The salient features of the three main study areas selected are described below.

STUDY AREA A.

This comprised the majority of beat South 3 (Map I) and its exact boundaries can be seen in Map II which also shows the various sub-areas recognised. The census figures for April 1970, that is the spring before the present research commenced, indicated that about eighty fallow were resident there.

The total extent of area A was some 1380 ha (3,400 acres) of which 35 percent was unenclosed. The area of each of the thirteen open forest vegetation types described in section 2.1.5.1. was found from the maps made available by Mr. Colin Tubbs. These are presented in Table 13 together with a summary of the ages and species of trees present in plantations and are compared with those for the entire New Forest. From this it is evident that the vegetational types on area A are representative of those of the New Forest generally with the exception of acid grassland which is uncommon im this particular place.

Dead material was collected from animals culled here (Section 3.2) and it was also decided to use it for intensive observational work for four reasons. Firstly, as has already been stated, a large population of fallow deer were present. Secondly, as can be seen on Map II, a large number of "high-seats" exist. These are platforms four or five metres above the ground (Plate 7). From these deer can be observed without disturbing them

Plate 7. Forestry Commission high-seat used in selective culling and for observing deer from.

Table 13. Extent of Open Forest Vegetation and Inclosure Types on the Study Areas and on the entire New Forest.

	New Forest	Study Areas A	B	C
Total Area (ha)	27,135	1,380	132	425
% Open Forest	66	35	64	70
% Inclosure	34	65	36	28
Open Forest Vegetation Types (%)				
1 Deciduous woodland	18	32	82	28
2 Holly hats	1	0	0	7
3 Scots Pine	4	2	11	2
4 Carrs	0	4	3	4
5 *Calluna*	33	25	1	16
6 *Calluna* with gorse	5	0	0	4
7 *Calluna* with bracken		0	0	0
8 Reseeded grassland	3	2	0	0
9 Lawn	2	11	0	4
10 Acid grassland		1	0	1
11 Acid grassland with gorse	23	2	0	7
12 Acid grassland with bracken		4	0	9
13 Wet heath & bog	15	18	3	19
6&11 Gorse dominated	9	2	0	11
Inclosure Types (%)				
Recently planted (p 1963-73)	17	17	0	4
Thicket/pole (p 1921-62)	48	46	44	78
Mature conifer (pre 1921)	8	10	6	1
Mature hardwood (pre 1921)	27	22	27	18
Fenced	-	5	22	0
Fields (as % total area)	-	1	1	2

(Cadman 1966). Thirdly the vegetational and plantation types present were representative of the New Forest. Lastly the results from the two methods of diet determination i.e. from dead and live animals, could be compared.

A series of transects were established to study the differential use of habitat types by using faecal counts. Vegetational surveys were conducted in both summer and winter.

Area A had the added advantage that the southern boundary was formed by the main Southampton to Weymouth railway line which is effectively fenced throughout its length. Three small bridges exist over the line but regular inspection for deer tracks or "slot" confirmed that they were very rarely used and the passage of fallow into and out of A on this boundary is negligible. This is further supported by the fact that although occurring to the south of the railway (section 2.2.2.), sika deer have never colonised this study area.

It was anticipated that there would be considerable disturbance by people during the summer as four camp sites existed on or adjacent to this study area, namely at Hollands Wood, Denny Wood, Matley Pit and Matley Ridge (Figure 5), which could hold 700, 70, 40 & 20 caravans or tents respectively. Matley Ridge was open only in the summer of 1971. Considerable numbers of day visitors also use the area and three riding schools organise regular pony treks there. However as has been indicated in section 2.1.3. disturbance by humans is found throughout the Forest and was believed to be no greater on area A than in the majority of places.

STUDY AREA B.

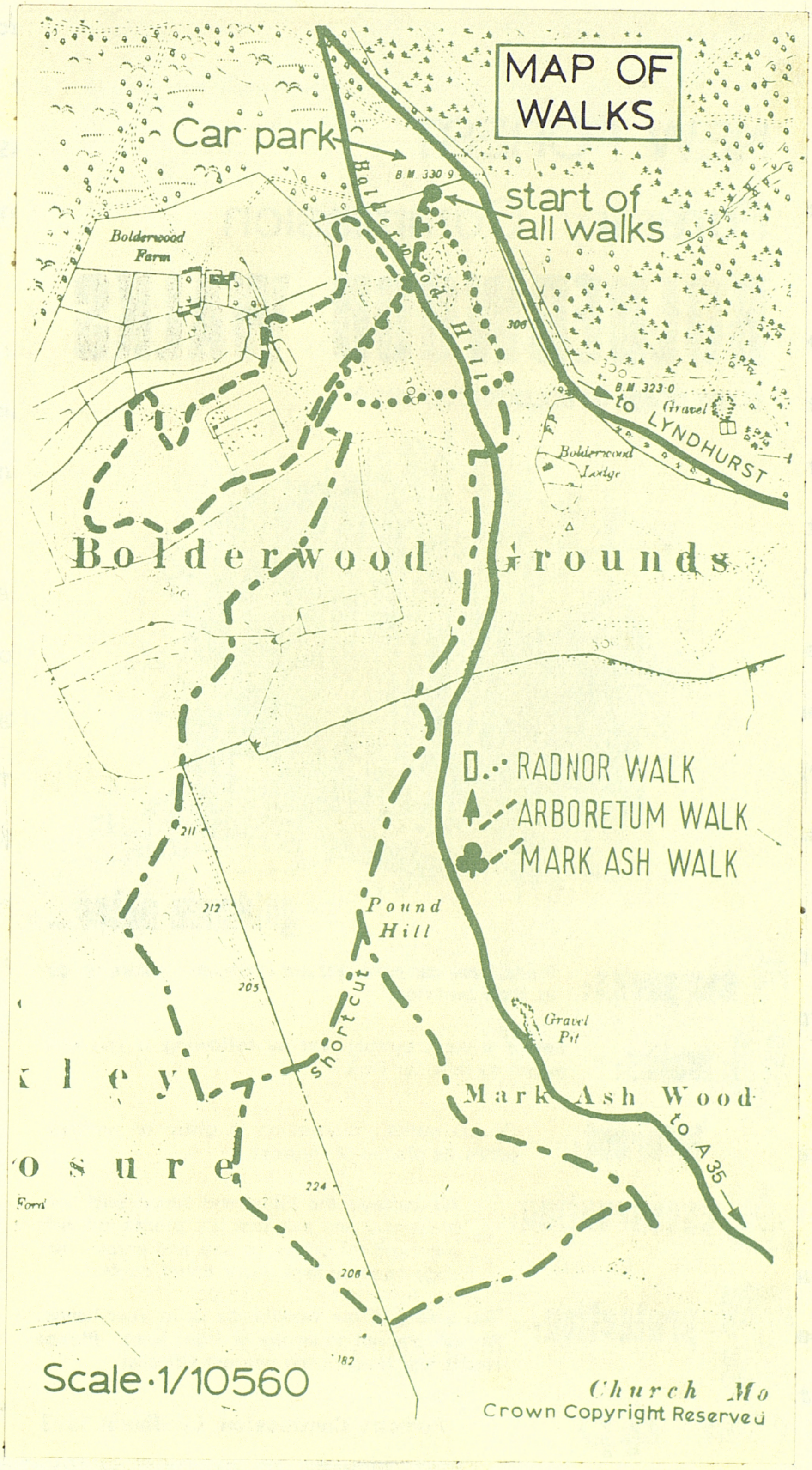
Area B consisted of the open forest region known as Mark Ash Wood with parts of the adjacent Bolderwood and North Oakley Inclosures (Map I; 37,38,39). The study area is situated on beat North 4 and is shown in greater detail on Map III. The fallow population in the spring of 1970 numbered approximately twenty animals but deer from neighbouring afforested area such as Knightwood, Anderwood and Holidays Hill (Map I; 40,41,42) entered Mark Ash to feed on occasions.

Culled material was obtained throughout the year from B but in common with the rest of the Forest few animals were shot between March and October. As has been previously stated, it was necessary to concentrate watching live deer to one study area, namely A, and no systematic observations were carried out on B. Similarly only the winter food availability was assessed there because little data on the summer diet was obtained.

This study area was considerably smaller than the previous one being only 132 ha (325 acres) in extent, of which 64 percent was open forest. The types and areas of the different vegetation and plantings found there are presented in Table 13. It can be seen that Mark Ash Wood is dominated by mature oak and beech woodland, much of which also has an extensive understorey of holly. Acorns and beechmast are said to be important foods for fallow deer in the autumn and early winter (Cadman 1966) and area B was selected for that reason. The plantations consisted mainly of thicket stage softwoods (44%), mature oak & beech (27%) or were fenced against deer (27%).

Considerable disturbance occurs in this region. A narrow unfenced metalled road runs through the centre of Mark Ash Wood (Map III) adjacent to which are several small carparks and lay-bys. The area is of great scenic beauty and the western half (Map III,3) has Forestry Commission nature trails running through it (Figure 6) which are used intensively throughout the year although public pressure is greatest in the summer.

Figure 6 Map of Nature Trails in Study Area B



STUDY AREA C.

The final study area, C, was also situated on beat North 4 and was comprised of two main regions; firstly the complex around Holmhill Inclosure, Acres Down and Wood Crates (Map I; 43, 44, 45 & Map IV) and secondly that known as Bolderwood Hollies (Map I;35 & Map III) comprising 324 ha (801 acres) and 96 ha (238 acres) respectively. The open forest vegetation types (Table 5) of these two regions are compared in Table 14.

From this it can be seen that the major differences between the two are in vegetation types 1, deciduous woodland, and 2, holly hats; some difference in the amounts of Calluna also exists. However it was felt that it was valid to pool the results from these two regions for the following reasons. Firstly no deer were obtained from Bolderwood Hollies until late November of the third winter of the study period when, as will be shown in greater detail later, nuts from deciduous trees were not abundant whereas they were in the previous two years. Secondly it should be remembered that although holly is abundant at Bolderwood, forming the dominant tree species, it is also widespread as an understorey in deciduous woodland in the other region and in fact is equally available in both places as will be shown in section 4.2. The two subareas were thus combined and the vegetation types found are given in Table 13.

It was shown in section 2.1.5.1. that acid grassland types and gorse brakes constitute 23 and 9 percent of the total area of the open forest. Table 13 shows that these are poorly represented in A and B. However on C they form 16 and 11 percent respectively and this area was originally selected to investigate the importance of these vegetation types in the feeding ecology of fallow deer.

The majority of the plantation (78%) is of thicket and pole stage trees where the canopy has closed, excluding sunlight and resulting in

Table 14. Comparison between the Extent of Different Open Forest Vegetation Types at Bolderwood Hollies with that on the Remainder of Area C.

	% of Study Area C	
	Bolderwood Hollies	Remainder
1 Deciduous woodland	4	39
2 Holly hats	20	1
3 Scots Pine	2	3
4 Carrs	4	4
5 _Calluna_	21	11
6 _Calluna_ with gorse	4	4
7 _Calluna_ with bracken	0	0
8 Reseeded grassland	0	0
9 Lawn	3	5
10 Acid grassland	0	0
11 Acid grassland with gorse	9	7
12 Acid grassland with bracken	13	7
13 Wet heath/bog	21	19
6 & 11 Gorse dominated	13	11

minimal ground flora.

As in area B, only dead material was studied from C and because of the paucity of summer samples the vegetation was only surveyed for the winter to determine the relative availabilities of different foods then.

Disturbance was average on the eastern complex, being concentrated at the extreme north end and along the metalled road forming the southern boundary to Wood Crates & James Hill (Map IV,5 & 6). However during the summer and at weekends throughout the entire year, disturbance was intense at Bolderwood Hollies due to the many visitors attracted to the locality by the deer sanctuary at Bolderwood Farm (Map III). This is an area of fields maintained as a sanctuary for fallow which are given limited supplementary feeding with potatoes. The animals become accustomed to people and regular educational visits are organised by the Forestry Commission for local schools and organisations to see the deer at close range. Only male-deer regularly frequent the fields and are free to enter or leave the sanctuary. The numbers present fluctuate seasonally.

In the spring of 1970 the fallow population for the two regions was about thirty (excluding all sanctuary deer).

Chapter 3. MATERIALS AND METHODS

3.1. Introduction

During the course of this research, use has been made of several different methods so that the results from one have complemented and augmented those obtained from the others. Expressed at their simplest these have involved two principal methods namely the examination of rumen content material from dead animals and direct observation of deer feeding in the field. These methods together with supplementary data collected at the same time have provided considerable relevant information not only on the types of food eaten but also on such aspects as feeding behaviour, habitat utilisation and condition of the animals. In addition, other studies have been made on the availability of different foods by means of vegetation surveys and of differential use of areas by using faecal counts.

3.2. Examination of Dead Material

3.2.1. Treatment of Dead Material in the Field

From the 1st November 1970 until 31st March 1973, dead material was collected from fallow deer culled by the Forestry Commission, killed in road accidents or found recently dead from a variety of other causes within the New Forest. Animals were taken to the nearest deer larder where they were weighed and eviscerated by Forestry Commission wildlife personnel. Relevant data was recorded at these times on prepared duplicated sheets (Figure 7). All weights were taken to the nearest pound on Salter spring balances which were checked regularly for accuracy; these readings were later converted to kilograms. Dead weight was taken to be that of the animal as shot and gralloched weight that of the whole animal after removal of the entire alimentary tract except the oesophagus. Time of death was recorded to the nearest five minutes.

Figure 7 Information Sheet on Culled Deer as Used by Keepers

INFORMATION ON CULLED DEER

NUMBER

SPECIES

F R

SEX

M F

WEIGHT

Dead

Gralloched

FAWN/KID

Yes No

YEARLING

Yes No

DISEASE	None	Little	Much
Lungworm			
Liver-fluke			
Ticks			
Keds			
Lice			

KEPT

Lower Jaw

Eyeball

Gralloch

Uterus, ovaries or Testicles

Liver

Heart, Lungs

Kidneys & Fat

LACTATING

Yes No

INCLOSURE

DATE

TIME

Shot:

Gralloched:

COMMENTS

SIGNATURE

The accuracy of these field measurements were frequently checked.

The alimentary tract, except the oesophagus, was placed in a stout polythene bag together with the kidneys and their encasing fat bodies. Each bag was then labelled and sealed tightly to prevent weight loss by evaporation. The heads or mandibles of the animals were also labelled and retained. Where the contents of the bag could not be examined within 48 hours during the months of November to February inclusive or within 24 hours outside this period then they were pierced and immersed in a solution of four percent formalin to await collection. A total of five gralloch (alimentary tracts) were weighed fresh and then immersed in the formalin and reweighed a week later. There was no difference between these weights and the fresh ones.

The alimentary tracts were then dissected into the following component parts which were weighed on Pesola spring balances to the accuracy indicated in the brackets:-

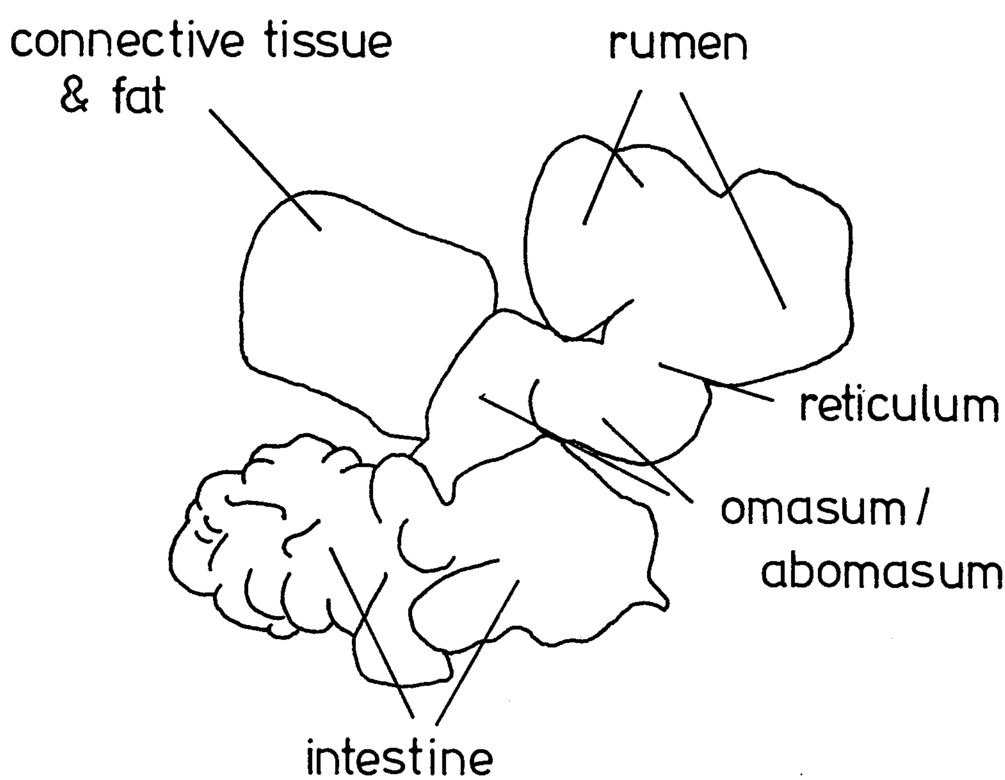
Spleen (2g); mesenteric fat and connective tissue (2g); fat deposit on the omasum & abomasum (2g); intestine (100g); reticulum, omasum & abomasum (10g); rumen (100g).

These portions are illustrated in Plates 8 & 9.

The entire contents of the rumen were then removed either by opening the wall or by carefully emptying the material through the rumino-reticular opening. The weight of the rumen wall was then obtained and hence that of the rumen contents (ingesta) found. The contents were then spread out and six random samples of approximately one hundred grams were taken from different parts of the food mass. In this way any bias due to sedimentation of different plant materials was avoided. This is basically the same technique as used by Field (1966) on ungulates in Uganda. The six samples were then combined and used in subsequent food analysis.

Plate 8. Gralloch (alimentary tract) of a fallow deer as removed from the animal.

Plate 9. Gralloch partially dissected and arranged to show the major component parts.



A further sample of known weight of approximately 200 grams was taken from the ingesta and was oven-dried at 50°C for 5 days. From the dry weight of the sample it was possible to calculate that of the entire rumen contents.

3.2.2. Rumen Volume

A series of freshly emptied rumens of known weight were used to determine the relationship between the weight of the rumen walls and their maximum potential volumes. The method outlined by Pytel (1969) was followed. This involves filling the rumens with known volumes of water to determine their capacity. In order to prevent undue expansion of the wall, support was provided by immersing all but the ruminoreticular opening in water. Only fresh material was used as it was found that preservation in formalin caused the tissues to harden.

3.2.3. Kidney Fat Deposits

The kidney fat index was used to express the amount of perinephric fat present which gave an index of the condition of the animal (Riney 1955; Blood 1966; Caughley 1970a,b; Bear 1971). The method employed involved removal of fat anterior and posterior to the kidney (Figure 8). The kidney and encasing fat were then weighed. This fat was then removed and the weight of the kidney found. Wherever possible this was done for both kidneys of every animal and the values combined. The kidney fat index is then expressed as the weight of the perinephric fat as a percentage of the kidney weight.

3.2.4. Mandibles

With the help of calipers, the length of the mandible from the edge of the alveolus of the first incisor to the hind margin of the ramus ascendens was measured to the nearest millimetre. This data could then be used as an indication of the skeletal size (Klein & Strandgaard 1972;

Reimers 1972). Using the technique of Chapman & Chapman (1970) it was possible to age animals less than three years old to the nearest month based on the pattern of tooth eruption. Deer older than this were then aged by comparison of wear on the molariform teeth with those of known age given by Ueckermann & Hansen (1968). These were separated into the following age classes:- four or five, six or seven, eight or nine, ten and older. The pattern of tooth wear with age may vary from location to location depending on such factors as the hardness of the teeth and the types of food taken. However as various authors have shown that jaw length and other measurements may vary with age in deer (Dzieciolowski 1970a; Klein & Strandgaard 1972) it was felt that some indication of the age of animals with a complete dentition was needed. Thus although the four age classes recognised may not correspond exactly to that in years given by Ueckermann & Hansen (1968), they can be taken as being four steps in a series from young adult to old adult animals.

3.2.5. Total Deer Obtained

Dead material was collected from November 1970 until the end of March 1973, a total of 29 months. 416 deer were supplied, 382 from routine culls, 26 from road traffic accidents, 6 as a result of other accidents and 2 which had been killed by poachers. The sex, age and number of deer obtained each month is given in Table 15.

A further 47 jaws were available from beats North 1 & 2, and South 1 from the winter cull of 1972-73.

3.3. Analysis of Rumen Contents

3.3.1. Sieving

The rumen contents were examined after removing much of the finer unidentifiable particles by means of a fine sieve. However Courtright (1959) and Bergerud & Russell (1964) demonstrated that various types of

Table 15. Numbers and Types of Dead Fallow Deer Obtained Monthly

	Male			Female			Total
Months	adult	yearling	fawn	adult	yearling	fawn	
Jan	8	8	27	28	5	19	95
Feb	4	6	17	18	8	21	74
Mar	5	3	3	0	0	0	11
Apr	6	5	4	2	0	1	18
May	0	0	0	3	0	0	3
June	0	1	0	1	1	0	3
Jul	1	1	1	0	0	0	3
Aug	7	10	0	0	0	0	17
Sep	12	13	0	1	0	0	26
Oct	3	1	0	1	0	0	5
Nov	3	0	30	24	7	32	96
Dec	2	2	24	14	9	14	65
Total	51	49	107	92	30	87	416

Figure 8 Method of Fat Removal used in determining the Kidney Fat Index

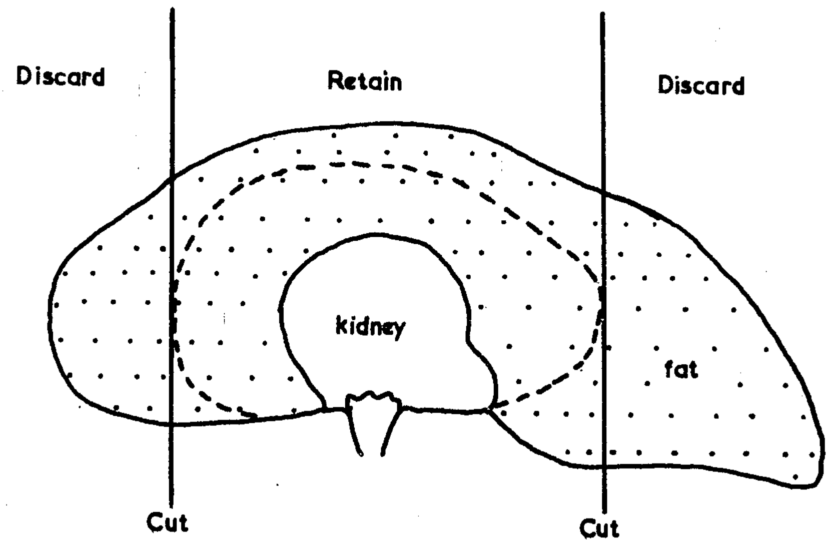
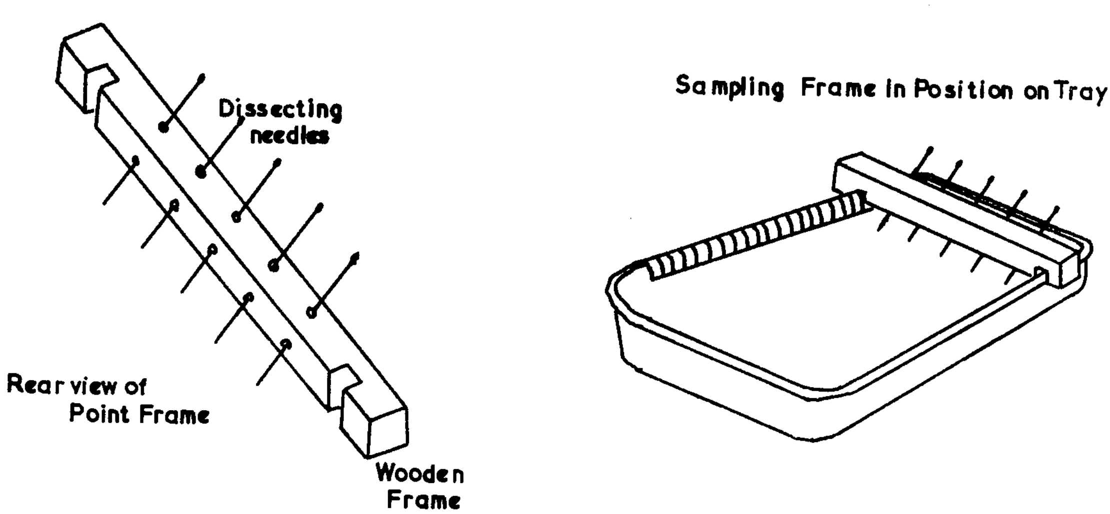


Figure 9 Diagram of Point Frame Sampling Apparatus



plant from the ingesta of caribou, *Rangifer tarandus* L., are not equally retained on coarse and fine sieves. But contrary to this, Dirschl (1962) working on the pronghorn (*Antilocarpa americana* Ord) found no significant difference between the qualitative and quantitative composition of plant fragments from rumens retained by three different mesh sieves and concluded that it was better to use as large a mesh as possible as large particles could be identified more rapidly and accurately than smaller ones.

In order to determine the most suitable procedure for examining the fallow deer material a series of rumen samples containing a wide variety of plant types were washed through Endecott test sieves of mesh size 4, 3, 2 & 1 mm. The plant fragments retained on each sieve were sorted into plant types and their relative amounts compared. It was found that with a mesh size greater than 2 mm the types of plant whose form was long and narrow e.g. small Graminae & Juncaceae, passed through the mesh thus biasing the results in favour of broadleaved species. However all particle types were retained equally on a 2 mm mesh sieve which was used for all subsequent work.

Subsamples of approximately 700 g wet weight were taken from the sample of rumen contents and were gently washed through the sieve. Excessive water pressure, although speeding the process, tended to force certain softer plants through the mesh which would otherwise have been retained and in view of this only gentle washing was practiced. If not examined immediately, retained food particles were stored in sealed jars containing four percent formol saline. This solution was found preferable to seventy percent alcohol which caused leaching of plant pigments and made subsequent identification more difficult.

3.3.2. Qualitative Identification

Most workers on rumen analyses identify plant fragments to either species level or to an easily recognisable plant type, such as fungi, herbs or grasses, by comparison with a reference collection of known species from the area they are working in (Saunders 1955; Cole 1956; Harry 1957; Bergerud & Russell 1964; Jensen 1968; Bayless 1969; Nellis & Ross 1969; Henry 1972). Others then separate each species further into its component parts such as leaf, stem or flower (Dzieciolowski 1970b).

In the present study plant fragments were normally identified to species level, by comparison to a reference collection from the study areas. However in the case of certain particles it was usually only practicable to classify them to a plant group type. For instance fungi and herbs normally occurred in only small amounts in the rumens yet could be comprised of numerous species. It would have been possible to identify each individual particle to species level but the relative quantity of any one species would be negligible. It would then be necessary to recombine these small individual values under their plant group type, i.e. fungi or herbs, to provide useful quantitative results. Hence unless a particle was easily identifiable to a species or family then it was only classed by its plant group type.

The plant group type classification followed throughout is shown in Table 16.

Grasses and grass like plants, graminids (Jensen 1968), form an important part of the diet but numerous species, subspecies, hybrids and cultivated varieties are involved. It would have been possible by microscopic examination to identify each particle to species level but it was felt that more useful results would be obtained from the examination of a larger sample in less detail than from a small number of rumens in greater detail. Furthermore, it is doubtful whether the latter exercise would have provided any more meaningful results and could have provided less useful information than is subsequently presented.

Table 16. Classification of Plant Group Types Followed.

1 Conifers

2 Broadleaved trees and shrubs

3 Dwarf shrubs

- a) Calluna
- b) Bilberry
- c) Gorse
- d) Others

4 Graminids

- a) Grasses (Graminae)
- b) Rushes (Juncaceae)
- c) Sedges (Cyperaceae)

5 Herbs

6 Ivy

7 Fungi

8 Mosses and liverworts (Bryophytes)

9 Ferns

10 Fruit,nuts and berries

11 Bark

- a) Coniferous
- b) Broadleaved

12 Holly

13 Bramble and Rose

14 Dead leaves

15 Other

16 Unidentifiable

The plant group type 16, unidentifiable (Table 16), was introduced to cover the few particles which could not be identified and also coarse, fibrous or woody material which may persist in the rumen for several days after the foliage and bark have been digested. As Jensen (1968) points out, inclusion of material such as this would bias the true food results in favour of woody and longer retained types. It was therefore placed in a separate category.

3.3.3. Particle Size & Form

Other relevant information about the segregated material was also recorded such as the relative size of the particles and the particular morph represented. For instance distinction could often be made between the triangular leaves of trailing ground ivy and the rounder, larger leaves of that obtained from climbing ivy available on felled trees. A similar difference exists between the prickled holly from lower branches and smooth-edged "blind" leaves from the tops of trees.

Having examined a series of rumens the maximum and minimum sizes of particles for each food type were recognisable and a subjective scale of 1, small, to 5, large, was devised for each type, standard samples of each size being kept. This was done separately for winter and summer as certain types such as grasses and herbs are larger in summer. Each plant type must be treated separately because the original size of bite taken will vary and soft material may be broken down into smaller particles than woody ones. However within any one rumen the relative sizes of all types of plant assessed on this scale were usually identical and an overall value for the food particles could be given.

3.3.4. Quantitative Identification

Various methods have been employed to quantify the different food plants once they have been identified e.g. by eye, weight, volume and the modified botanical technique of point frame analysis.

3.3.4.1. Volumetric Analysis

Initially samples were taken from the sieved food particles and were identified and manually separated into component plant groups or species. Identification could usually be achieved by eye or by using a dissecting lens although occasionally a binocular microscope was needed. The separated types were then rolled dry in filter paper and their volumes found to 0.1 cc by water displacement in a modified burette. Their actual and percentage volumes were thus obtained. Analysis by separation and volumetric methods was found to be extremely time consuming.

3.3.4.2. Point Frame Analysis

The point analysis method of sampling vegetation has been widely applied and consists of randomly or systematically placing a frame holding equally spaced pins in the vegetation being sampled. The number of pin "hits" on each species or type are recorded and can then be used to determine frequency and percentage composition in the vegetation sampled (Levy & Madden 1933; Tinney, Aamodt & Ahlgren 1937; Johnston 1957; Brun & Box 1963).

Chamrad & Box (1964) created artificial rumen contents by clipping, mashing and then mixing known volumes of known species of plants, then subjecting them to point analysis. The percentage hits on each species were then compared with the known percentage volumes and were not significantly different. They then used the point frame procedure for analysing ingesta from white tailed deer (Odocoileus virginianus Zimmerman). The technique has since been used by Boeker, Scott, Reynolds & Donaldson (1972) to analyse the rumen contents from mule deer (Odocoileus hemionus Rafinesque).

In order to test the validity of using the point frame method in the present study a series of actual rumen samples, whose composition had already been determined using manual separation and volume displacement (section 3.3.4.1.) were analysed using the procedure and apparatus described by Chamrad & Box (1964).

A frame consisting of a wooden bar with five fine dissecting needles sliding through it and evenly spaced along it was constructed so that it slid easily along the top of a plastic tray on which were a series of equally spaced markings (Figure 9). The sample was spread evenly in the bottom of the tray and was then systematically analysed by dropping each pin into the material, recording the first hit on a plant fragment and then moving the bar along a fixed distance before repeating the procedure. A total of one hundred hits were recorded for each sample and the percentage of each food type found.

This was then compared with the composition from the volumetric analysis using the 2n contingency X^2 test. There was found to be no significant difference between the results of the two methods, provided that only foliage was present. This can be seen in samples 1 to 8 (Table 17) or when fruit and seed were well chewed as in 9. However in cases 10-13, where large amounts of fruit and nuts of large size were present, the two methods are not comparable (P less than 0.05), their importance being under-estimated by the point frame analysis. This is because the point frame method estimates the amounts of food present from their surface areas and those with low surface area to volume ratios such as nuts, fruit and fungi will be underestimated when compared with the volumetric method.

Consequently where such foods were estimated to constitute more than five percent by volume, this material was separated off from the foliage by immersion in a large, shallow pan of water; when this was gently swilled the denser fruit, fungi and nuts sedimented out from the green material and were removed. The volumes of the denser material

Table 17. Comparison of Point Frame and Volumetric Methods of Rumen Analysis

S	M	A	B	C	D	E	F	G	H	I	J	K	X^2	^{o}f	P	
1	1	22		52	42			10	45		13	20	6.16	6	0.2-0.5	NSD
	2	140		270	200			60	220		60	100				
2	1	29			25				20		16	10	8.21	4	0.05-0.1	NSD
	2	405			340				255		110	150				
3	1				28			43			15	12	2.71	3	0.2-0.5	NSD
	2				185			290			65	55				
4	1		15	17	103			25			7	38	7.49	5	0.1-0.2	NSD
	2		70	60	405			100			35	115				
5	1	14			42	53			48	14	10	22	10.33	6	0.1	NSD
	2	90			250	370			285	85	85	75				
6	1	21							90		21	19	2.34	4	0.5-0.8	NSD
	2	110							635		135	95				
7	1	17						47	17		27	17	4.49	5	0.5	NSD
	2	110						320	80		120	100				
8	1	50			25				24		26	26	0.15	5	0.9-1.0	NSD
	2	19			10				8		9	9				
9	1		11		34		47				6		0.19	3	0.9-1.0	NSD
	2		170		600		840				80					
10	1				61		114				30		61.30	2	0.001	SD
	2				120		895				135					
11	1				73		111				28		15.10	2	0.001	SD
	2				645		1370				150					
12	1				35		115			22	18		50.63	3	0.001	SD
	2				215		2140			120	315					
13	1				42		139				21		50.34	3	0.001	SD
	2				295		2955				155					

^{o}f= degrees of freedom   NSD = no significant difference(at 5% level)
SD = significant difference (at 5% level)

S = sample number   M= method

Method 1;number of hits with point-frame   Method 2 ; actual volume(in units of 0.05ml)

A; coniferous browse   E; ivy   I; dead leaves
B; broadleaf browse   F; fruit & nuts   J; rest
C;dwarf shrub   G holly   K; unidentifiable
D graminids   H; bramble

and the foliage were then determined separately. Foliage was then analysed using the point frame method and the remainder was segregated manually into food types, their volumes being determined by water displacement. The percentage volumes of all the different food types could then be calculated.

Replicates of one hundred hits showed no significant difference when tested using X^2. Point frame analysis was found to be much quicker than the volumetric method yet provided equally accurate results. The majority of the ingesta samples were therefore analysed using the point frame, using one hundred hits for each.

3.3.5. Analyses Completed.

The contents of the rumens of 325 deer were analysed in detail. The number done each month are summarised in Table 18. One male fawn, killed in a road accident at Furzey Lawn (Map I,51) was supplied in July 1973. Its age was estimated as being between one and two weeks and it was treated separately from the rest of the data as it had not begun to take solid food to any extent.

3.4. Direct Field Observation.

Direct field observation was used throughout the year as an alternative method of determining the diet of the fallow deer. Information could also be gained at the same time on behaviour, of area utilisation, herd size and various other aspects of their biology relevant to feeding. It also became apparent that at certain times of the year there would be a scarcity of dead material and on such occasions direct observation would be the only practicable way of accumulating a considerable quantity of data on the diet. These observations were all made on study area A (section 2.3.) unless otherwise stated.

Following a preliminary survey in March, intensive watching commenced in April 1971 and continued until the end of October 1972, a

Table 18. Numbers of Rumens Analysed Monthly ,November 1970 to March 1973.

Month	Year				
	1970	1971	1972	1973	Total
January		17	24	32	73
February		13	15	20	48
March		0	6	5	11
April		4	13		17
May		1	2		3
June		1	1		2
July		1	1		2
August		0	16		16
September		5	21		26
October		2	3		5
November	14	12	44		70
December	13	10	28		51
					325

total of 19 months. During this period visits were made to the study area as often as possible and at least three times a week. No fixed watching pattern was followed but it was ensured that during the course of any one calendar month all types of habitat were visited. Visits were made in all weathers and at all hours of daylight but principally at the beginning and end of the day when disturbance due to forestry and recreational activities were minimal and deer could be located more readily.

Various workers have used spotlights to count deer at night and to observe their preferences for different feeding areas (Montgomery 1963; Progulske & Duerre 1964; Ahlen 1965; Horwood 1966,71). An attempt was made to watch fallow at night by the use of dim spotlights but proved unreliable as the deer became very wary often moving off before their numbers, sex, age or feeding sites could be determined. Progulske & Duerre (1964) working on white tailed and mule deer in Dakota also found that although the animals were not frightened by lights they tended to move off to the far edge of their feeding grounds. Although Ahlen (1965) states that it is possible to distinguish between red, fallow and roe deer from the colours their eyes reflect when in the spotlight, considerable difficulty was experienced in telling the latter two apart in the present study. Similarly it also proved difficult to distinguish deer from ponies or cattle at long range or in dense cover. It was also noticed that the first time an area was scanned with the beam, few deer were seen but the number increased as the light was shone round again. This suggested that deer might be bedded on an area and only stand up once the beam has first passed over them; the true number of deer feeding on an area cannot therefore be assessed. Except in very open grassland habitats, deer which are lying down will not be picked out in the beam and may be missed entirely. For this reason it was decided not to carry out a major programme of night-time observation.

Initially the majority of the observations were carried out from high seats (section 2.3.), waiting for the deer to appear. However this proved inefficient as although excellent and lengthy views of the animals were achieved only a few were seen on any one visit and only certain sites in the study area could be watched. It was thus felt that a better assessment of the feeding habits could be achieved by observing more animals for shorter periods in as many different locations as possible. As a result, deer were located by stalking on foot or from a slow moving vehicle and were observed from ground level unless a high seat was conveniently available.

A good network of private gravel roads exist on A (Map II), especially within Inclosures. It was found that fallow usually took little notice of slow moving vehicles and in many places this proved the easiest method of locating them. They could often then be watched from the stationary vehicle provided that movement and noise by the observer were minimal. Alternatively, having first seen the deer, the vehicle could then be parked out of sight and the observer could then stalk back to watch them. In more remote places the animals could only be approached on foot. By adopting these methods the ground covered and the numbers of fallow seen per hour spent in the field were greatly increased.

Various methods have been used to quantify the foods eaten by large herbivores in the field. One commonly used technique is that of "feeding minutes", first used by Dixon (1934) on mule deer. It has also subsequently been used by Buechner (1950), Eddy (1961), Bergerud & Nolan (1970) and Leuthold (1971) on pronghorns, collared peccary (Tayassu tajacu Copy), caribou and gerenuk (Litocranius walleri Brooke) respectively. This measures the length of time that an animal feeds on a particular species or type of plant, observations normally being timed to the nearest five seconds.

However this technique is not always practicable (Saunders 1955; Dunkeson 1955), especially in areas of denser vegetation of a complex nature, and other workers have noted the exact site where an animal has been seen to feed and later visited it to determine which food species had been taken by close examination of the foliage. This method has been employed by many people including Knowlton (1960), Bayless (1969), Dorn (1970) and Constan (1972) working on moose (Alces alces L.), pronghorn, moose & bighorn sheep (Ovis canadensis Shaw), mule deer and elk (Cervus canadensis Erlexeben) respectively. In the present study numbers of mouthfuls taken or "bites" were recorded at each feeding location.

It was decided to use both methods here if possible. Two types of situation arose whilst watching deer:-

(a) where the animal could be seen feeding on one particular species or type of plant and both the time spent and the number of bites taken could be recorded;

(b) where the overall time spent feeding and the number of bites taken at a particular site were recorded but subsequent close examination of foliage was necessary to determine which plants had been used.

Although vestigial maxillary canine teeth may be present in young fallow (Chapman & Chapman 1973;pers.obsv.) these deer possess no incisiform teeth in the upper jaw. When feeding, vegetation is grasped between the mandibular incisiform teeth and a hard pad of fibrous tissue in the upper jaw with each bite necessitating a small but discernible jerk of the head to remove the food. This is particularly noticeable when they are feeding on coarse, springy or rank vegetation. Thus the number of bites taken can be scored by counting these head movements should there be difficulty in seeing the animal's mouth. When searching for fruits and nuts they quarter the ground with heads lowered and moving slowly. On taking a fruit there is a momentary pause in this movement as it is picked up and in the case of acorns these are then rolled in the mouth, this being believed to remove the acorn cup. These pauses correspond to one bite.

Thus the monthly results have been expressed both qualitatively and quantitatively in two ways.

(a) In certain types of habitat, such as open grassland, it was easier to observe deer for longer periods of time than in others, such as dense scrub, and bias may result in favour of certain plant associations. To avoid this, the number of bites taken of a particular food type each month were computed using the aggregate percentage method of Martin, Gensch & Brown (1946). For each record of a deer feeding the percentage of bites of different foods were calculated and the aggregate percentage of all these individual observations found. Thus, however many bites were taken, all observations were treated equally and any bias due to the difficulty of watching deer in denser vegetation was minimised.

(b) The average time taken for one bite of a particular plant type was calculated from observations where both time feeding and bites taken were known. This value was then multiplied by the aggregate percentage of bites for that type (from (a)) and the time thus found was expressed as a percentage of the total time spent feeding on all foods each month.

Observations were carried out using 8 x 50 and 20 x 60 binoculars. Where a group of deer were being watched, each individual was studied in turn if possible. No one deer was watched feeding for more than five minutes to avoid possible bias due to the overselection of certain individuals (Harper 1962). Food plants utilised were recorded to species level wherever possible but in the case of certain herbs, grasses and sedges it was sometimes impracticable to classify them further than their plant group type especially if they had been heavily utilised by the deer. If a species could not be readily identified in the field a sample was taken back to the laboratory for confirmation.

At each visit a full record was kept of the weather conditions and precise route taken by the observer together with any other pertinent data such as forestry practices being carried out and large scale disturbance such as hunting. All sightings were recorded, whether the animals were feeding or not, together with the time, number and type of deer, behaviour, exact location and any other relevant information. Forestry Commission Planting Maps, such as Maps II, III & IV, of scale six inches to one mile were used for recording the position of all deer seen.

During the study period visits were made to area A on 279 different days with in some cases up to three visits being made at different hours. A total of 56, 570 minutes (943 hours) were spent in the field and monthly details are given in Table 19. A total of 3,964 fallow sightings were recorded and of these 1,551 were watched to determine their diet.

3.5. Vegetation Surveys

3.5.1. Summer survey on Study Area A

3.5.1.1. Relative availability of different plants.

A vegetational survey of study area A, where direct feeding observations were carried out, was undertaken in order to determine the relative quantities of all plants present during the summer months. This was with a view to comparison with the actual amounts of different food types eaten so as to enable feeding preferences to be established. The method employed was based on that of Aldous (1944) working on deer yards in the United States and later used by Harry (1957) with moose, and Daburon (1968) with roe deer in France. A sampling grid was set up across the whole area from a six inches to one mile scale (1:10,560) Forestry Commission Planting Map. One of the marked latitudinal kilometre grid lines was used as the base line and sampling points were then marked out at fifty metre intervals along lines parallel to and at one hundred metre intervals from it. These sampling points could be easily located

Table 19. Time spent and Visits made to Study Area A, April 1971-October 1972.

Month		Time(mins)	Days
1971	April	2,515	15
	May	3.130	16
	June	3,240	17
	July	4,580	16
	August	3,810	14
	September	2,535	13
	October	3,010	17
	November	2,430	17
	December	1,955	12
1972	January	2,970	18
	February	2,565	14
	March	2,065	12
	April	2,160	13
	May	2,840	16
	June	1,760	12
	July	2,985	14
	August	4,655	14
	September	4,600	14
	October	2,765	15
	Total	56,570	279

in the field by use of the Planting Map, pacing, compass bearings and aerial photographs.

This work was carried out in August and September 1972. A total of 2177 points were located from the grid. Seventy-two of these were effectively fenced against deer and were excluded from the survey, giving a total of 2105 actual points which were used to determine the food availabilities.

At each point a quadrat 7.07m square was set up, giving a sample plot of fifty square metres. This size was found to be the maximum workable as it was difficult to estimate the relative cover of each species or plant type in denser vegetation using larger quadrats.

The relative cover of each species or plant type was estimated visually for each quadrat using the following scale:-

	Cover (%)	Midpoint
0	absent	0
1	1 - 5	3
2	6 - 25	15
3	26 - 50	38
4	51 - 75	63
5	76 -100	88

This was done for all green vegetation available to deer i.e. that less than 1.60m above ground level. Observations on browse lines (Plate 10,11) had shown this to be the maximum height to which fallow would browse in all but exceptional situations.

The following plant species or types were scored:-

Conifers	-	Identified to species
Deciduous trees	-	Identified to species
Dwarf shrubs	-	Identified to species
Grasses	-	<u>Molinia caerulea</u>; <u>Deschampsia caespitosa</u>; <u>Agrostis setacea</u>; <u>Brachypodium sylvatica</u>; "Sweet" grasses (all species excluding those listed above).
Rushes	-	<u>Juncus bulbosus</u>; all other Juncaceae.
Sedges		
Herbs		
Palatable grassland	-	All sweet grasses together with <u>Juncus bulbosus</u> & <u>J. squarrosus</u>, all sedges and all herbs associated with such grassland.
Ferns	-	<u>Pteridium aquilinum</u>; <u>Dryopteris felix-mas</u>.
Ivy		
Holly		
Bramble; Rose; Bramble & Rose.		

To obtain the average cover for a particular plant over the whole study area, the total sum of all the midpoint values for all sampling points was found and divided by the total number of points. The total number of quadrats on which a particular plant was found was expressed as a percentage of all sampling points to show its frequency of occurrence.

3.5.1.2. Browsing Index.

An estimate of the extent and intensity of browsing by deer on woody vegetation within areas from which domestic stock were excluded was made using the procedure outlined by Aldous (1944). When a twig is browsed and its apical or leader shoot removed then it gradually dies back to a lateral bud or to the previous years terminal bud scar. Twigs were examined for evidence of such browsing since their last season of growth

Plate 10. Holly at Bolderwood illustrating how lateral growth below the browse line has been suppressed and clipped back by constant browsing by deer (right) whereas that above it has grown out freely over the track.

Plate 11. Heavily browsed beech in Stubby Copse Inclosure showing the stunted, squat growth form below the normal browsing height compared with the normal unsuppressed growth above it.

and an estimate of the number of shoots taken to those available was made on the following scale:-

			Mid point
O	-	no browsing	0
L	-	light - trace to 25% of shoots browsed	12.5
M	-	medium - 26 to 60% of shoots browsed	43.0
H	-	heavy - 61 to 100% of shoots browsed	80.5

These categories were also used by Thomson (1966) when studying browsing by roe of young trees in Glentress Forest, Scotland.

The same sampling grid was employed as in the previous section (3.5.1.1.) so that browsing indices were completed on the same plots as the relative cover estimates. A total of 1625 quadrats of size 7.07m square were used.

The average browsing intensity for each woody species was then calculated by summating the midpoint values for all plots and dividing by the total number on which that particular plant was recorded. The frequency of occurrence of each species was also found.

3.5.1.3. Light Intensity.

It is known that wherever possible deer are highly selective in their choice of food and are capable of selecting the most nutritious food (Swift 1948) although this does not necessarily imply that it is the most palatable (Shafer 1965). The nutritional value, digestibility and palatability of available forage material may vary from species to species, seasonally, with the age of the plant, between adjacent individual specimens, from one leaf to the next, and with site factors such as soil and light (Cook & Harris 1950; Swank 1956; Dietz 1965; Short, Dietz & Remmenga 1966; Miller 1971).

From casual field observation of summer browsing by deer it seemed apparent that it was most intense in places were most light reached the plants. In order to test this, eighteen compartments were selected out of the total of ninety on area A by using random number tables (Fisher & Yates 1963). At each of the sampling points visited in connection with the previous two sections (3.5.1.1. & 3.5.1.2.) in these compartments the amount of incident light was expressed in terms of the percentage of the sky visible in an area of approximately 15m from the centre of the quadrat. Thus on a new plantation where there was no tree canopy the value would be 100%, whereas in dense pole stage coniferous types where little or no sky was visible this might fall to 10 or 5%. Values were estimated to the nearest five percent.

3.5.2. Winter Survey on Areas A, B & C.

It was decided that more detailed studies were needed on areas A, B & C to demonstrate the relative abundance of useful foodstuffs in the winter and to compare this with the observed diet. Late winter and early spring are the times of year when the deer will be shown to be in their poorest condition (Chapter 6) and when food is scarcest. It was also anticipated that the proposed vegetation study would show the importance of different habitat types to the fallow at this crucial time of year. The survey was carried out in March 1973.

Aldous' method used in the summer survey had proved to be extremely laborious and it was felt that a simpler, more efficient and quicker method should be used for this aspect of the work. It was decided to visit the three study areas and assess the relative abundance, in terms of cover, of those food plants found ,as a result of dietary studies (Chapter 5), to be important to deer at this time. Each place visited could be subdivided into many easily recognisable distinct vegetational units of differing floristic composition and the percentage cover of the following plants were assessed visually on a scale of 0 to 10 for each of these units:-

(a) Heather - *Calluna vulgaris*;

(b) Bramble & Rose - *Rubus fruticosus* agg. & *Rosa* spp;

(c) Bilberry - *Vaccinium myrtillus*;

(d) Palatable grassland - see section 3.5.1.1.;

(e) Holly - *Ilex aquifolium*;

(f) Gorse - *Ulex europea* & *U. minor*.

Of these plants, only gorse was not an important winter food in the three years studied but was included in this survey as it is taken freely by ponies on the open forest in February and March (Tubbs 1968; Tyler 1972; pers.obsv.) and is reportably taken by fallow in severe weather (Cadman 1966).

Holly was subdivided into two categories:-

(i) available - foliage between ground level and 1.60m, the normal browse line height; i.e. holly readily accessible to deer at all times.

(ii) tree - all holly above 1.60m.

The second category was included for two reasons. Firstly much holly is cut prior to Christmas and branches without berries are left on the ground (Section 2.1.5.1.). Secondly large numbers of green leaves are known to fall from certain trees in December (Peterken 1965;pers.obsv.) and are taken by the deer. In both cases the holly thus available is normally from the tops of the trees and is without prickles or "blind".

The vegetational units recognised were plotted on six inches to the mile (1:10,560) Forestry Commission Planting Maps. In most cases within Inclosures the ground vegetation was governed by the planting type and little remapping was needed as the units followed the compartment boundaries. On the open forest the boundaries of the different units recognised in this survey were often the same as those recognised on the maps prepared and made freely available by Mr. Colin Tubbs of the Nature Conservancy, Lyndhurst. Any unit of less than one acre in extent was excluded. The area of each individual unit was found from the maps and multiplied by the cover value obtained for each of the listed plants present. The relative cover in different regions of the three main study areas could then be found for each food by summating these values obtained for each of the units comprising the region and dividing by the total area.

Thus although the relative cover of different species of food plant within one particular unit or area is not a strict indication of their quantitative amounts available as deer food, it was felt that comparisons of any one food plant between areas were. For instance if an area had a cover value of 5 for both Calluna and palatable grassland this would not necessarily imply that there would be equal quantities of both to eat. But if two units of the same acreage both had cover values of 5 for Calluna or for grassland, equal quantities of these should be obtainable at both places.

3.6. Faecal Counts

The use of faecal counts as indices of the relative use of different habitats or plant associations by deer is well established (Riney 1957; Batcheler 1960; Bowden, Anderson & Medin 1969) and has been used recently in studies on red deer in Scotland (Holloway 1967; Charles, McCowan & East 1967, in prep.; Miller 1971; Miles 1971). Various sampling methods have been employed and are reviewed by Neff (1968). In this study random transects were used as this appeared the most appropriate and workable method for present purposes. These were set up in three regions of Denny New and Parkhill Inclosures on study area A, (Map II;3,12) where several different vegetation types were in juxtaposition. One transect was established in each type. Transects were marked by wooden stakes or by painting trees in areas of denser vegetation (Bennett, English & McCain 1940); in both cases the poles or trees indicated the central line of the transect. It was found that the maximum width of ground that could be accurately scanned when searching for faecal pellet groups was 1.50m; with the widths of the transect therefore defined as 3.0m. The observer first walked up one side of the central line of the transect and then returned on the opposite side. In this way some degree of overlap was also achieved and the chances of missing a pellet group were further minimised. A pellet group was taken to be ten or more faecal pellets and was considered to be within the transect if more than half of them were within 1.50m of the central line.

A total of fifteen transects were set up totalling 2,600m in length and 7,800m^2 in area. These were searched at monthly intervals from May 1971 until September 1972, with the exception of five transects which were only counted from July 1971 onwards. The number of faecal pellet groups on each were noted and removed. A total of 930 fallow pellet groups were recorded. The location of the transects is given in Table 20, together with the length, number of months searched and short descriptions of their vegetation. The geographical situation of the compartments listed can be found on Map II.

The number of roe deer pellet groups present was also noted. No difficulty was experienced in distinguishing between fresh faecal droppings of the two species which were distinguished by size, shape and colour (Page 1971). Some authors distinguish between pellets from male and female fallow on the basis of their shape and size (Cadman 1966; Page 1971) but as others doubt whether these differences always exist (Chapman & Chapman 1970) no attempt was made to differentiate between them. It was also found that in May and June pellets were often soft and adherent and no true shape or size was distinguishable.

Table 20. Location and Description of Transects used in Faecal Pellet Group Study

location	length(m)	Months scored	Type and Year of Planting
Series I			
Parkhill			
Comp. 54a	150	17	p 1970 Western hemlock,Corsican pine;some mature oaks
54b	200	17	p 1967 Corsican pine
50/54	150	17	Ride with overhanging oaks
51a	100	17	p 1971 Western hemlock;canopy of mature oak/beech
50	250	17	p 1947 Scots pine/oak & p 50 Corsican pine;thicket/pole stage
50/51	200	17	Ride
Series II			
Parkhill			
Comp. 43a/b	200	17	p 1852 Mature oak
43c	150	17	p 1852 Mature oak/beech
43/48	200	17	Ride with overhanging oak/beech
48c	150	15	p 1968 Corsican pine
52b	100	15	p 1860 Mature Scots pine/European larch
Series III			
Denny New			
Comp. 30	250	17	p 1970 Corsican pine
31a	200	17	pre 1900 Mature oak/beech woodland
31b	100	15	p 1870 Mature Scots pine
31e	100	15	p 1966 Western hemlock
34c/31d	100	15	p 1950/52 Scots/Corsican pine;thicket stage

From June to September 1972, counts were performed by Mr. H. Hanna and for the remainder of the time by the author. Riney (1957) has shown that two observers scoring the same transects do achieve comparable results and in the present study a careful check was made to ensure the same high level of accuracy was maintained.

3.7. Other Sources of Information

The census records compiled annually by the Forestry Commission (see section 2.2.1.) of the total deer population in the New Forest were made freely available. The cull figures and venison returns for recent years were also available giving the numbers of animals shot, their sex, approximate age, date and place of culling and the weight of the carcass as sold to the butcher.

Records of deer numbers, behaviour and activity obtained from Forestry Commission wildlife personnel were also kept but are not included here unless specified.

Chapter 4. RESULTS OF VEGETATION SURVEYS

4.1. Summer Survey on Area A

4.1.1. Relative Availability of Different Plants

The results obtained from the summer survey of all available food plants on Area A are given in Table 21. Plants occurring in less than 0.5 percent of the quadrats are recorded as a trace (t) as are those with an average cover of less than 0.01 percent. The latter can be taken as an estimate of the amount of that plant available compared with others of the same plant type (e.g. conifer; graminids) and the percentage of plots in which it is present as an indication of its frequency of occurrence. The significance of these results is discussed in section 5.2.

4.1.2. Browsing Index

The frequency of occurrence, average percentage cover and mean percentage of available twigs browsed for each woody species on Area A are given in Table 22. The value of the percentage cover multiplied by the browsing index is also given and gives an approximate indication of the relative quantitive importance of that species of food type in the diet. Plants occurring in less than 0.5 percent of the quadrats are recorded as a trace (t) as are those with an average cover value of less than 0.01 percent.

Species of trees and shrubs of low occurrence cannot be considered typical as it has been shown that they are often browsed abnormally intensively by deer, possibility due to a curiosity value (Juon 1963; Zai 1964; Cadman 1966; Chard 1970). The results from Area A show that of conifers present in greater than one percent of all plots, Norway spruce, larches and western hemlock were all subject to light use. Roe deer do occur on the study area and are known to browse young conifers to a varying degree in late winter and early spring (Thomson 1966) but

Table 21. Relative Availability of Different Plants on Area A, Summer 1972

Species	% quadrats present	Mean % cover
Douglas fir (*Pseudotsuga menziesii*)	8	0.99
Scots pine (*Pinus sylvestris*)	11	0.83
Western hemlock (*Tsuga heterophylla*)	4	0.55
Norway spruce (*Picea abies*)	4	0.35
Corsican pine (*Pinus nigra*)	5	0.28
Larches (*Larix* sp.)	1	0.07
Redwood (*Sequoia sempervivens*)	t	0.03
Noble fir (*Abies procera*)	t	0.02
Cypressus (*Chamaecyparis lawsoniana*)	t	0.02
Western red cedar (*Thuja plicata*)	t	0.02
Sitka spruce (*Picea sitchensis*)	t	0.01
Yew (*Taxus baccata*)	t	t
Beech (*Fagus sylvatica*)	40	5.31
Birch (*Betula pendula*)	20	1.55
Oaks (*Quercus* sp.)	18	1.55
Hawthorn (*Crataegus monogyna*)	24	1.08
Sloe (*Prunus spinosa*)	12	0.69
Alder-buckthorn (*Alnus glutinosa*)	6	0.24
Willows (*Salix* sp.)	2	0.18
Sycamore (*Acer pseudoplatanus*)	1	0.03
Sweet chestnut (*Castanea sativa*)	1	0.03
Crab apple (*Malus sylvestris*)	t	0.02
Dogwood (*Swida sanguinea*)	t	t
Ash (*Fraxinus excelsior*)	t	t
Rowan (*Sorbus aucuparia*)	t	t
Hazel (*Corylus avellena*)	t	t
Guelder rose (*Viburnum opulus*)	t	t
Alder (*Frangula alnus*)	t	t
Heather (*Calluna*)	27	6.69
Cross-leaved heath (*Erica tetralix*)	12	0.63
Gorse (*Ulex europea*)	2	0.27
Bog myrtle (*Myrica gale*)	1	0.09
Rhododendron (*Rhododendron ponticum*)	1	0.06
Butchers broom (*Ruscus aculeatus*)	2	0.04
Bilberry (*Vaccinium myrtillus*)	1	0.04
Fine-leaved heath (*Erica cinerea*)	1	0.03
Privet (*Ligustrum vulgare*)	t	0.02
Broom (*Sarothamnus scoparius*)	t	t
Purple moor grass (*Molinia caerulea*)	54	9.14
Sweet grasses	56	7.97
Tufted hair-grass (*Deschampsia caespitosa*)	22	1.86
Wood false-brome (*Brachypodium sylvaticum*)	21	1.59
Bulbosus rush (*Juncus bulbosus*)	50	1.01
Sedges (*Carex* sp.)	12	0.79
Bristle bent (*Agrostis setacea*)	8	0.59
Other Juncaceae	35	0.42
Wood rushes (*Luzula* sp.)	5	0.12

Table 21. (contd.)

Species	% quadrats present	Mean % cover
Herbs	66	2.92
Palatable grassland	58	8.86
Ivy (*Hedera helix*)	51	2.98
Bracken (*Pteridium aquilinum*)	60	12.40
Male fern (*Dryopteris felix-mas*)	1	0.04
Holly (*Ilex aquilifolium*)	30	2.91
Bramble (*Rubus fruticosus* agg.)	51	2.70
Rose (*Rosa* spp)	25	0.93
Bramble and Rose	54	2.96

t = trace;less than 0.5 (column 1);less than 0.01 (column 2)

Table 22. Results of the Browsing Survey on Area A

Species	1	2	3	2x3
Abies procera	t	0.03	29.1	0.87
Chamaecyparis lawsoniana	t	0.03	21.5	0.65
Picea abies	5	0.46	10.9	5.01
Larix spp	2	0.10	8.7	0.87
Thuja plicata	t	0.30	6.3	1.87
Tsuga heterophylla	5	0.71	5.6	4.00
Pinus nigra	6	0.36	0.7	0.23
Pinus sylvestris	13	0.92	0.0	0.00
Pseudotsuga menziesii	10	1.28	0.0	0.00
Picea sitchensis	1	0.01	0.0	0.00
Sequoia sempervivens	t	0.01	0.0	0.00
Taxus baccata	t	t	0.0	0.00
Prunus spinosa	14	0.86	42.5	36.51
Alnus glutinosa	5	0.21	41.5	8.72
Malus sylvestris	t	0.01	40.8	0.41
Acer pseudoplatanus	1	0.07	36.7	2.57
Fagus sylvatica	47	6.68	32.9	219.80
Quercus sp.	18	0.82	31.6	25.90
Crataegus monogyna	29	1.34	30.5	40.86
Castanea sativa	1	0.04	21.6	0.86
Frangula alnus	t	t	12.5	0.00
Sorbus aucuparia	t	t	12.5	0.00
Corylus avellena	t	t	12.5	0.00
Betula pendula	22	1.78	12.3	21.87
Salix sp.	2	0.05	10.2	0.51
Swida sanguinea	t	t	4.2	0.00
Viburnum opulus	1	0.02	1.0	0.02
Fraxinus excelsior	t	t	0.0	0.00
Sarothamnus scoparius	t	t	80.5	0.00
Calluna vulgaris	18	1.14	20.8	23.71
Ruscus aculeatus	2	0.04	23.1	0.93
Ligustrum vulgare	t	0.02	15.1	0.30
Erica tetralix	5	0.23	1.1	0.26
Erica cinerea	1	0.03	0.0	0.00
Myrica gale	t	t	0.0	0.00
Rhododendron ponticum	t	0.02	0.0	0.00
Ilex aquilifolium	33	2.35	31.4	73.70

t= trace; less than 0.5 (col 1); less than 0.01 (col 2)

Column 1; % occurrence on all quadrats

Column 2; average % cover

Column 3; average % of twigs browsed

their effect on the browsing pressure will be minimal compared with fallow due to their low population. In a few locations, growth of these conifers had been suppressed by browsing.

The three most abundant softwoods, Scots pine, Corsican pine & Douglas fir were not browsed to any significant extent.

Of the hardwood species present in more than 1% of the quadrats, sloe, alderbuckthorn, sycamore, oak, beech & hawthorn were all browsed moderately whereas willows, guelder rose and birch were used only lightly, the latter despite its widespread occurrence and the fact that it was one of the first deciduous trees to produce new foliage in spring. Cadman (1966) states that birches are not often taken by fallow unless no alternative broadleaves are present.

Calluna and butchers broom were both used moderately as was holly but browsing was miminal on *Erica tetralix* & *E. cinerea*. In March 1971, compartments 51a & 54a in Parkhill (Map II,12) were planted with western hemlock; heavy and extensive browsing damage by deer was recorded. A short survey, conducted in April 1971, revealed that between 80-90% of all trees had been browsed compared with only 1% of all Corsican pine planted on 54a at the same time.

Deer browsed selectively. The amount of incident light was found to be an important factor in determining the acceptability of different trees (section 4.1.2.1.) but instances were common where browsed and unbrowsed specimens of the same species were growing adjacently in apparently identical edaphic conditions (Plate 12).

Severe and continuous removal of current new growth by browsing may result in specimens becoming bushed (Plates 13 & 14). This was particularly prevalent with hawthorn, beech, sloe & holly, all of which are used for hedges by man. Beech and oak will respond to browsing by producing secondary new growth later in the season (Vanek 1958;pers.obsv.).

Plate 12. Selective browsing of Western Hemlock.
The trees were all planted in the same year in apparently identical edaphic conditions; those in the right foreground have grown normally but a sudden transition to squat, stunted individuals, suppressed by constant browsing, can be seen to the left of the photograph.

Plate 13. Heavily browsed compact holly bushes in the foreground compared with the normal growth form seen in the fenced area behind it to which deer do not have access.

Plate 14. Sloe tree showing the compact bush-like shape and much branched growth form associated with heavy and persistent browsing.

Oak was found to be killed by overbrowsing in Stubby Copse Inclosure (Map II,7).

The causes and factors affecting the incidence of browsing are complex and are not always attributable to the nutritive value of the plants. Mention of the susceptibility of rare species has already been made. Juon (1963) has stressed the need for a certain amount of indigestible organic material or ballast in the diet which he states has a promotive effect on the digestive tract and utilisation of food in the intestine. Bubenik (1959) found that when roe deer were fed soft concentrated foods they showed an increased inclination to browse. Bubenik & Casnocha (1963) demonstrated that when the feeding periodicities of red deer were upset by disturbance they browsed more.

4.1.2.1. Effect of Light on Browsing Intensity

The two commonest browse species on Area A were beech and holly with percentage cover values of 6.68 & 2.35 respectively (Table 22). The results of the study of the relationship between light and browsing intensity are shown in Table 23. It is evident that the better the light the greater the browsing intensity. It is suggested that trees growing in open conditions will be richer in nutrients than those under closed canopies and the former are more readily acceptable to the deer.

The browsing indices of herbaceous or semi-woody vegetation such as graminids, herbs and bramble is difficult to assess with accuracy. However inspection of known food plants, notably graminids and bramble, and field observations do strongly suggest that feeding is most intensive in open areas, where these types of plants are also more plentiful (section 4.3.).

4.2. Winter Survey on Areas A, B & C.

Winter vegetative surveys were carried out in March & April 1973 for Calluna, bramble & roses, palatable grassland, bilberry, available

Table 23. Effect of Light Intensity on Browsing Pressures on Beech and Holly on Area A

Light Intensity	Beech		Holly	
(% sky visible)	sample size	mean browse index	sample size	mean browse index
100–91	44	65.4	22	75.4
90–81	19	57.9	11	70.9
80–71	14	54.7	8	46.3
70–61	14	47.7	6	51.6
60–51	5	58.0	1	43.0
50–41	14	44.5	3	53.7
40–31	12	27.9	6	37.9
30–21	17	25.4	9	38.4
20–11	41	17.4	26	25.6
10–0	55	5.1	23	11.3

Table 24. Relative Availabilities of Winter Foods on Areas A, B, and C

	Food Type						
	Brb	Call	Grass	Bilb	Holly av	Holly tree	Gorse
Area A							
1 Parkhill Wood	1.37	2.92	3.35	0.85	0.92	1.84	0.10
2 Matley	1.44	3.71	0.39	0.00	0.00	0.00	0.10
3 Denny New	2.46	1.61	1.71	0.00	1.79	1.51	0.00
4 Denny Wood	1.52	0.85	3.82	0.09	1.67	2.66	0.07
5 B.o.W.P.	0.08	4.75	1.36	0.00	0.03	0.07	0.14
6 Denny Lodge	1.59	0.70	1.67	0.00	0.77	0.10	0.00
7 Stubby	1.42	0.46	0.68	0.00	0.78	0.02	0.00
8 Perrywood	1.17	0.41	1.43	0.00	0.34	0.00	0.02
9 Pignalhill	1.82	0.11	2.13	0.00	0.66	0.00	0.00
10 Whitley	0.40	1.14	4.92	0.00	1.06	1.34	2.28
11 Pignal	2.01	0.68	1.95	0.00	1.60	0.29	0.02
12 Parkhill	1.73	0.48	1.56	0.06	1.05	0.46	0.00
13 Ramnor	2.82	0.00	1.90	0.00	0.87	0.11	0.00
14 Kings Hat	1.52	0.71	1.57	0.00	1.24	3.43	0.00
15 Driftways	0.81	1.41	4.21	0.33	1.24	1.52	0.00
Total	1.40	1.57	1.83	0.07	0.86	0.62	0.09
Area B							
1 Bolderwood	0.19	0.06	1.63	0.09	0.17	0.09	0.03
2 North Oakley	0.01	0.08	0.79	0.08	0.00	0.00	0.04
3 Mark Ash West	0.11	0.11	2.68	1.56	0.61	3.76	0.00
4 Mark Ash East	0.06	0.63	1.52	3.71	0.88	2.71	0.00
Total	0.08	0.30	1.72	1.84	0.57	2.12	0.01
Area C							
1 Highland Water	0.09	0.17	0.51	0.88	0.16	0.20	0.08
2 Holmhill	0.22	0.09	0.85	0.65	0.33	0.19	0.00
3 Wick Wood	0.45	1.51	1.95	2.11	1.78	3.63	0.02
4 Acres Down	0.42	2.24	3.74	0.04	0.42	0.48	1.96
5 Wood Crates	0.68	2.45	2.75	0.71	0.81	2.38	0.02
6 James Hill	0.19	0.61	1.08	1.63	1.97	3.93	0.00
7 Bolderwood Hollies	0.09	3.44	1.45	0.50	0.63	1.23	0.81
Total	0.27	1.64	1.83	0.86	0.74	1.35	0.60

Brb; bramble

Call; Calluna

Bb; Bilberry

av;available

& tree holly and gorse as described in section 3.5.2. The cover assessment values obtained for each of the three study areas and the sub-areas comprising them are given in Table 24, from which it is apparent:-

i) that there may be a considerable difference between the amounts of different foods in adjacent areas;

ii) that there are considerable differences in the amounts of the important winter food plants between Areas A, B & C. These will be discussed in greater detail in section 5.1.3.

4.3. Influence of Stand Age on Available Food

The values for the availability of bramble and sweet grasses obtained from the winter vegetation assessments within Inclosures were compared with the age of the stands concerned. The results are shown in Figure 10 and Table 25.

It can be seen that on new plantations with only young trees present conditions are optimal for the growth of bramble and sweet grasses, both of which are important foods. As the young trees grow the canopy closes, light is excluded and the available forage is minimal. In time the crop will be thinned and as it matures more light will be able to penetrate and suitable food plants will become restablished. However even in stands of over a century in age, the available forage will not be as abundant as that present on young plantations prior to reaching the thicket stage.

A similar effect has been demonstrated by Neumann (1963) in Germany and by Ehrenreich & Murphy (1962) for most forest types in North America. They found that total herb and forage production was greatest at seedling and sapling stages and least under pole stands, increasing again as the stands mature.

As was shown in section 4.1.2.1., available browse in densely shaded areas may also be less acceptable to deer than that growing in the open.

The barren natures of thicket, pole and certain high forest stands

Figure 10 Relationship between Stand Age & Relative Availability of Bramble & Sweet Grasses

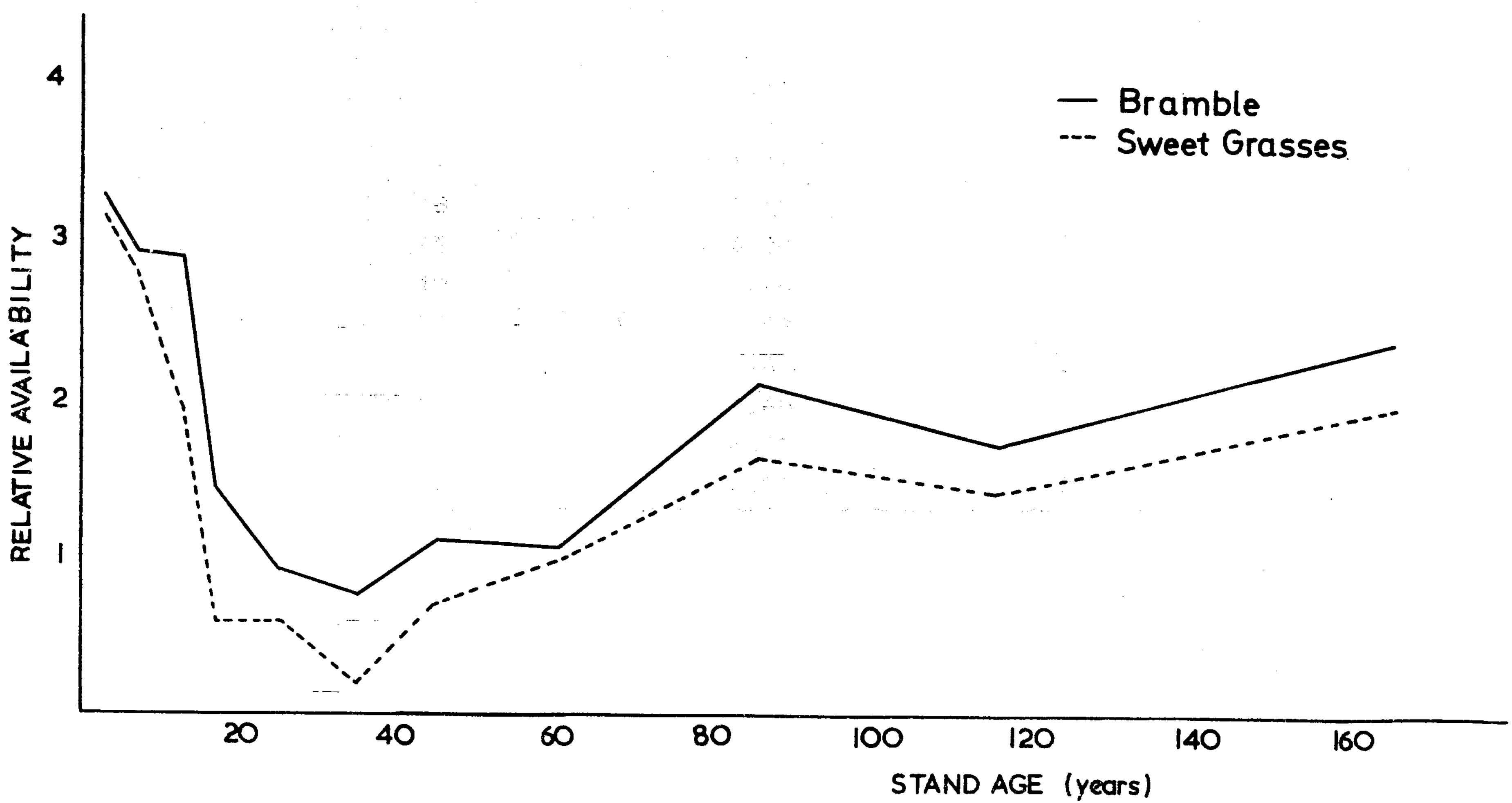


Table 25. Effect of Stand Age on Availability of Sweet Grasses and Bramble on Area A

Stand Age		Cover Value	
(years)	sample size	sweet grasses	bramble
0-4	34	3.15	3.22
5-9	15	2.80	2.93
10-14	21	1.95	2.89
15-19	18	0.61	1.44
20-29	47	0.60	0.90
30-39	10	0.20	0.89
40-49	35	0.69	1.11
50-69	6	1.00	1.00
70-99	21	1.62	2.09
100-149	46	1.41	1.70
150+	24	0.98	2.38

are illustrated in Plates 15-18 where it can be seen that ground vegetation is virtually non-existent.

Plates 15-18, illustrating the virtual absence of ground flora or regenerating scrub and the barren nature of certain plantation types within Inclosures.

Plate 15. Pole stage European larch in Holidays Hill Inclosure (Map I 42)

Plate 16. Mature oak/beech in South Oakley Inclosure (Map I 31)

Plate 17. Pole stage Douglas fir in Holmhill Inclosure
(Map I 43;IV 2)

Plate 18. Mature coniferous stand in Highland Water Inclosure
(Map I 46:IV) showing minimal available food apart
from felled branches.

Chapter 5. DIET.

5.1. Determination of the Diet by Rumen Content Analysis

5.1.1. Annual Diet

Rumen contents were analysed from 325 fallow deer obtained between November 1970 and March 1973. For each month of the year, the average percentage of each food type in the rumens and the percentage of the animals which had been feeding on it were calculated. The results are given in Figure 11 and Tables 26 & 27. During the period May to July and in October, sample sizes were small (Table 18) and this should be remembered when interpreting data from these months.

(1) Conifers

Coniferous browse was found in the ingesta principally between November and March but never constituted more than 20% by volume of the monthly diet. However, with the exception of March, it was present in over 80% of all animals examined and in certain individuals constituted up to 70% of the rumen contents. This food type must therefore be considered an important winter food for fallow.

It was possible to identify most coniferous browse to species level by using the morphological features outlined in Edlin (1970) and by direct comparison with material collected from trees in the study areas. The frequency of occurrence of different species in the rumens can be seen in Table 28.

(2) Broadleaved Trees & Shrubs

Browse from these plants was found in the ingesta mainly between April and November, occurring in more than 70% of all deer examined each month. Sample sizes in May, June & July, the times when most species produced abundant new growth, were small and the quantitative

Figure 11 Annual Diet determined by Rumen Analysis

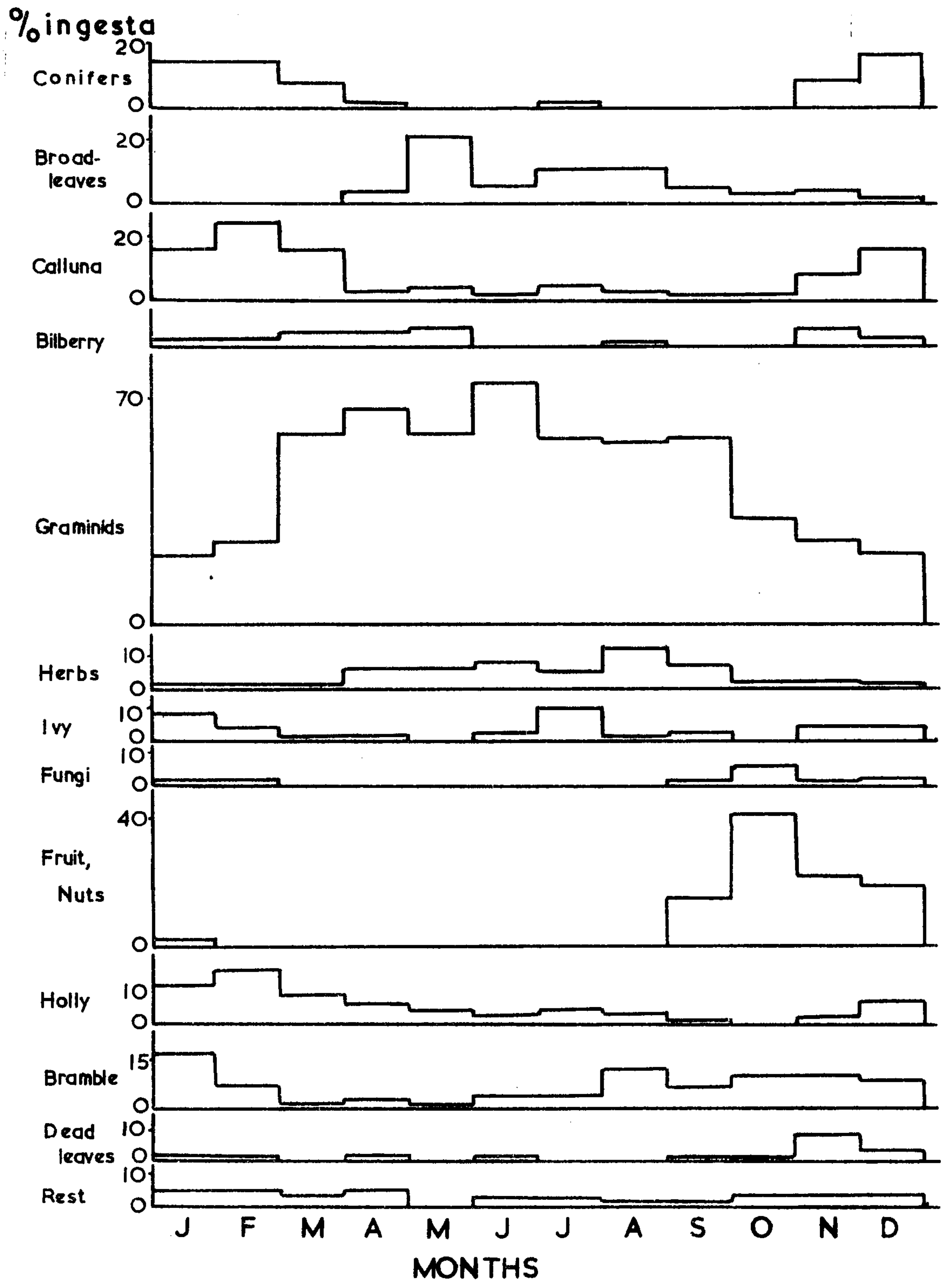


Table 26. Percentage Quantitative Composition of the Annual Diet determined by Rumon Analysis

Food Type		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conifer		14	14	7	1	t	0	1	0	t	t	8	17
Broadleaf tree		t	t	0	4	21	5	11	11	5	3	4	1
Dwarf shrub	*Calluna*	16	24	16	3	4	2	5	3	2	1	8	16
	Bilberry	2	2	4	4	5	0	0	1	t	t	5	2
	Other	t	t	0	1	0	0	0	t	0	t	t	t
	Gorse	t	t	0	0	0	0	1	t	t	1	t	t
Graminids		21	25	59	67	59	75	58	57	58	33	26	21
Herbs		1	1	1	6	6	8	5	12	7	2	2	1
Ivy		8	4	1	1	t	2	10	1	2	t	4	4
Fungi		1	1	t	0	0	0	0	0	1	6	1	2
Moss		1	2	1	1	t	2	0	t	t	t	1	t
Fern		2	1	t	1	0	0	1	t	t	t	1	1
Fruit & nuts	Acorn	2	t	0	0	0	0	0	0	13	32	19	14
	Mast	t	t	0	0	0	0	0	0	t	9	2	1
	Crab apple	0	t	0	0	0	0	0	t	1	0	1	t
	Other	t	t	0	0	0	0	0	0	1	0	t	t
Bark	Conifer	t	1	t	2	0	0	0	0	t	0	t	t
	Deciduous	t	t			0	0	1	0	0	0		
Holly		12	17	9	7	4	2	5	3	1	t	2	7
Bramble/Rose		17	7	2	3	1	4	4	12	7	10	10	8
Dead leaves		1	1	t	1	t	1	0	t	1	1	8	3
Other		t	1	0	0	0	0	0	t	t	t	t	t
No. deer		73	48	11	17	3	2	2	16	26	5	70	51

Table 27. Percentage Occurrence of Different Food Types in Rumens Analysed

Food Type		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Months											
Conifer		85	83	55	41	33	0	50	0	27	20	81	86
Broad-leaf tree		14	6	0	76	100	100	100	88	92	80	70	20
Dwarf shrub	*Calluna*	86	92	82	53	33	50	100	38	35	60	74	76
	Bilberry	36	29	36	29	67	0	0	19	15	20	44	41
	Other	11	16	0	6	0	0	0	6	0	20	10	25
	Gorse	7	6	0	0	0	0	50	6	4	20	3	2
Graminids		100	100	100	100	100	100	100	100	100	100	100	100
Herbs		36	35	55	82	100	100	100	100	96	80	69	55
Ivy		74	79	45	65	67	100	100	56	46	50	71	71
Fungi		27	23	9	0	0	0	0	0	38	60	44	41
Moss		38	50	27	47	33	50	0	6	23	40	36	37
Fern		58	44	27	47	0	0	50	6	23	40	43	59
Fruit & nuts	Acorn	25	4	0	0	0	0	0	0	42	80	37	29
	Mast	10	2	0	0	0	0	0	0	4	0	14	22
	Crab apple	0	4	0	0	0	0	0	6	12	20	16	16
	Other	5	2	0	0	0	0	0	0	15	0	13	29
Bark	Conifer	4	8	18	12	0	0	50	0	4	0	11	10
	Broadleaf	10	15			0	0	0	0	0	0		
Holly		90	90	64	65	67	50	100	63	23	20	41	73
Bramble/Rose		81	63	36	71	67	100	100	94	85	100	83	69
Dead leaves		52	63	36	59	67	50	0	38	50	60	80	69
Other		8	4	0	0	0	0	0	13	4	20	10	4
No. deer		73	48	11	17	3	2	2	16	26	5	70	51

Table 28. Monthly Occurrence of Different Species of Coniferous Browse in Rumens Analysed

Month	N	% with that Conifer									
		SP	CP	WH	DF	NF	NS	SS	Lx	Yew	Unknown
January	62	68	5	18	8	0	24	3	0	5	2
February	40	80	3	15	15	0	35	5	3	5	0
March	6	83	0	0	0	0	0	0	0	17	0
April	7	57	0	0	14	0	43	14	0	14	0
May	1	100	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0
July	1	100	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0	0
September	7	100	0	0	0	0	0	0	0	0	0
October	1	100	0	0	0	0	0	0	0	0	0
November	57	69	4	12	11	0	18	0	0	4	0
December	44	73	3	11	9	3	36	0	0	7	0

N; total number with coniferous browse

SP; Scots pine
CP; Corsican pine
WH; Western hemlock
DF; Douglas fir
NF; Noble fir
NS; Norway spruce
SS; Sitka spruce
Lx; larches

Table 29. Relative Importance of Species of Broadleaf Browse from April to October determined by Rumen Analysis

Month	Species																		Sample size
	beech		birch		hawthn		sloe		oak		alder		willow		sw.ch		?		
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	
April	31	12	92	66	23	3	0	0	23	15	0	0	8	4	0	0	0	0	13
May	100	61	100	25	33	5	33	2	33	5	0	0	0	0	0	0	33	2	3
June	100	60	50	10	0	0	0	0	100	30	0	0	0	0	0	0	0	0	2
July	50	40	50	9	50	17	0	0	100	30	0	0	0	0	0	0	50	4	2
August	14	9	7	1	14	4	0	0	79	71	14	6	0	0	0	0	14	9	14
September	27	7	21	3	13	4	0	0	96	84	8	3	0	0	4	t	0	0	24
October	25	10	25	10	25	8	0	0	100	72	0	0	0	0	0	0	0	0	4

column a; % occurrence in all rumens that month
column b; % of the broadleaf browse that each species formed quantitatively

sw.ch; sweet chestnut ?; unidentifiable

importance of this food type is therefore difficult to assess from the rumen analyses. Table 29 presents the data for all deer obtained between April and October which had fed on this browse, to show the frequency of occurrence and amount of this food type that various broadleaved species formed.

Results for birch, beech and oak demonstrate that a seasonal pattern of use exists. Birch, the first of these three species to produce new leaves, is present in April in over 90% of deer with this food type, constituting 66% of it by volume; its relative importance subsequently declines. Beech buds break about May and this species is important as a food from then until July, when oak, the last of these trees to sprout new leaves, becomes the commonest browsed hardwood until October.

The picture may become confused in that beech and oak may both produce a second flush of new growth should the first ones be removed by browsing or killed by disease (Vanek 1958).

Any seasonal pattern of use in the other species listed is difficult to assess but would seem to indicate that hawthorn is taken throughout this period.

(3) Dwarf Shrubs.

(a) Calluna vulgaris

From Figure 11 and Tables 26 & 27 it can be seen that Calluna is an important food plant between November and March, forming between a tenth and a quarter of the food and being present in 70-90% of all deer. Peak usage occurred after Christmas when individuals were found with a maximum of 79% of the ingesta being Calluna.

It is also found in smaller amounts during the rest of the year, notably in animals from poorer moorland areas where the new spring growth of grass is often delayed and Calluna may still be taken in sizeable amounts into early May. For instance two deer killed in road traffic accidents on 13.4.72 at Markway (Map I,87) and on 7.5.72 in the extreme northwest of the Forest contained 28 & 9% of Calluna respectively. Grasses on moorland stretches are also liable to dry out rapidly in late summer (section 2.1.2.), because of the shallow soil and exposed conditions, as happened in 1972. At such times this plant is again taken, two prickets (yearling males) shot on 7.8.72 at Hampton Ridge (Map I,11) and on 19.9.72 at Hasley (Map I,14) containing 27 & 40% Calluna and 41 & 18% graminids respectively.

(b) Bilberry

Bilberry was found in small amounts in August and from November until May but never formed more than 5% of the monthly diet quantitatively. As has been shown in section 4.2., bilberry is only locally abundant but in areas where it is found it may form a substantial part of the diet as will be shown subsequently (section 5.3.1.). New young growth may also be taken in March and April as is illustrated by four deer culled in Mark Ash & Holidays Hill (Map I,39,42) on 6.4.72, 25.4.72, 26.4.72 and 8.3.73. Their ingesta comprised 9, 31, 22 and 22% bilberry respectively.

(c) Gorse

The gorses Ulex europea and U. minor were never found in more than one tenth of the animals examined each month, with the exception of July and October when sample sizes were small, and never constituted more than 1% of the diet quantitatively of the total of 15 individuals with gorse during the entire study, fourteen had U. europea and one the smaller cat gorse, U. minor.

(d) Others

Of the other dwarf shrubs, butchers broom and bog myrtle were never found in a single rumen. Rhododendron Rhododendron ponticum was found scattered throughout the New Forest but only one animal was found to have taken this plant, a doe poached between Bolderwood Inclosure and Highland Water (Map I,37,46) on 12.1.73 containing 10% of young leaves.

Erica tetralix and *E. cinerea* are both common on the open forest, particularly the former (section 2.1.5.1.) but the maximum amounts ever found in rumen contents were 11 & 2% respectively. It can be seen from Table 26 & 27 that these two heathers (which effectively comprise the food type "other dwarf shrubs") never comprised more than 1% of the monthly diet by volume or were found in more than one quarter of the deer in that period. These species are not important as a food for fallow in the New Forest.

(4) Graminids.

These were found in every animal examined and were also important quantitatively throughout the year, never forming less than 20% of the volume in any one month, and comprising 55-75% of the diet from March until September (Fig.11, Tables 26,27).

The main types of graminid recognised were described in section 3.3.2. and their frequency of occurrence in all rumens examined is given in Table 30. The percentage volume of the monthly graminid food which each type constituted is shown in Table 31.

From these two tables it is evident that sweet grasses are the most important of the graminids which were present in all but two rumens analysed and forming at least 75% of this food type in any month. *Molinia* was of very little use and *Deschampsia caespitosa* was only ever isolated from two rumens. The bristle bent, *Agrostis setacea* was never found in any large number of animals or in any significant amounts.

The small rush, *Juncus bulbosus*, could be distinguished from other types and was a minor foodstuff especially from August until February being present in 20% of all animals and found in monthly amounts of up

Table 30. Percentage Occurrence of Graminid Types in Rumens

Month	Graminid type								
	sw.gr	Mo	Desc	As	Jb	J	Cx	Br.sl	n
Jan	100	14	0	1	15	11	25	14	73
Feb	96	17	2	10	19	17	25	13	48
Mar	100	9	0	0	0	0	9	8	11
Apr	100	6	0	12	6	6	12	6	17
May	100	33	0	0	0	0	0	0	3
Jun	100	50	0	0	0	0	0	0	2
Jul	100	100	0	0	0	0	0	0	2
Aug	100	6	0	6	19	6	13	0	16
Sep	100	7	0	4	23	4	19	15	26
Oct	100	20	0	0	20	0	20	20	5
Nov	100	11	0	6	23	9	7	1	70
Dec	100	12	1	10	20	8	14	0	51

Table 31. Percentage Volume of the Graminid Food in the Rumen which each Type Constituted

Month	Graminid type								
	sw.gr	Mo	Desc	As	Jb	J	Cx	Br.sl	n
Jan	77	3	0	t	4	4	7	5	73
Feb	82	2	t	2	3	2	5	4	48
Mar	95	2	0	0	0	0	1	2	11
Apr	88	2	0	1	2	2	4	1	17
May	98	2	0	0	0	0	0	0	3
Jun	96	4	0	0	0	0	0	0	2
Jul	95	5	0	0	0	0	0	0	2
Aug	86	5	0	1	5	1	2	0	16
Sep	83	1	0	1	10	1	2	2	26
Oct	86	2	0	0	3	0	3	6	5
Nov	88	2	0	1	5	2	1	1	70
Dec	88	2	t	2	4	2	2	0	51

sw.gr; sweet grasses
Mo ; *Molinia caerulea*
Desc ; *Deschampsia caespitosa*
As ; *Agrostis setacea*
Jb ; *Juncus bulbosus*
J ; other Juncaceae
Cx ; *Carex* sp.
Br.sl; *Brachypodium sylvaticum*

n; sample size
t; trace; less than 0.5%

to 10% (Table 30). Individuals were examined in which as much as 40% of their total food was this rush. Larger rushes occurred less frequently and only in small amounts, no individual being found with more than one tenth of its ingesta comprising this plant type.

The Cyperaceae, or sedges, were found in small amounts in most months of the year and assumed minor importance in January & February when they formed over 5% of the graminid intake and were present in 25% of the specimens. However no individual contained more than 12% of sedges in its total rumen contents.

The large grass, Brachypodium sylvaticum, the wood false-brome, occurred in the diet principally in the New Year, when new shoots were taken, but also in autumn when foliage was not ingested, the deer selecting only the oat-like seed heads.

Therefore although all types of graminid may be of limited value as a food for fallow at certain times of the year, the sweet grasses are extremely important throughout.

(5) Herbs

Although herbs were found in rumens from all months they were primarily encountered from April until September when over 80% of all animals examined had been feeding on them and they comprised between 5 & 12% of the diet quantitatively. Peak values occurred in August (Fig.11, Tables 26 & 27). During this period individuals were found with up to 30% of the ingesta being herbs but occasionally deer culled during the winter also had large amounts present. For example a fawn shot in November 1970 in Holmhill contained 40% wood sorrel (Oxalis acetosella), a doe in January 1971 from Mark Ash 26% comprised of white clover (Trifolium repens), pennywort (Hydrocotyle vulgare) & wood sage (Teucrium scrodonium) and a fawn on the same day from Bolderwood Inclosure with 21% of the bedstraw, Galium saxatile.

(6) Ivy

Although in some cases distinction could be made between the darker triangular leaved trailing ivy and the larger, rounded ones of the climbing form, this was not always possible and the two morphs are included together here. During the winter months over 70% of all deer had taken ivy and although the actual amount never constituted more than 10% of the diet it was recorded in certain deer in amounts of up to 43%.

It may also be taken at other times of the year. A buck killed in July 1971 near Burley contained 12% of this food and a doe from Furzey Lawn (Map I,51) 20%. Both these animals were killed in areas immediately adjacent to compartments where mature Scots pine was being felled and the shape and size of the leaves in the rumen both suggested that the ivy taken was from this newly cut timber. It was also of note that neither animal had been browsing on the pine foliage.

(7) Fungi

Fungi were of minor importance between September and March but especially in early winter when this food was found in over 40% of all deer and although forming only a few percent of the overall diet at this time individuals were found with as much as 20% in the ingesta. Recognition of fungal particles was often difficult and the only species positively identified were <u>Trametes gibbosa</u>, <u>T.versicolor</u> and <u>Auricularia auricula</u>.

(8) Bryophytes

Bryophytes, the mosses and liverworts, were never important quantitatively as a food although it was found in 20-50% of the deer examined each month. Only the large hair mosses (<u>Polytrichium</u> sp.) were of regular occurrence being found in 60% of rumens containing bryophytes in the period from November to February. It was also the only bryophyte to constitute in excess of 5% of the ingesta of any one deer, being found in five individuals listed in Table 32. It would appear that this

Table 32. Occurrence of *Polytrichium* sp. in Certain Rumens Analysed

Date	Place	Sex	Age	% ingesta	Study Area
Apr 71	Highland Water	M	pricket	9	C
Jan 72	Acres Down	M	fawn	14	C
Jan 72	Wood Crates	F	fawn	26	C
Feb 72	Holmhill	F	fawn	31	C
Jan 73	Parkhill	M	fawn	11	A

Table 33. Occurrence of *Dryopteris felix-mas* in Certain Rumens Analysed

Date	Place	Sex	Age	% ingesta	Study Area
Jan 70	Bolderwood I	F	doe	9	B
Jan 70	Acres Down	M	fawn	29	C
Dec 71	Bolderwood I	M	fawn	8	B
Nov 72	Acres Down	F	fawn	5	C
Jan 73	North Oakley	F	yearling	9	B
Jan 73	North Oakley	M	fawn	5	B
Feb 73	Ramnor	F	fawn	8	A

particular species of moss, which forms small "carpets" under mature broadlead woodland, is taken intentionally by fallow.

(9) Ferns

From Table 26 it is evident that although ferns were found in the diet during most of the year they were never of any importance quantitatively. During the winter cull, from November until February, the male fern Dryopteris felix-mas was present in 70% of all deer with this food type and dead bracken in 60%. The former fern was occasionally found in appreciable amounts in the ingesta being present as 5% or more in the seven animals in Table 33.

Dead bracken was never found in amounts greater than 3% in any particular specimen. Green bracken was available extensively throughout the New Forest (section 2.1.5.1.) from April until October & of 71 rumens examined during that period 13 contained this fern but in only three was live material present. In none of these three did green bracken constitute more than 1% by volume of the contents. These observations strongly suggest that bracken is not normally actively taken by fallow deer at any time of the year, the small amounts of dead material found being ingested accidentally whilst feeding.

(10) Fruit and Nuts

Fruit and nuts, especially acorns, were important as foods from September until January as can be seen from Tables 26,27 and Figure 11. As will be shown in section 5.1.2. the importance of acorns and beech mast may fluctuate greatly from year to year and when the results for the two Septembers in the study period are presented separately (Table 36) this difference is evident. When considering this particular food type it is thus essential to consider each season separately but it is clear that in the autumn of 1971 acorns were extremely important in the diet.

Maximum quantities recorded for any individual sample were 73% for acorns and 40% for beech mast. No husk from mast were ever found and in only one rumen was one particle of the basal "cup" of acorns ever found.

Trace quantities of blackberries were found in 12 deer, yew in 1 and sweet chestnuts in 3. Hollyberries were present in 14 animals in quantities of up to 6%; in six of these instances no holly foliage was present suggesting that the berries were actively selected. One berry of the garden bush Berberus was seen in a pricket from Busketts Wood (Map I,53) in July 1972.

(11) Bark

From Table 27 it was evident that with the exception of July when only two deer were available, bark was never found in more than a fifth of the rumens examined in any one month. Freshly ingested bark was isolated from 41 samples and their types identified; these are given in Table 34.

Only holly, western hemlock, Scots pine, Norway spruce and Douglas fir were ever present as more than 5% in any rumen and these are shown in Table 35.

The results from the rumen analyses indicate that barking is not a widespread habit in fallow and occurs principally during the winter, holly and felled Scots pine being the most susceptible species.

(12) Bramble and Rose

With the exception of March, over 60% of all animals obtained had fed on bramble or rose (Table 27). This food type was especially important quantitatively from August until February with a peak in January when it comprised 17% of the rumen material (Table 26).

(13) Holly

Holly was found in the majority of deer from December to August although it was of low occurrence in September and October. Quantitatively it was most important from December until the following April, comprising between 7 and 12% of the food (Table 26).

Table 34. Number of Rumens in which Bark of Various Trees Occurred

Month	Tree Species							
	Bi	Ho	WH	Oak	SP	NS	DF	Unknown
January	1	9	0	0	2	1	0	0
February	1	3	0	0	5	1	0	0
March	0	1	0	0	1	0	0	0
April	0	1	1	0	0	0	0	0
May	0	0	0	0	0	0	0	0
June	0	1	0	0	1	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	1
October	0	0	0	0	0	0	0	0
November	0	2	1	1	2	0	1	0
December	0	3	0	2	2	0	0	4

Bi : Birch WH : Western hemlock NS : Norway spruce
Ho : Holly SP : Scots pine DF : Douglas fir

Table 35. Occurrence of Bark in Certain Rumens Analysed

Date	Place	Sex	Age	Tree Species	% ingesta
Jan 72	Acres Down	F	Adult	Holly	35
Jan 73	Whitley Wood	M	Adult	Holly	8
Apr 72	New Park	M	Adult	Western hemlock	20
Jan 72	Denny New	M	Yearling	Scots pine	9
Feb 73	Perrywood	F	Adult	Norway spruce	8
Nov 72	Highland Water	M	Fawn	Douglas fir	8

Table 36. Occurrence of Fruit and Nuts in Rumens in September 1971 and 1972

Type	Year					
	1971&1972		1971		1972	
	a	b	a	b	a	b
Acorn	13	42	60	100	1	33
Mast	t	4	1	20	0	0
Crab Apple	1	12	2	20	t	10
Others	1	15	0	0	1	19
Sample size	26		5		21	

column a; mean % monthly ingesta
column b; % of deer with that food type

Table 37. Percentage Occurrence of Dead Broadleaf Species in Rumens in November and December

Species	% with that species	
	November	December
Alnus glutinosa	11	7
Crataegus monogyna	18	6
Frangula alnus	4	0
Fraxinus excelsior	7	0
Quercus sp.	82	83
Sorbus aucuparia	7	0
Viburnum opulus	7	0
Acer pseudoplatanus	2	0
Sambucus nigra	2	0
Betula pendula	13	0
Fagus sylvatica	21	26
Salix sp.	4	0
Castanea sativa	2	0
Unidentifiable	27	9
Sample size	56	35

(14) Dead Broadleaves

During the period from January until October small amounts of dead broadleaves, never forming more than one percent of the monthly diet, were found in approximately half of the deer. During November and December these figures rose to 8 & 80 and 3 & 69% respectively (Table 26 & 27). The species identified and their frequency of occurrence in the 81 deer shot during these two months are shown in Table 37. Of these, 17 contained more than ten percent of dead broadleaves which are listed in Table 38 together with the relative percentage of each species they contained, determined by volumetric measurement.

From this it can be seen firstly that beech, which occurred in 21-26 % of the rumens (Table 37), was never quantitatively important. However other species which are rare in the New Forest may be taken in large amounts, e.g. ash and rowan, suggesting that they may be actively selected. All of the important species in Table 36 are those in which the leaves often fall whilst still partially green unlike the hard, leathery ones of beech.

(15) Other Materials Consumed

Recently ingested extraneous material was found in trace amounts in less than 14 % of the deer in most months of the year (Table 27). Some of the material such as aphids and small lepidopteran larvae were undoubtably taken in accidentally with other plants. The presence of items such as ladies knickers, sweet papers and plastic baler twine suggested that these may be taken from curiosity. One buck culled near the large car park at Bolderwood Green on 12.2.73 was found to contain 25 % of freshly ingested paper bags and is believed to have been scavanging around the litter bins there.

Table 38. Percentage of the Ingesta formed by Various Species of Dead Broadleaves in Deer in which this Food-Type constituted at least 10% of the Rumen Contents.

Date	Place	Sex/Age	% ingesta that species formed												
			Oak	Be	Ro	Fa	Vo	Hw	Bi	Ag	Ash	Sx	Ed	?	Total
Dec 70	Acres Down	M fawn	10	2	0	0	0	0	0	0	0	0	0	0	12
Nov 72	Highland Water	M fawn	9	0	29	0	0	0	0	0	0	0	0	0	38
Nov 72	Acres Down	F doe	4	0	0	0	8	0	0	0	0	0	0	26	38
Nov 72	Acres Down	F fawn	9	1	0	0	20	12	3	0	0	0	0	0	48
Nov 72	Holmhill	F fawn	7	0	0	0	5	0	0	2	0	0	0	4	18
Nov 72	Holmhill	F fawn	4	0	0	0	3	5	0	0	0	0	0	3	15
Nov 72	Holmhill	M fawn	11	0	8	1	0	8	0	2	0	0	0	23	53
Nov 72	Highland Water	M fawn	0	0	0	0	5	0	0	4	0	0	0	7	16
Nov 72	Holmhill	F fawn	7	0	0	3	0	0	0	0	0	0	0	0	10
Nov 72	North Oakley	M fawn	0	0	5	0	0	0	0	5	7	0	0	0	17
Nov 72	New Park	F fawn	19	0	0	0	0	4	5	0	1	2	0	13	44
Nov 72	Woodfidley	F fawn	27	0	0	0	0	3	0	0	18	0	0	11	59
Nov 72	Woodfidley	F fawn	3	0	0	0	0	0	0	0	38	0	0	0	41
Nov 72	Ramnor	M fawn	4	1	0	0	0	0	0	0	0	0	8	0	13
Dec 72	Holmhill	F doe	7	2	0	0	0	0	0	0	0	0	0	6	15
Dec 72	Holmhill	F fawn	7	1	7	0	0	1	1	0	0	0	0	4	21
Dec 72	Mark Ash	M fawn	2	0	0	0	0	5	0	3	0	0	0	2	12

Be: beech   Fa: *Frangula alnus*   Hw: hawthorn   Ag: *Alnus glutinosa*   Ed: elder
Ro: rowan   Vo: *Viburnum opulus*   Bi: birch   Sx: willow   ? : unidentifiable

5.1.2. Diet in the Winters of 1970-71, 71-72 & 72-73.

The diet of deer obtained during each of the three winters, November to February, of the study period was determined by analysis of the rumen contents. The average percentage of the ingesta that each food type constituted was calculated monthly and the results are present in figure 12 and Table 39. The frequency of occurrence of different foods in the rumens are given in Table 40.

From this data it is evident that the relative importance of different foods may vary from year to year. In 1970 and 1971 good crops of acorns and mast were present and formed an important food for deer but the oaks & beech bore few nuts in the following year. The other important foods during this period such as conifers, grass, *Calluna*, holly and bramble are less susceptible to such marked annual variation in availability but it can be seen that their importance as foods may also change from year to year.

As might be expected, if one food is absent i.e. acorns & mast, then others will be taken instead. This can be seen in 1972-73, and to a lesser extent in the previous winter, when conifers & *Calluna* were present in greater amounts. They also became important earlier in the winter as did other major foods such as bramble and holly and the minor ones like bilberry and ivy, although their status did not alter quantitatively. The situation regarding dead broadleaves has been discussed in detail in the previous section 5.1.1.

It should be noted that the importance of grass in the diet was the same in all three years.

5.1.3. Winter Diet in Areas A, B & C.

Figure 14 & Tables 41 & 42 show the relative importance of different food types in the winter diet as determined by rumen content

Figure 12 Diet in the Three Winters (November-February), 1970-71, 71-72 & 72-73 determined by Rumen Analysis

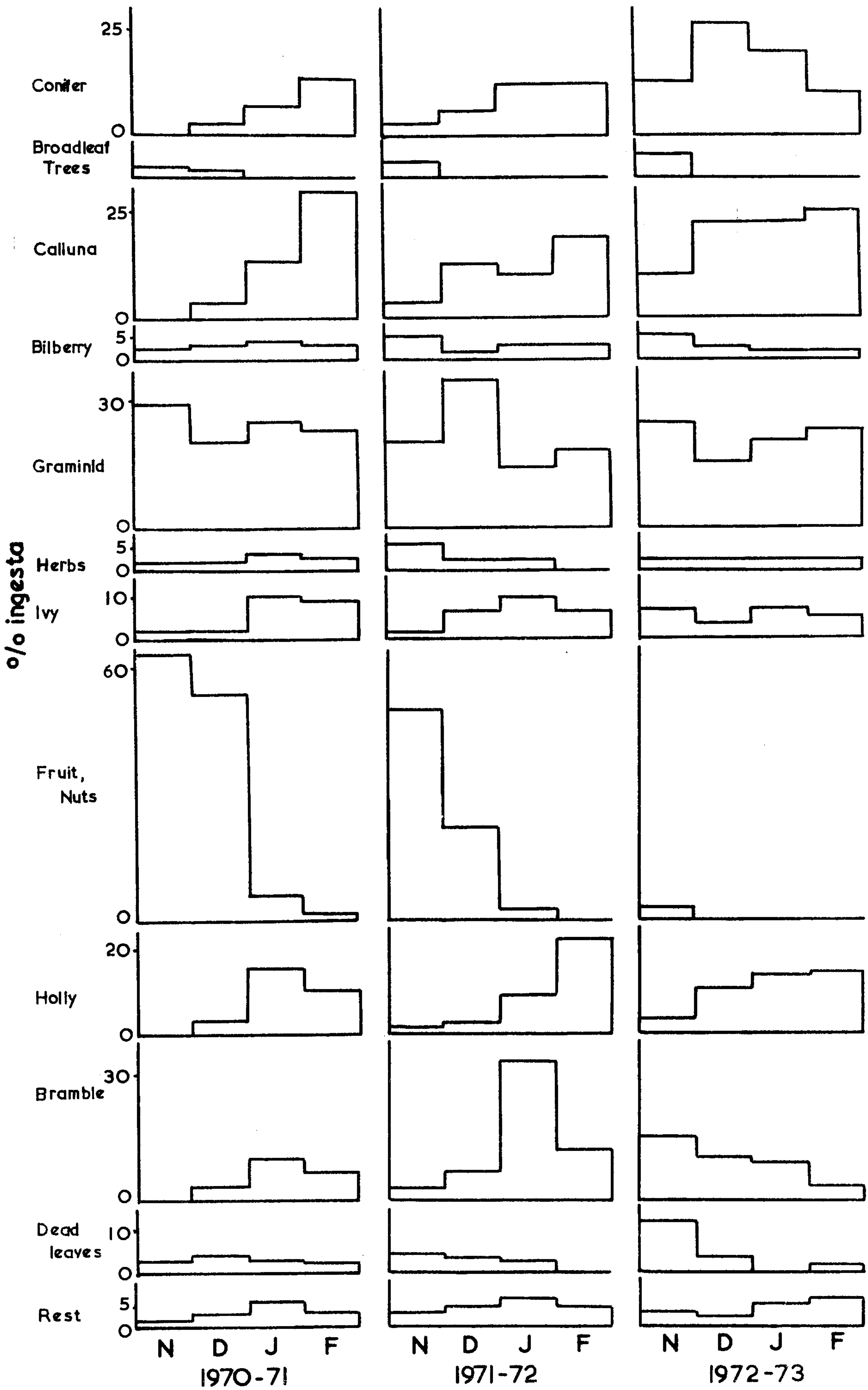


Table 39. Percentage Quantitative Composition of the Ingesta in the Three Winters, November-February, 1970-71, 71-72 and 72-73

Food type		1970-71				1971-72				1972-73			
		Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb
Conifer		1	3	7	13	3	6	12	12	12	27	20	16
Breadleaf tree		2	1	t	t	3	t	t	t	5	t	t	0
Dwarf shrub	*Calluna*	t	4	13	30	3	12	10	19	11	22	22	24
	Bilberry	1	2	3	2	5	1	3	3	6	2	1	1
	Other	t	t	t	t	0	0	t	1	1	2	t	t
	Gorse	0	t	t	t	0	0	t	t	t	0	t	t
Graminids		29	21	25	23	21	35	14	18	26	15	23	30
Herbs		1	1	3	2	5	1	1	t	1	1	1	1
Ivy		1	1	10	8	1	7	11	7	6	4	6	5
Fungi		1	4	1	1	2	1	1	t	1	2	t	1
Moss		t	t	t	1	t	1	2	3	t	t	1	1
Fern		t	t	3	1	t	2	1	t	1	1	1	1
Fruit & nuts	Acorn	53	39	5	t	50	20	2	0	t	0	0	0
	Mast	9	13	t	1	0	1	0	0	0	0	0	0
	Crab apple	1	1	0	0	1	1	0	t	t	0	0	t
	Other	0	1	0	0	t	t	t	0	t	t	t	t
Bark	Coniferous	5	t	t	t	1	t	0	0	t	0	t	1
	Deciduous		t	t	t			2	t	t	t	1	t
Holly		t	2	16	10	1	2	8	23	3	11	13	14
Bramble/rose		t	3	11	7	2	7	30	12	16	10	9	3
Dead leaves		1	3	2	1	4	3	1	1	12	3	t	1
Other		0	0	1	t	0	0	t	0	t	t	t	1
No. deer		14	13	17	13	12	10	24	15	44	28	32	20

t= trace; less than 0.5%

Table 40. Percentage Occurrence of Different Foods in the Ingesta in the Three Winters, November to February, 1970-71, 71-72 and 72-73.

Food Type		1970-71				1971-72				1972-73			
		Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb
Conifer		50	77	82	92	100	70	96	87	86	96	78	75
Broadleaf tree		64	46	6	8	100	20	17	13	64	7	16	0
Dwarf shrub	<u>*Calluna*</u>	21	46	76	100	83	90	83	93	87	86	94	85
	Bilberry	43	38	59	31	42	50	29	47	46	39	28	15
	Other	7	23	12	23	0	0	4	20	14	36	16	10
	Gorse	0	8	6	8	0	0	4	7	5	0	9	5
Graminids		100	100	100	100	100	100	100	100	100	100	100	100
Herbs		57	54	41	46	100	50	46	27	64	57	25	35
Ivy		71	69	59	77	67	70	83	87	73	71	75	75
Fungi		50	46	41	38	58	30	29	7	39	43	19	25
Moss		43	46	41	46	83	70	54	67	20	21	25	40
Fern		36	62	59	54	67	90	75	40	39	46	44	40
Fruit &nuts	Acorn	100	69	41	15	92	60	46	0	2	0	0	0
	Mast	71	77	41	8	0	60	0	0	0	0	0	0
	Crab apple	21	15	0	0	25	10	0	7	11	0	0	5
	Other	0	23	0	0	8	40	8	0	18	7	6	5
Bark	Coniferous	{7	23	6	8	{42	{10	0	0	2	0	6	15
	Deciduous		23	6	15			13	7	2	11	19	20
Holly		29	38	82	85	75	70	88	87	36	89	97	95
Bramble/rose		43	54	82	62	92	70	96	80	93	75	69	50
Dead leaves		71	85	71	62	92	80	71	60	80	57	28	35
Other		0	0	12	8	0	0	13	0	16	7	3	5
No. deer		14	13	17	13	12	10	24	15	44	28	32	20

Figure 13 Diet on Areas A, B&C in the Winters 1970-71 & 71-72 as determined by Rumen Analysis

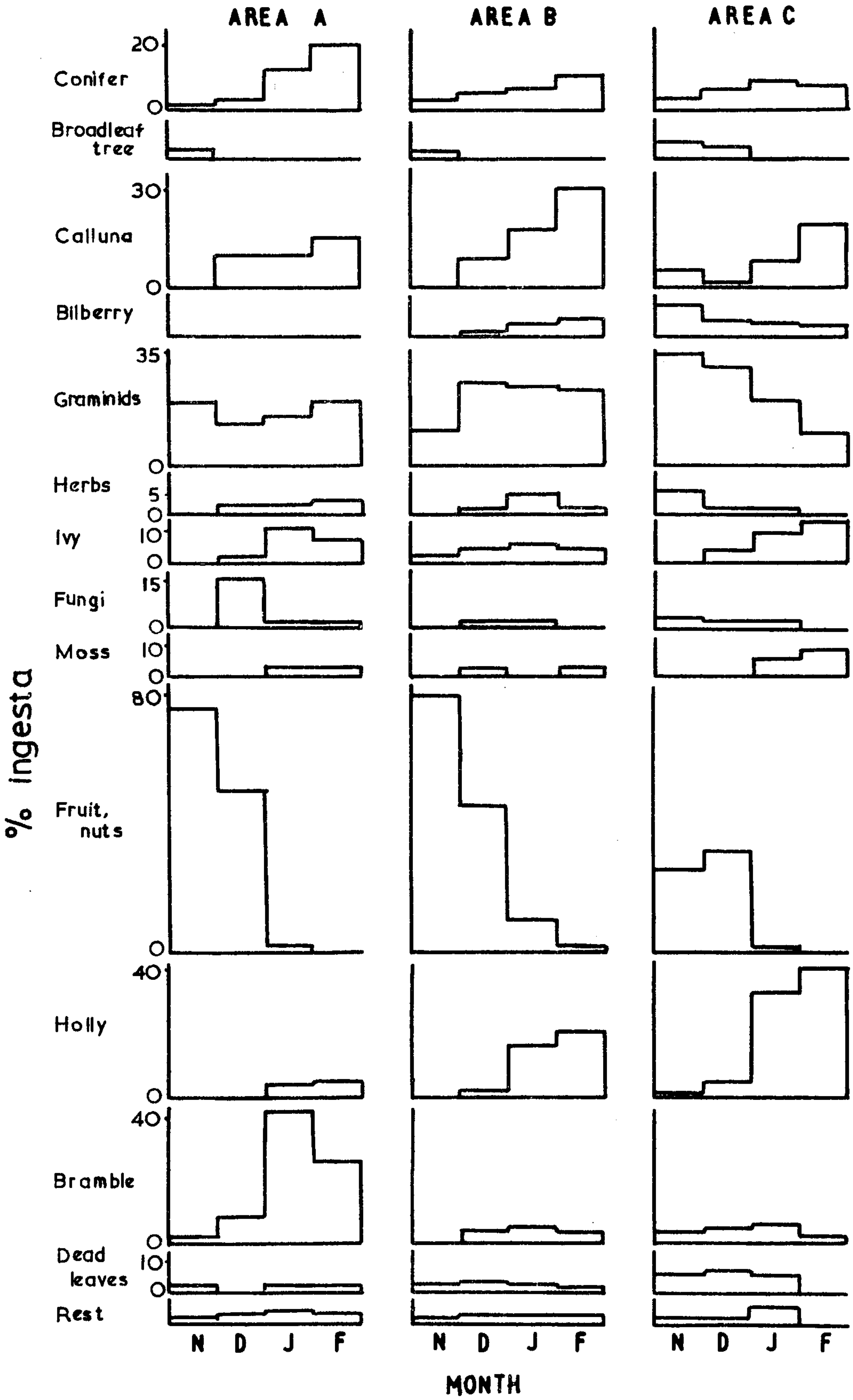


Table 41. Winter Diet, determined by Rumen Analysis, of Fallow Deer from Study Areas A, B, and C for November–February 1970–71 with 1971–72

Food type		Area A								Area B								Area C							
		Nov		Dec		Jan		Feb		Nov		Dec		Jan		Feb		Nov		Dec		Jan		Feb	
		a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Conifer		6	1	2	3	19	13	8	20	6	2	10	5	9	8	10	12	5	2	3	6	9	8	5	6
Broadleaf tree		5	1	1	t	2	t	0	0	9	2	4	t	1	t	3	t	5	5	3	3	2	t	1	1
	Calluna	3	t	1	9	17	9	8	15	4	t	9	8	7	17	12	32	5	5	2	1	8	7	4	19
Dwarf	Bilberry	0	0	1	t	1	t	0	0	3	t	4	1	8	4	8	5	7	9	3	6	7	5	2	3
shrub	Other	0	0	1	1	1	t	4	1	1	t	3	t	2	t	3	1	0	0	0	0	0	0	0	0
	Gorse	0	0	0	0	1	t	0	0	0	0	0	0	1	t	0	0	0	0	0	0	1	t	0	0
Graminds		6	19	3	12	20	15	8	20	9	12	13	27	12	25	12	23	8	36	4	32	9	20	5	11
Herbs		5	t	2	1	11	1	6	3	5	t	5	1	6	5	3	1	7	7	2	1	1	1	0	0
Ivy		5	t	3	1	19	11	7	7	6	1	9	4	6	5	8	2	3	1	2	3	5	9	5	12
Fungi		4	t	3	15	6	1	4	1	4	t	5	1	5	1	1	t	4	2	1	1	3	1	1	t
Moss		5	t	3	t	10	1	6	1	6	t	9	1	12	t	6	1	5	t	0	0	4	4	3	7
Fern		2	t	3	t	15	2	6	t	5	t	9	2	8	2	7	1	5	t	3	1	5	4	0	0
	Acorn	6	74	3	40	10	2	0	0	9	65	10	36	6	6	1	t	7	20	1	1	2	t	1	t
Fruit	Mast	0	0	3	10	0	0	0	0	6	13	4	3	7	4	1	1	4	4	4	28	0	0	0	0
&nuts	Crab apple	2	1	1	t	0	0	0	0	3	1	2	2	0	0	0	0	1	1	0	0	0	0	1	t
	Other	0	0	0	0	0	0	0	0	1	t	4	5	1	t	0	0	1	t	2	3	2	1	0	0
Bark	Coniferous	2	1	2	1	0	0	3	1	2	t	2	t	1	t	1	t	2	1	0	0	0	0	0	0
	Deciduous			2	t	1	t							1	t					0	0	2	5	0	0
Holly		3	t	1	t	18	2	7	6	5	t	7	1	10	17	11	20	5	1	2	4	7	27	5	40
Bramble/rose		6	2	3	7	20	42	8	25	5	t	7	3	9	4	7	1	5	2	1	4	8	6	2	1
Dead leaves		5	1	3	t	13	1	8	1	9	2	9	3	8	1	7	1	7	5	4	6	2	3	2	t
Other		0	0	0	0	3	1	1	t	0	0	0	0	0	0	1	t	0	0	0	0	0	0	0	0
No. deer		6		3		20		8		9		13		12		12		8		4		9		5	

column a; number of deer with that food column b; average % of that food type in all deer that month

t = trace; less than 0.5%

Figure 14 Diet on Areas A, B & C as determined by Rumen Analysis, Winter 1972 - 73

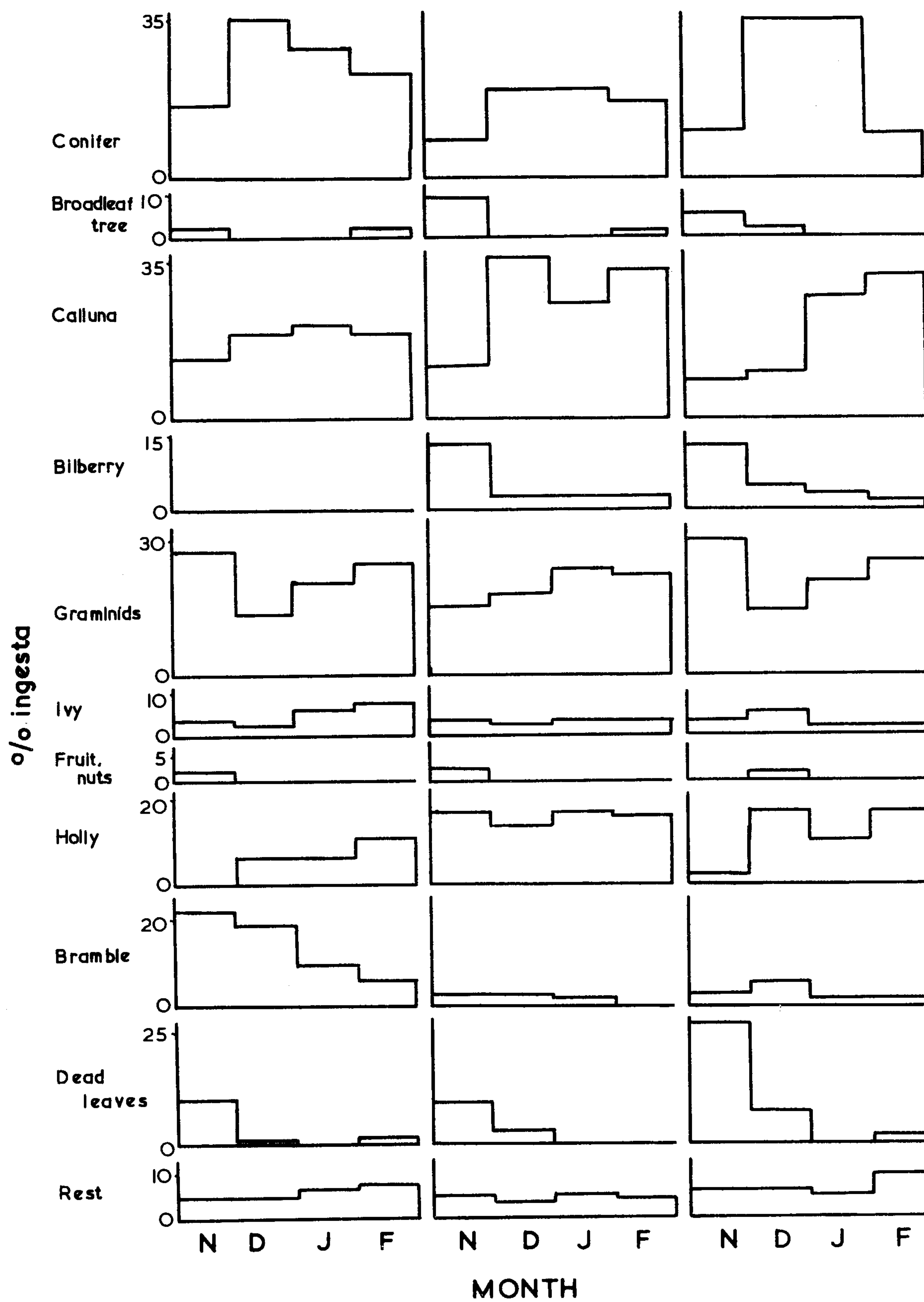


Table 42. Winter Diet, determined by Rumen Analysis, of Fallow Deer from Study Areas A, B, and C for November–February 1972–73

Food type		Area A								Area B								Area C							
		Nov		Dec		Jan		Feb		Nov		Dec		Jan		Feb		Nov		Dec		Jan		Feb	
		a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b		
Conifer		17	16	13	35	8	29	6	24	5	8	9	20	4	20	5	18	9	11	5	34	7	34	3	10
Broadleaf tree		8	2	0	0	2	t	0	0	4	9	0	0	1	1	0	0	10	5	2	1	0	0	0	0
	<u>Calluna</u>	17	13	13	19	9	21	6	18	5	12	9	37	5	27	4	34	11	8	6	11	6	27	4	32
Dwarf	Bilberry	2	t	0	0	0	0	0	0	5	16	6	2	2	2	1	2	11	16	5	4	4	3	2	1
shrub	Other	2	1	6	1	1	t	1	t	1	t	0	0	2	t	1	t	1	1	2	1	1	t	0	0
	Gorse	0	0	0	0	1	t	1	t	0	0	0	0	0	0	0	0	2	t	0	0	1	t	0	0
Graminids		18	27	13	13	9	22	7	25	5	16	9	18	5	24	5	26	12	28	6	12	6	20	5	25
Herbs		13	1	12	2	5	1	4	1	0	0	2	t	1	t	0	0	10	2	2	t	0	0	1	t
Ivy		16	6	10	4	8	5	6	8	3	3	7	2	4	3	3	3	9	3	3	5	2	1	3	1
Fungi		5	1	8	1	2	1	1	t	4	3	3	1	3	2	1	2	7	1	3	2	0	0	3	3
Moss		7	t	2	t	2	2	2	t	2	t	3	t	0	0	3	2	0	0	1	1	2	1	2	1
Fern		7	1	6	1	5	1	3	3	2	t	4	1	3	3	2	t	6	2	3	1	3	t	2	1
	Acorn	1	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fruit	Mast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
&nuts	Crab apple	2	t	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Other	2	t	0	0	0	0	0	0	2	1	1	t	1	t	0	0	1	t	1	1	0	0	0	0
Bark	Coniferous	0	0	0	0	1	1	2	4	0	0	0	0	1	t	0	0	1	1	0	0	0	0	1	t
	Deciduous	0	0	0	0	1	1	1	t	1	1	1	t	0	0	0	0	0	0	2	1	1	t	2	1
Holly		3	t	10	6	9	6	7	11	4	17	9	13	15	17	5	14	5	1	6	17	6	10	4	17
Bramble/rose		18	22	13	18	8	9	6	5	4	2	4	2	1	1	0	0	11	2	4	4	3	1	1	1
Dead leaves		15	9	8	1	2	t	3	1	5	9	4	2	0	0	1	t	10	21	4	7	1	t	1	1
Other		4	t	1	t	0	0	0	0	1	t	1	t	0	0	0	0	1	t	0	0	1	2	1	6
No. deer		18		13		9		7		5		9		5		5		12		6		7		5	

Column a; number of deer with that food   column b; average % of that food in all deer that month

t = trace; less than 0.5%

analysis for the three study areas. The results for the first two years, when acorn and most yields were abundant compared with 1973, were pooled as samples were small in certain months of both years. Clear differences in the diet between the three areas can be seen.

The differences in availability of the major winter foods are given in section 4.2. and are summarised in Table 43. The expression of the potential availability of acorns and mast in the three areas was obtained by finding the percentage of their acreages on which there was mature oak and beech and using this value.

Table 43. Relative Availability of Important Winter Foods on Study Areas A, B and C.

Assessment Values

	Bramble	Calluna	Grass	Bilberry	Holly available	Holly tree	Oak, Beech
Area A	1.40	1.57	1.83	0.07	0.86	0.62	35
Area B	0.08	0.30	1.72	1.84	0.57	2.12	62
Area C	0.27	1.64	1.83	0.86	0.74	1.35	23

The assessment values were done in March and April 1973 but the results were applicable to the previous years as the relative cover of these rooted vegetations had not changed appreciably during the study period.

(1) Conifers

Coniferous browse was an important food in all three areas, notably in the winter of 1972-73. In section 2.1.5.2. it was shown that with the working plan followed in Inclosures, most deer will never be near to a supply of felled coniferous browse. Browse indeces on Area A (section 4.1.2.1.) have shown that some browsing of softwood trees occurs but this is not extensive or severe enough to possibly account for the large amounts present in the winter diet (Figs. 13 & 14). In Area B the majority of young plantations are fenced against deer (Map III) and inspection of the only compartment of saplings on Area C showed minimal browsing. Once trees in stands reach the thicket stage and older, very little browse is available to deer as lower branches are often brashed or are shaded out and die. Therefore the large amounts of coniferous browse found in the ingesta must have come from felled material. It can be seen from Table 44 that the types of conifer found in deer from different study areas was a reflection of the tree types there (Maps II, III, IV) with the exception of sitka spruce which was felled on both A & B but was not extensively taken.

Table 44. Occurrence of Coniferous Species in Rumens from the Three Study Areas in Winter.

number with that species

	SP	CP	WH	DF	GF	NS	SS	YEW	N
Area A	66	4	16	4	1	18	4	1	79
Area B	42	0	6	7	0	16	4	0	58
Area C	34	1	4	5	0	11	0	4	46

N: total number of deer
SP: Scots Pine
CP: Corsican Pine
WH: Western Hemlock
DF: Douglas Fir
GF: Grand Fir
NS: Norway Spruce
SS: Sitka Spruce

(2) Broadleaved trees and shrubs

Deciduous tree browse was not important as a winter food although it was found in amounts of up to 9% in November.

(3) Dwarf Shrubs

(a) Calluna

This was an important winter food in all areas in all winters. From the vegetation assessments (Tables 24 & 43) it can be seen that although least Calluna is present in Area B that this is the place where it is most important in the diet. The only subarea there with an appreciable amount of this food is Mark Ash East (Map II,4; Table 24), and it is suggested that deer from the western side of Area B utilise the moorland on the open forest on the far edge of North Oakley to a certain extent (Map III).

(b) Bilberry

Bilberry was found in the diet in areas B and C in small quantities (Tables 41 & 42). Its absence from the diet in Area A is explained by its low abundance there (Table 43). It is of note that in Area B in the first two winters when acorns were plentiful (section 5.1.2.), bilberry was only taken in small amounts late in the winter whereas in C over the same period and in both areas in 1972-73, when there were few nuts, it appeared earlier in the diet and in greater amounts.

Gorse and other dwarf shrubs were not important quantitatively in the diet in any of the areas and are not discussed here.

(4) Graminids

All areas had equal amounts of palatable grassland (Table 43) although it was shown in section 2.3. that C tends towards acidic grassland more than the other two do. Graminids were of equal dietary importance in all three areas (Tables 41,42). The percentage occurrence of the different types of graminid recognised in this study for each of the areas for each winter month are given in Table 45. From this it can be seen that sweet grasses are important in all three places, whereas _Molinia_ is of only minor occurrence. As might be expected, _Agrostis setacea_ is most prominent in deer from C but is also present in those from B, which supports the view expressed in paragraph 3(a) that animals from this area may also use the moorland to the west of North Oakley as feeding grounds in certain seasons. Sedges are often associated with poorer grasslands and in both A & B they appear to be most frequently taken in late winter.

The small rush, _Juncus bulbosus_, was found in rumens from all three areas but its actual relative availability was not known. Other rushes

Table 45. Percentage Occurrence of Different Graminid Types in Ingesta of Fallow Deer from Areas A,B and C, November to February

Area	Month	sw.gr	Mo	Desc	As	Jb	J	Cx	Br.sl	Sample size
A	November	100	13	0	0	17	13	4	4	24
	December	100	13	6	6	6	6	0	0	16
	January	100	10	0	0	3	7	14	21	29
	February	87	7	0	0	7	20	20	20	15
B	November	100	21	0	21	21	0	7	0	14
	December	91	4	0	9	9	0	23	0	22
	January	100	18	0	29	29	0	53	12	17
	February	100	29	0	24	24	0	41	12	17
C	November	100	5	0	10	25	5	10	0	20
	December	100	20	0	10	10	20	20	0	10
	January	100	13	0	0	19	0	19	6	16
	February	100	10	0	20	20	0	10	0	10

(Graminid Type: sw.gr to Br.sl)

sw.gr; sweet grasses
Mo; Molinia caerulea
Desc; Deschampsia caespitosa
As; Agrostis setacea
Jb; Juncus bulbosus
Cx; Carex sp.
J; other Juncaceae
Br.sl; Brachypodium sylvaticum

were found in a small proportion of the deer from both Areas A & C although not B even though they are found there. Brachypodium sylvaticum occurred as a late winter food and is normally found in mature deciduous or mixed woodland which is of less prominence on Area C (section 2.3.) which explains its infrequency in the diet there.

Food types (5) Herbs, (6) Ivy, (7) Fungi, (8) Bryophytes, (9) Ferns and (11) Bark - :- these six types of food plants were of only minor importance in the diet and showed similar patterns of usage in all three areas. Full vegetation assessments were not undertaken on them and detailed comparison of their use in the three study areas are not included here.

(10) Fruit and Nuts.

Acorns & beech mast have been shown to fluctuate in abundance annually (section 5.1.2.) and this is reflected in Figures 13 & 14. This food type is of less importance on Area C (Fig.13) as mature oak and beech comprise less of that area (Table 43). The diet on C varies accordingly; for instance graminids are still an important food there in November and December of 1970 & 71 as is bilberry (Figure 13).

(12) Holly

All areas have comparable amounts of available holly in them (Table 43). Holly is cut in November and December, especially in hats and holms (section 2.1.5.1.) which are most frequent on Area C (Table 13) although holly is also cut in Mark Ash (Area B). Little holly is cut on Area A. Thus slightly more of this food is available on B and C than on A which is reflected in their diet (Figs.13 & 14) although other foods such as bramble are more important and are taken preferentially on the latter area.

(13) Bramble and Rose

From Figures 13 & 14 it is evident that bramble & rose forms a major constituent of the diet in the winter on Area A but less so on the other two areas where it grows less abundantly (Table 43). However although little of this food type is present on B and C it is of note that the majority of deer from there have taken some bramble or rose (Table 41 & 42) suggesting it was a preferred food.

(14) Dead Broad Leaves

In the early winters of 1970 & 71 small amounts of dead broad leaves were found in the rumens from all areas but never constituted more than 5% of the diet quantitatively. However during November 1973, large amounts of freshly ingested leaves were present in the ingesta examined, notably in those from Area C. It has been shown in section 6.1.1. that certain species are believed to be actively selected.

From the comparisons made here it can be seen that the observed diets and feeding preferences of the animals on these three study areas in winter can be explained in terms of the relative availabilities of important food plants. Similarly changes in diet with food availability has been shown by Dzieciolowski (1970d) for red deer in different habitats in Poland.

5.2. Determination of the Diet by Direct Field Observation

Between April 1971 and October 1972, 1,551 fallow deer were watched on Area A to determine their feeding habits and a total of 80,672 bites were recorded. The monthly totals are presented in Table 46.

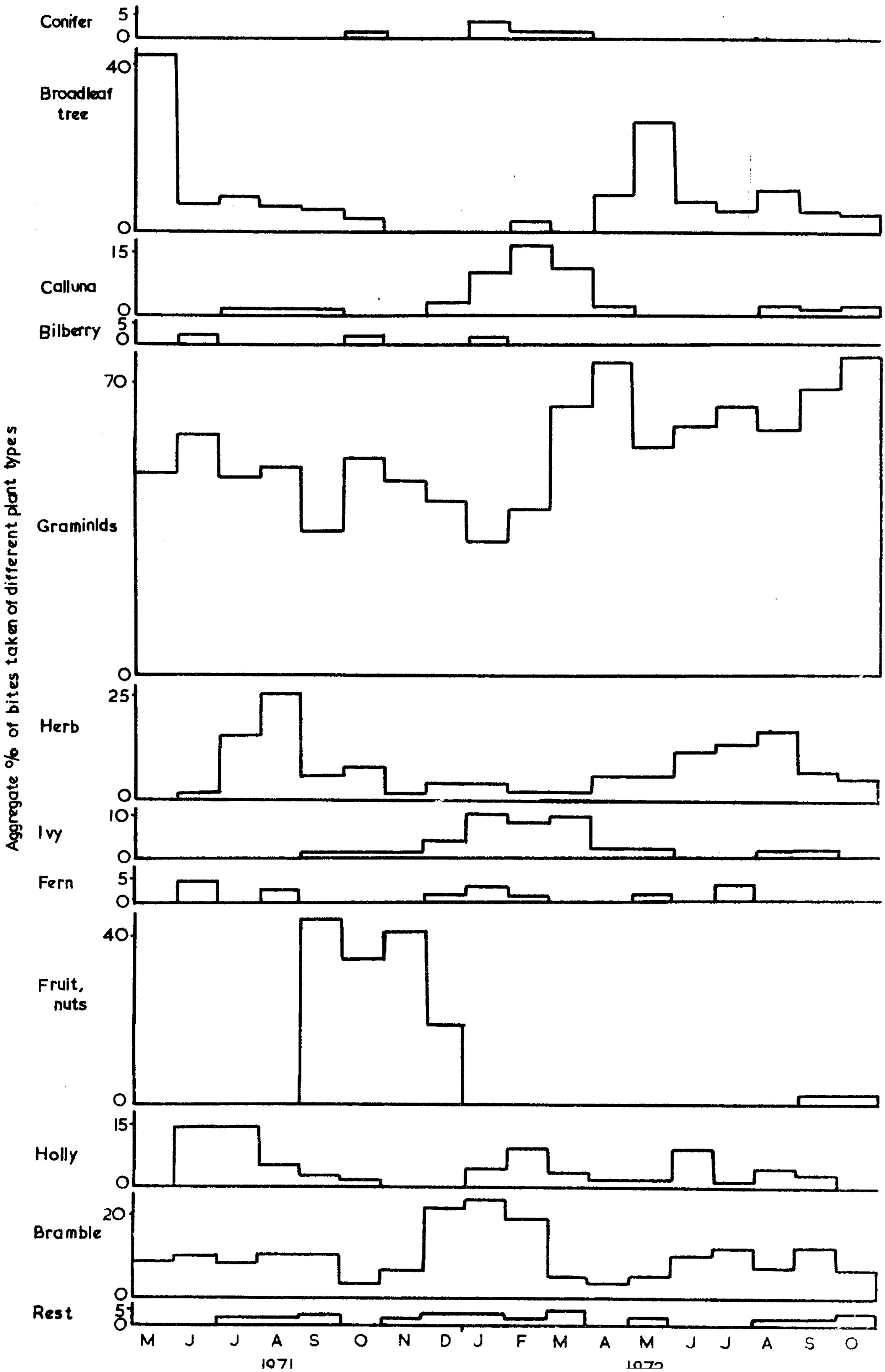
The results on the foods taken were expressed using the aggregate percentage method (section 3.4.) and can be seen in Figure 15. Data for April 1971 is not included as the nine deer seen were in two herds in only two locations and it was felt that the results obtained were therefore unrepresentative of the whole study area for that month.

The average time taken for one bite of certain foods was calculated from observations where both the time spent feeding on a plant and the

Table 46. Number of Fallow Deer Observed Feeding and Bites Recorded on Area A, April 1971-October 1973

Date		Number observed feeding	Number of bites recorded
1971	April	9	717
	May	26	1,138
	June	18	1,291
	July	33	2,155
	August	45	2,448
	September	67	1,710
	October	62	2,526
	November	53	1,485
	December	44	1,358
1972	January	101	2,864
	February	85	4,498
	March	147	6,946
	April	130	5,906
	May	124	7,504
	June	81	4,963
	July	110	6,584
	August	125	7,791
	September	147	9,867
	October	144	8,921
	Total	1,551	80,672

Figure 15 Diet determined by Direct Feeding Observation (aggregate %/o of bites) on Area A, May 1971 - October 1972



number of bites taken from it were known (section 3.4.). The results are shown in Table 47. Holly was subdivided into new soft summer growth and older mature leaves which had become hard and prickled. In the case of the few plants for which the average time per bite was unknown it was assumed to be the same as that of a similar food plant. For instance *Erica tetralix* and *E. cinerea* would be given the same time as *Calluna*.

The percentage time spent feeding on a food type per month could then be found as the percentage of bites taken was already known. The amount of time spent feeding on a particular food gives a better quantitative representation of its importance because the size of one bite of for instance a small cropped grass might be considerably smaller than that from a tree in terms of weight and volume yet both are scored equally by the bite method. The results for each month of the study period are given in Figure 16.

The importance of different foods are discussed below, following the food types outlined in Table 16.

(1) Conifers

Coniferous browse was taken principally from January to March but never formed more than 6% of the diet. Fallow were seen to take western hemlock and Scots pine on three occasions and Norway spruce and Douglas fir once.

(2) Broadleaved Trees and Shrubs

Browse from broadleaved trees and shrubs was important in the diet between April and October, forming 40% of the observations in May 1971. The relative importance of different species during the summer can be seen in Table 48, the results for the two summers being combined.

Table 47. Average Time Taken per Bite for Different Foods

Food Type	Time per Bite (to 0.1 sec)
Conifer	5.6
Broadleaf tree/shrub	3.8
Calluna	5.3
Gorse	8.6
Graminids	2.8
Herbs	2.8
Ivy	5.8
Moss	4.0
Fern	6.0
Acorns	8.3
Holly a) new soft growth	2.7
b) mature leaves	5.0
Bramble/Rose	3.9
Bark	6.5

Figure 16 Diet determined by Direct Feeding Observation (% time) on Area A, May 1971 - October 1972

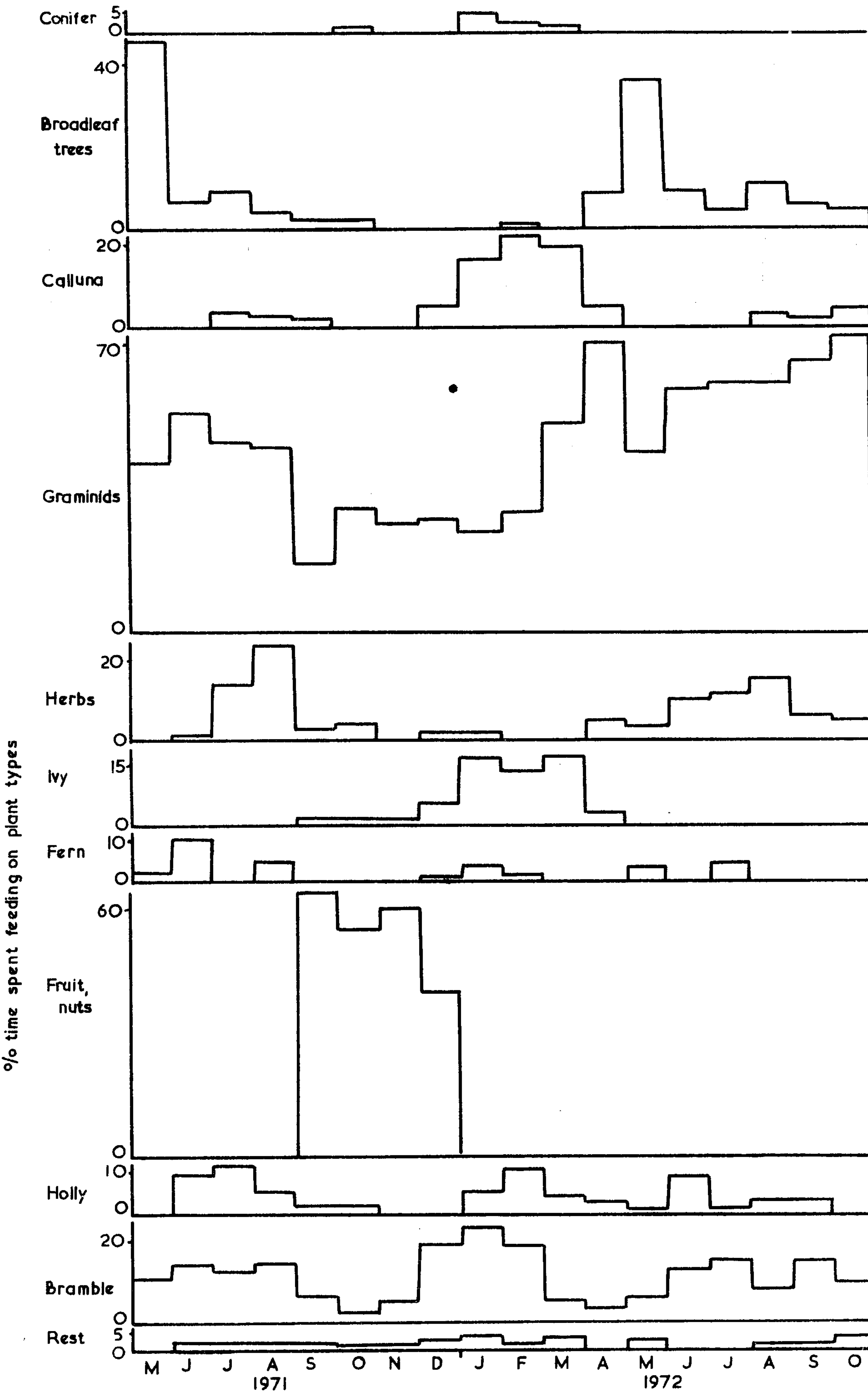


Table 48. Species Composition of all Bites of Broadleaf Browse taken on Area A, in the Summers of 1971 & 72.

Month	Be	Bi	Hw	Sloe	Oak	Alder	Syc	Sx
Apr	11	30	49	10	0	0	0	1
May	44	13	24	13	4	0	0	1
Jun	30	22	22	22	0	2	1	0
Jul	21	14	40	17	5	3	0	0
Aug	4	18	13	13	46	3	0	4
Sep	4	0	23	16	56	0	0	1
Oct	0	0	0	0	82	8	0	10

Be: Beech   Hw: Hawthorn   Sx: _Salix_ sp.

Bi: Birch   Syc: Sycamore

Alder, sycamore and willows were of low occurrence on A (Table 21). Although hawthorn & sloe were both used throughout the period from April until September, beech, birch and oak were used differentially. Beech was important from late April until July and birch was also taken about this time. Oak was browsed during August, September and October.

Browsing was most intense on new growth and the seasonal changes in preferences reflect this, beech and birch breaking bud earlier in the season than does oak. A similar pattern of use was seen from the rumen analyses (Table 29).

(3) Dwarf Shrubs

Calluna

Although small amounts of _Calluna_ were taken during the summer, this food was most abundant in the diet from November until April, especially between January and March when deer spent 15-20% of their time feeding on it (Figure 16).

The other dwarf shrubs never constituted more than one percent of the food taken. Soft new growth of gorse was taken in small amounts by three deer in summer. Bilberry is scarce on Study Area A (Table 21) and was never found as more than 1% of the monthly diet (Figure 15).

Erica tetralix was found on 12% of the area (Table 21) but was only seen to be taken by five deer in small amounts. This is supported by the results of the browsing survey (Table 22). Similarly Erica cinerea was not important as a food. Butchers broom, rhododendron, broom and privet are all rare on this study area (Table 21) and only the latter species was ever seen to be browsed by deer.

(4) Graminids

Graminids were an extremely important food throughout the year, especially during the summer months (Figs.15 & 16). It can also be seen that during September and October 1971, when acorns were plentiful, the amount of this food taken fell sharply, remaining at that level until the following March. However in the autumn of 1972, graminid intake remained at its summer level as no acorns or mast were produced.

The main types of graminid recognised were as in Table 16. The percentage of the monthly total of bites that each type formed are shown in Table 49, together with their availabilities determined in the summer survey (section 4.1.1.). Certain species, notably Molinia, die back in the winter but the dead tussocks remain and are available to the deer. It was thus felt that the availability figures obtained during the summer were valid for winter months as well. From Table 49 it is evident that seasonal usage of different types does occur and that species may be abundant but are not taken by the fallow to any significant extent.

Table 49. Occurrence of Graminid Types in the Diet of Fallow Deer on Area A, determined by direct feeding observation, Compared with their Relative Availabilities

Graminid type	% of total graminid bites per month each type formed																		% plots present	mean % cover
	1971								1972											
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O		
Molinia caerulea	0	2	12	11	8	t	0	4	2	0	t	4	t	1	5	4	t	t	54	9.14
Deschampsia caespitosa	0	0	6	2	5	2	5	1	1	0	1	0	t	1	3	2	2	t	22	1.86
Brachypodium sylvaticum	4	1	3	1	5	t	t	1	18	7	5	3	1	2	t	19	12	0	21	1.59
Agrostis setacea	0	0	0	3	1	1	0	0	0	1	t	t	t	t	t	t	t	0	8	0.59
Carex spp	0	0	0	2	0	3	3	1	3	3	t	0	t	0	0	1	2	2	12	0.79
Juncus bulbosus	0	0	0	0	0	2	2	0	7	3	2	0	1	0	1	10	3	10	50	1.01
Other Juncaceae	0	0	1	1	0	1	t	4	7	t	1	2	1	1	2	3	0	0	35	0.42
Sweet grasses	96	97	78	80	80	90	90	89	62	86	90	91	96	95	88	61	81	88	56	7.97
Palatable grasses	96	97	78	82	80	95	95	90	72	92	92	91	97	95	89	81	86	100	58	8.86

t = trace; less than 0.5%

The purple moorgrass, Molinia caerulea, was taken in only small amounts during its vegetative period from April to September despite its abundance. It never comprised more than 12% of the monthly intake. Occasionally dead leaves were also taken. Field observations showed that Molinia was selected at two main stages of its growth; firstly when the new shoots were a few centimetres long and secondly when the inflorescences first appeared, encased in leaf sheaths. Mature seed heads were occasionally taken in the autumn.

Deschampsia caespitosa is fairly widespread within Inclosures on the study area occurring in 22% of plots with an average cover of 1.86% (Table 49). However the leaves are extremely rough (Hubbard 1968) and were only ever taken in small quantities during July & August; from September to November the seedheads were sought after to the exclusion of any other parts of the plant.

Brachypodium sylvaticum occurs to about the same extent on Area A as the previous species but can be seen from Table 49 to be of considerably more importance, principally at two times of the year. This grass produces new shoots from the New Year onwards which were readily taken by deer and formed 18% of the total graminid usage in January. During August and September the oat-like seed heads were avidly taken by the deer and up to 19% of the graminids taken at this time consisted of these.

Agrostis setacea, the bristle bent, was of low occurrence on Area A (Table 49) although it was found more extensively in other parts of the New Forest (section 2.1.5.1.). It was rarely taken by deer on this study area, never forming more than three percent of the monthly graminid total.

The following species of sweet grasses were recorded as being taken by fallow on Area A:-

Agrostis canina canina

Agrostis canina montana

Agrostis tenuis

Cynosurus cristata

Dactylis glomerata

Deschampsia flexuosa

Festuca ovina

Holcus lanatus

Holcus mollis

Lolium perenne

Melica uniflora

Poa annua

Poa pratensis

Sieglingia decumbens

From Table 49 it is evident that this type of graminid is only as abundant as Molinia yet forms between 60-100% of the monthly intake of this food type. Sweet grasses are therefore extremely important in the diet.

Sedges were grazed by deer to a small extent, especially during the winter months but were only actively sought after in late summer when small amounts of the seed heads of Carex panicea and C. echinata were selected.

Juncus bulbosus is a small rush found widely on Area A (Table 49) especially on wet rides or those being recolonised after being denuded by vehicles during forestry operations. It was taken in small amounts during the winter of 1971-72 and again during the dry period in the late summer and early autumn of 1972 (section 2.1.2.) when sweet grasses on better drained soils tended to become dry and scorched.

The larger Juncaceae, notably the jointed rush (Juncus articulatus) & the soft rush (J. effusus) were found in moderate amounts in damper habitats throughout area A but stems were only taken in small quantities, principally during the winter, accounting for a maximum of 7% of the graminid food in January 1972. Seed heads of these two species were actively taken in small amounts in summer.

Palatable grasses, that is sweet grasses, Juncus bulbosus, sedges and associated herbs, normally grow in close association, the exact proportions of the three in a sward varying with situation. This type of grassland is second only to Molinia in terms of its average cover and was found in 58% of all quadrats (Table 49). It comprised over 70% of the graminid intake, which in turn have been shown to be a major food plant type in the diet (Figures 15,16).

(5) Herbs

During the course of field observation, 60 species of herb taken by the deer were positively identified (Table 50). The only widely occurring herbs never seen to be taken were the foxglove (Digitalis purpurea), ragwort (Senecio jacobaea) and stinging nettle (Urtica dioica).

Most small species associated with grassland were taken; others were actively sought after, including the tormentil (Potentilla erecta), various trefoils and vetches and lambs-tail plantain (Plantago media). New growth was taken preferentially on all herbs but this was especially true of bluebells (Endymion non-scriptus), and thistles (Cirsium palustre & C. vulgare) where soft young shoots were sought after in June. With the wood sage (Teucrium scrodonia) only flowers were ever seen to be ingested.

As a food type, herbs were observed to be taken in all months, except the first May, but were especially important during June, July & August when they were at their most abundant. In August 1971 they comprised over 20% of both the bites and the time spent feeding (Figures 15,16).

(6) Ivy

Although ivy was seen to be taken between September and May it was only important quantitatively between January & March, accounting for 10% of the bites and 15% of the time spent feeding. Deer quartered the ground (section 7.2.) in search of ground ivy and readily browsed that

Table 50. List of Species of Herbs taken by Fallow Deer on Study Area A

Ajuga reptans
Anagallis arvensis

Bellis perennis
Betonica officinalis

Campanula rotundifolia
Cirsium dissectum
Cirsium palustre
Cirsium vulgare

Endymion non-scriptus
Epilobium augustifolium
Epilobium montanum
Epilobium palustre
Euphrasia nemorosa

Fragaria vesca

Galium saxatile

Hieracium spp.
Hydrocotyle vulgaris
Hypericum humifusum
Hypochoeris radicata

Lathyrus montana
Leontodon taraxicoides
Lotus corniculatus
Lotus ulginosus
Lysimachia nemerorum
Lysimachia nummularia

Melampyrum pratense
Mentha aquatica

Odontites verna

Plantago lanceolata
Plantago major
Plantago media
Polygala serpyllifolia
Polygonum aviculare

Ranunculus acris
Ranunculus bulbosus
Ranunculus ficaria
Ranunculus repens
Rumex acetosa
Rumex acetosella

Saponaria officinalis
Scrophularia nodosa
Senecio vulgaris
Stellaria graminae
Succisa pratensis

Taraxacum officinale
Teucrium scorodonia
Trifolium campestre
Trifolium pratense
Trifolium repens

Veronica chamaedrys
Veronica officinalis
Viola spp.

Wahlenbergia hederacea

present on felled conifers.

(7) Fungi

Fungi were never important quantitatively and are not shown as a separate food type in Figures 15 & 16. Most fungi were short lived and were sporadic in occurrence although often abundant. The following species were seen to be fed on:-

Armillaria mellea	_Lyophyllum decastes_
Auricularia auricula	_Mycena_ spp.
Collybia fusipes	_Russula atropurpurea_
Coprinus atramentarius	_Russula emetica_
Gymnophilus penetrans	_Trametes gibbosa_
Hygrophoropsis aurantiaca	_Trametes versicolor_
Hypholoma fasciculare	

(8) Bryophytes

Bryophytes were only seen to be fed on by deer on two occasions in April 1972 when small amounts of hair moss (_Polytrichium_ sp.) were grazed.

(9) Ferns

During the summer months bracken was abundant on Area A (Table 21). However it was rarely used, being seen to be taken in small amounts by only eight individuals during July and August. Deer often fed amongst bracken but took the sparse vegetation from amongst it. Fallow can be seen feeding amongst bracken in Plate 19 but were in fact taking etiolated sweet grasses from ground level.

The male fern, _Dryopteris felix-mas_ was of limited occurrence on A (Table 21) but was heavily browsed by fallow at two times of the year. Firstly in May and June when the fronds are fully extended but individual pinnae are still curled and secondly in early winter. Since it is of low occurrence this fern does not form an important food quantitatively

(Figure 15 & 16) but was occasionally taken in large amounts by certain individuals.

(10) Fruit and Nuts

Acorns were an extremely important food during the period from September until Christmas 1971, deer spending more than 40% of their time each month feeding on them (Fig.16). A minimal acorn crop was recorded in the autumn of 1972.

Other fruit and nuts taken included mast, blackberries, holly berries, crabapples and hips, but these were of little importance compared with acorns on Area A.

(11) Bark

Bark was not seen to be taken in sufficient quantities for it to form more than a trace of the food taken in any month and is thus excluded from Figures 15 & 16. Inspection of plants showed that felled Scots pine and western hemlock were barked on A by fallow in late winter and May respectively (Plates 20-22). Holly bark was stripped from both felled and standing material in January. Ivy bark was seen to be taken by one doe in Parkhill in March (Plate 23). In the case of all but western hemlock, all the areas of bark taken from trees showed a green tinge to them; for instance on Scots Pine only the upper felled branches were peeled.

(12) Holly

Holly was taken mainly during the late winter and early spring, January to April, and again in June and July. In the first case mature prickled holly is taken but in the summer new soft leaves are taken (Figure 15 & 16). It has been shown in section 6.1.3. that holly is not as an important food on Area A as on the other two winter study areas, but it still comprises 10% of the diet determined by field observation at these times of year.

Plate 19. Herd of small-deer in close proximity to the main A27 road, shown by the fence line in the background. Although feeding in bracken the animals were taking etiolated sweet grasses growing amongst the fronds.

Plate 20. Initial stage of bark-stripping of young western hemlock by fallow deer showing how the incisors have been used as a gouge to attempt to lever up pieces of bark.

Plate 21. Later stage of bark-stripping of western hemlock illustrating how large strips of material may subsequently be torn off. This results in growth being retarded and increases the risk of fungal infection. Girdling of the tree will result in its death.

Plate 22. Bark-stripping of the upper branches of felled Scots pine demonstrating how the incisiform teeth are used as a gouge to remove pieces of bark.

Plate 23. Ivy bark is taken to a limited extent during the winter leaving the bare white wood exposed. South Oakley Inclosure, March 1973.

(13) Bramble and Rose

This type of food is available throughout Area A (Table 21 & 24) and was important in the diet throughout the year. Amounts taken were at their lowest in autumn 1971, when acorns were a major food, and again in late spring when most bramble & rose leaves had been browsed and new grass was being avidly taken (Figure 15,16). Maximum values of 20% were found in December, January & February.

(14) Dead broadleaves

These were not an important food, never forming more than one percent of the diet. However on 31.10.73 six deer were seen in Woodfidley feeding on fallen ash leaves and were observed for twenty minutes taking these. Ash is extremely rare on Area A (Table 21).

5.3. <u>Comparison of the Diet Determined by Rumen Content Analysis and by Direct Field Observation</u>

5.3.1. <u>Winter Months</u>

During the period from November to February 1971-72 the diet of the fallow deer on Area A was determined by both rumen analysis and direct field observation. The results can be seen by comparing Figures 13 & 14 with 15 & 16. It can then be seen that the types of food taken and their patterns of use over these four months were similar both qualitatively and quantitatively except in the case of conifers which appeared in large amounts in the rumens but not in the direct feeding results. This was due to the fact that during felling, brashing and thinning it was found very difficult to enter such places undetected to try to watch the deer because of the mass of cut lying branches. It was evident from examining the foliage that it was being freely taken but the problem was one of access. A similar problem was encountered in thicket stage and under-planted areas but it has been shown in sections 4.3. & 4.1.2.1. that little food was found there and was little used.

5.3.2. Summer Months

During the summer months, no strict comparison between the two methods was possible because so few deer were obtained during this period on Area A. However when the results from the direct field observations on A were compared with the results of rumen analyses from the whole New Forest (Figures 11, 15 & 16) the same seasonal dietary pattern was seen in both.

The results obtained by using the two methods were thus comparable except in the case of felled coniferous material.

5.4. Comparison of Male-deer and Small-deer Diets

For much of the year, male-deer live in separate herds from small-deer mixing freely with them only during the rut and again in late winter and early spring (section 7.3.1.). Distribution of male and small-deer herds in the New Forest is uneven, bucks tending to be found in closer association with agricultural land (section 7.3.3.). It is therefore important to compare the diets of these two herd types wherever possible to determine whether any significant differences exist as a result of these differences in spatial distribution.

When mixed herds associated with the rut formed from September to November there was no more variation between the feeding habits of bucks and does than there was between each small-deer; their diets were apparently the same.

During October 1972 when male-deer were occupying the same areas as small-deer on Area A (section 7.3.3.), although not necessarily feeding with them, sufficient feeding observations were obtained to allow meaningful comparisons to be made. Records from Denny New, Denny Wood and Parkhill Wood (Map II, 1,3 & 4) were excluded as bucks normally frequent these locations all year (section 7.3.3.). Feeding data was obtained from 22 bucks and 113 female deer and the aggregate percentage of each food type was calculated (Table 51). The diets were then compared using the $2nX^2$ contingency test; a X^2 value of 0.88 was obtained, giving a P value of 0.90-0.95, showing their diets to be very similar here.

In January 1973, 32 rumens were analysed from the whole Forest of which 7 were male-deer. The results obtained are shown in Table 52. Considerable variation occurs in diet with location (section 5.1.3.) but of the natural foods of widespread occurrence i.e. Calluna, grass, ivy and holly, all were present in similar amounts in both male and small-deer. Coniferous browse varies with the amount of felling and it was also suggested that bucks would experience difficulty in moving and feeding amongst loose cut branches. Bramble is of localised occurrence (Table 24) and its presence in rumens varies accordingly (section 5.1.3.). The diets here can thus be considered similar.

This is of particular importance when one considers where these bucks were killed; three from New Park & Whitley, two from Bolderwood Hollies, one from Furzey Lawn and one from Mallards Wood (Map I; 72, 73,35,51,58). With the exception of the last deer, all the others were in areas adjacent to fields yet their diets were comparable to those of small-deer. Therefore at this season male-deer did not feed solely on agricultural land.

Between mid-August and mid-September 1972, male-deer were culled on Area A and their rumen contents were analysed, These animals all came from male-deer herds. The average percentage of each food and the numbers of deer with it (in brackets) are given below:-

Conifer	t	(2)	Fungi	t	(1)
Broadleaves	10	(8)	Ferns	t	(2)
Calluna	1	(3)	Fruit	1	(3)
Gorse	t	(2)	Bark	t	(1)
Graminids	45	(8)	Holly	2	(5)

Herbs	13	(8)	Bramble	25	(8)
Ivy	1	(4)	Dead leaves	t	(1)

These results are comparable with those obtained from the direct feeding observations for all deer on Area A (Figs. 15,16). The value for bramble is higher but this might be expected as three of the specimens were shot in the west of Denny New where this plant is particularly abundant (Table 24).

During March & April & again in August & September the majority of the dead material supplied and rumens analysed were from male-deer (Tables 15 & 18). In any good shooting programme deer doing damage such as feeding on fields will be culled in preference to those in less vulnerable areas. Male deer are often found close to agricultural land (section 7.3.3.) and the majority of bucks are shot adjacent to fields. It might therefore be expected that their diet would tend to contain a greater proportion of grass than that of deer from other areas. It has been shown that this is not true in January, and if the diet determined by rumen analyses in March & April is compared to that found by direct field observation on Area A at this time, the two sets of data are similar (Figures 11,15 & 16). The same is true for the results from the two methods for August and September 1971 and 1972.

It is therefore suggested that the types of food taken by male and small-deer are the same and show similar seasonal trends but that bucks tend to take graminids from maintained pastureland to a greater extent.

At the height of the rut, both male and female deer fed only furtively and food consumption must have dropped correspondingly.

5.5. Feeding in Young Fawns

Reproductive studies on fallow in the New Forest by Armstrong et al. (1969) have demonstrated that their breeding is highly

Table 51. Diets of Male and Small-Deer on Area A (excluding Denny Wood and New) in October 1972, determined by Direct Observation

Food Type	% of the diet	
	Male	Small
Conifer	0	t
Broadleaf tree	7	3
Calluna	1	1
Graminids		
a) sweet grasses	72	67
b) *Molinia caerulea*	0	t
c) *Deschampsia caespitosa*	0	t
d) *Carex* sp.	1	2
e) *Juncus bulbosus*	15	7
f) All	81	76
Herbs	5	5
Acorn	2	t
Bark	0	t
Holly	1	t
Bramble/rose	4	9
Dead leaves	0	4
Number of deer	22	113

Table 52. Comparison of the Diets of Male and Small-Deer determined by Rumen Analysis, January 1973

Food Type	Male		Small	
	a	b	a	b
Conifers	6	7	22	20
Broadleaf tree	1	t	4	t
Calluna	6	24	24	22
Other dwarf shrubs	1	t	4	t
Gorse	1	t	2	t
Graminids	7	20	25	23
Herbs	1	1	7	1
Ivy	5	9	21	6
Fungi	1	t	5	t
Moss	1	1	7	1
Fern	2	t	12	1
Bark	4	2	4	1
Holly	6	17	24	13
Bramble/rose	5	18	16	9
Dead leaves	3	1	8	t
Number of Deer	7		25	

column a; number of deer with that food
column b; mean % of the ingesta that food constituted

synchronised. Chapman & Chapman (1970) state that the majority of fawns are born in mid-June and field observations in the present work support this, although newly born fawns were also encountered in late May and late ones until the end of September. Table 53 shows the amount of time that fawns were seen to feed compared with their mothers during the first two months of life. By mid-August fawns were feeding steadily with their dams.

During late June and early July several fawns were observed to nose plants but not ingest them or to "bob" up and down as if going to feed but making no contact with the prospective food plant. Ingestion of small quantities of soil from gravel roads by small fawns was noted twice. The significance of ingestion of earth in very young herbivores is not clear but can be presumed to have a promotive effect on intestinal peristalsis (Bubenik 1965). Such behaviour has also been recorded in roe (Bubenik 1965; Espmark 1969), white-tailed deer (Short 1964) and a variety of Cervidae kept in deerparks including fallow (Lau 1968).

The rumen contents of a fawn, estimated to be one week old, killed by a car at Furzey Lawn (Map I,51) on 1.7.73 were analysed volumetrically. Colostrum formed 95% of the ingesta, sweet grasses and dead bracken both 2% and a small dead twig 1%, showing that ingestion of solid material occurred at a very early age.

From examination of dead material, lactation in fallow does may continue until mid-January as is shown in Table 54. It should be remembered that these figures will include not only does with fawns at foot but also those which were barren and those whose young were shot or lost earlier in the year.

5.6. Variation of Diet within a Herd

It is known that when moving deer towards waiting guns, it is possible that two herds lying up in thick cover may coalesce and emerge

Table 53. Comparison of the Feeding Rates of Does and their Fawns

Feeding Rate	June	July 1-15	July 16-31	August
Doe feeding steadily but not fawn	5	6	0	1
Doe feeding steadily, fawn 0-25% time	1	7	3	1
Doe feeding steadily, fawn 25-50% time	0	6	2	1
Doe feeding steadily, fawn 50-75% time	0	0	1	1
Doe feeding steadily, fawn 75-100% time	0	1	17	35
Fawn feeding steadily but not doe	0	0	0	1

Table 54. State of Lactation of Dead Adult Does Obtained

Date		Number lactating	Number non-lactating
June		1	0
October		1	0
November	1-15	5	3
	16-30	9	2
December	1-15	10	4
	16-31	0	0
January	1-15	9	1
	16-31	10	6
February		1	16
April		0	2
May		0	3

as one group. Hence confusion may arise as to herd identities during culling. Fourteen examples were obtained where two deer which were believed to be members of the same herd were shot at the same place within five minutes of one another. The rumen contents were analysed for each animal of the pair and the results for the two were then tested for similarity using the 2n X^2 contingency test (Bailey 1969), and probability values were obtained from Fisher & Yates (1963). The results are given in Table 55.

Of these 14 instances, 11 showed no significant difference in their diets at the 5% level. In the remaining three cases these deer were shot during large scale culls and confusion may have arisen as to their herd identity. The results show that individuals within a herd take very similar foods both qualitatively and quantitatively.

5.7. Variation of Diet of Deer culled within the Same Area on the Same Day.

Twenty one samples were available where two or more deer were shot from one area on the same day but from different herds, fifteen of these involving two individuals, three with three, two with four and one with six. The diet of each individual was found by rumen analysis and the results of the deer in each sample were tested for similarity using the 2n X^2 contingency or R x c contingency tables (Bailey 1969); probability values were obtained from Fisher & Yates (1963). The results are shown in Table 56. Of the 21 samples only three were significantly alike at the 5% level.

Table 57 gives the results of analyses from two such occasions:
a) on 14.1.71 when six deer were culled in Mark Ash and Bolderwood Inclosure (Map III,1) between 10.05 and 12.45 hours;

b) on 1.12.70 when four deer were shot in Mark Ash between 08.45 and 09.45 hours.

Table 55. Comparison of the Diet determined by Rumen Analysis between Individuals believed shot from the Same Herds at the Same Time (using 2n X^2 contingency test)

Case	° freedom	X^2	P	
1	4	1.52	0.8-0.9	NSD
2	3	1.52	0.5-0.7	NSD
3	6	11.04	0.05-0.1	NSD
4	5	2.12	0.8-0.9	NSD
5	4	6.24	0.1-0.2	NSD
6	5	7.08	0.2-0.3	NSD
7	4	21.44	0.001	SD
8	5	21.73	0.001	SD
9	5	27.88	0.001	SD
10	4	5.69	0.2-0.3	NSD
11	6	10.20	0.1-0.2	NSD
12	6	11.00	0.05-0.1	NSD
13	3	1.72	0.5-0.7	NSD
14	3	0.80	0.8-0.9	NSD

NSD= no significant difference
SD= significant difference

$\Big\}$ at 5% level

Table 56. Comparison of the Diet, determined by Rumen Analysis, between Individuals shot from Different Herds in the Same Area on the Same Day, using the 2n X^2 Contingency Test

No. deer	°freedom	X^2	P	
2	2	18.52	0.001	SD
2	2	44.24	0.001	SD
2	3	36.84	0.001	SD
2	5	13.24	0.02-0.05	SD
2	4	30.84	0.001	SD
2	5	13.04	0.02-0.05	SD
2	4	22.12	0.001	SD
2	2	18.92	0.001	SD
2	4	48.44	0.001	SD
2	4	58.48	0.001	SD
2	3	67.44	0.001	SD
2	4	2.44	0.5-0.7	NSD
2	6	15.12	0.01-0.02	SD
2	3	11.76	0.001-0.01	SD
2	1	0.08	0.7-0.8	NSD
3	2	4.68	0.05-0.1	NSD
3	12	114.27	0.001	SD
3	10	189.75	0.001	SD
4	6	58.08	0.001	SD
4	12	144.93	0.001	SD
6	35	471.47	0.001	SD

NSD= no significant difference } at 5% level
SD= significant difference } at 5% level

Table 57. Examples of Variation in Diet of Deer Shot from Different Herds in the Same Area on the Same Day

(1) Mark Ash and Bolderwood Inclosure;14.1.73;10.05-12.45 hrs.

Food type	% of the ingesta					
	Deer number					
	1	2	3	4	5	6
Conifer	5	8	1	15	6	0
Dwarf shrubs	t	29	1	13	4	0
Graminids	23	41	24	28	19	20
Herbs	0	1	26	1	1	21
Fern	3	t	1	2	9	1
Fruit & nuts	50	8	5	14	29	0
Holly	0	1	0	5	12	0
Bramble	1	1	22	0	2	46
Rest	5	5	5	12	9	5
Unidentifiable	14	7	14	8	10	7

(2) Mark Ash;1.12.70;08.45-09.45hrs.

Food type	% of the ingesta			
	Deer 1	Deer 2	Deer 3	Deer 4
Graminids	9	22	35	7
Fruit & nuts	86	67	50	81
Rest	2	7	8	3
Unidentifiable	3	4	7	9

Therefore it is evident that the ingesta of deer in different herds shot in one area on the same day may vary considerably although the fact that they were all killed in one locality needs not necessarily infer they used common feeding grounds.

5.8. Ruminal Fill

The results of the experiment to determine the relationship between the volume of the rumen and the weight of its wall, as determined by the method outlined in section 3.2.2. are presented in Figure 17. The relationship is a linear one and hence the weight of the rumen wall can be taken to be a measure of the potential maximum ruminal fill.

Short (1964) studied the postnatal development of the alimentary tract in white-tailed deer and showed that the proportional weights of the different stomachs, namely the rumen, reticulum and omasum & abomasum, changes in early life. At birth the rumen is very small and the abomasum & omasum are large & functional. By two months of age the rumen and reticulum have greater weight and volume dimensions than do the other stomachs and by four months the proportions are similar to those of adult deer. He also showed that white-tailed fawns are functional ruminants by 2 weeks old, essentially dependent on ruminant digestive processes by 5 weeks and nutritionally self sufficient by four months of age.

It has been shown in the present study (section 5.5.) that fallow deer fawns also start to take solid food within the first month of life, and are feeding constantly on plant material by ten weeks. Only one fawn was obtained which was less than four months old, the results from which are excluded here. It therefore seems valid to assume that the relative proportions of all fawns in this study are the same as in adult deer and the two age classes can be compared.

Short (1964) also found very close correlation between the body weight of his animals and that of the rumino-reticular tissue, and suggested that as fawn growth slows in winter so would that of these

Figure 17 Relationship between Rumen Volume & Weight of Rumen Wall

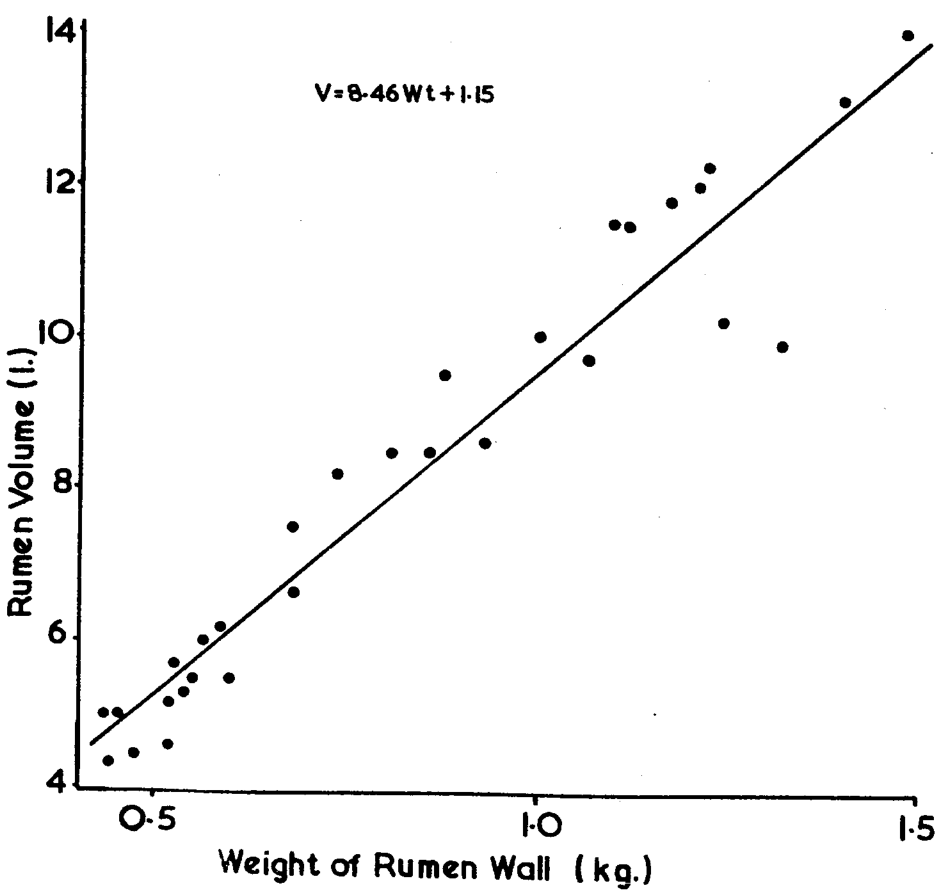
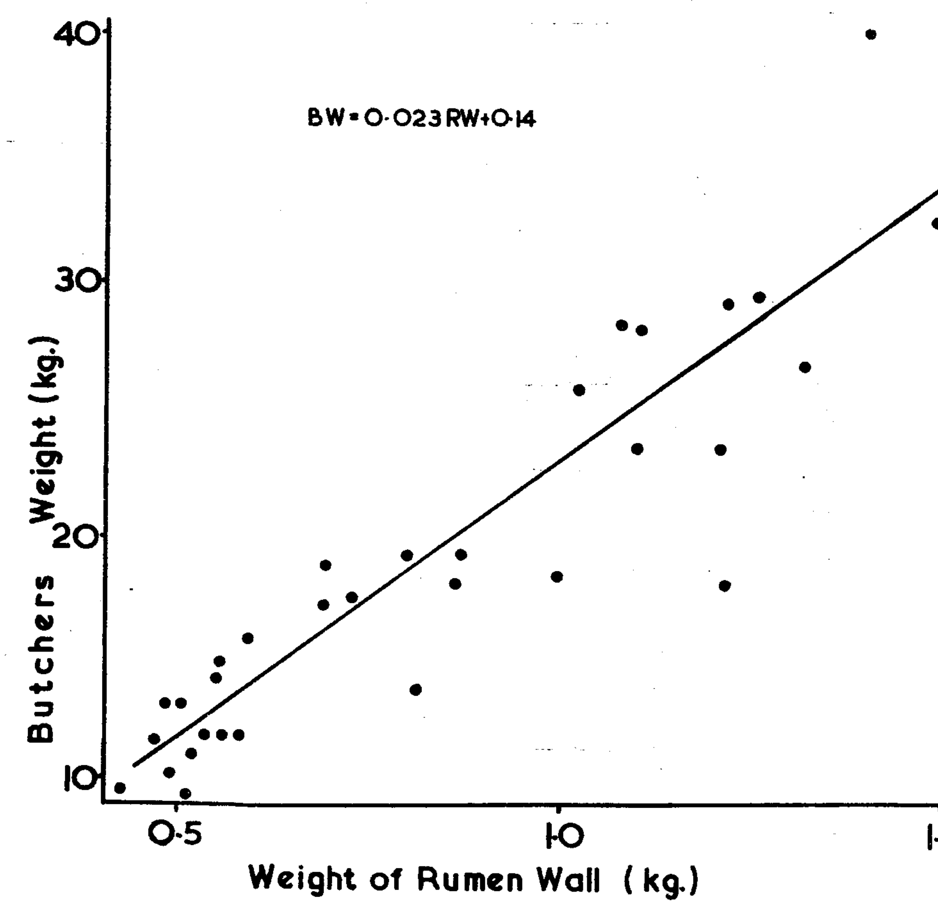


Figure 18 Relationship between Butchers Weight & Weight of Rumen Wall



stomachs. Working on red deer in Poland, Dzieciolowski (1970a) found that although the body weight of the animals reached a peak at about 8 years of age and declined after this, the weights of the internal organs showed a similar pattern. The relationship between the butchered weight and that of the rumen wall for the sample of fallow used in the determination of the rumen volume experiments is given in Figure 18; correlation between the two measurements is significant ($r=0.90$, $n=32$, $P < 0.001$).

The weight of the rumen wall was therefore taken to be proportional to the body weight of an animal, independent of age excepting very young fawns. The ratio of the weight of the ingesta to that of the wall will hence be an indication not only of the fullness of the rumen but also the amount of food present in relation to the animal's body weight.

The ratio of the wet weight of the rumen contents to that of the wall were used to investigate both the feeding patterns of the deer and the amounts of food ingested.

5.8.1. <u>Winter Feeding Patterns</u>

The nutritional requirements of animals will vary not only seasonally but also with their sex, age and life cycle events such as antler growth, the rut, pregnancy & lactation (de Nahlik 1959; Klein 1965; Field 1970; Mitchell 1971), and their intake rates may vary accordingly. It was therefore necessary in studying the feeding patterns of deer from the ratio of the wet weight of the ingesta to that of the rumen wall to consider animals with comparable metabolic needs at the same times of year. Fawns during the winter provided the only group from which a sufficiently large sample was obtained for the daily feeding pattern to be studied. In section 5.1.2. it was shown that during the first two winters acorns & mast were an important food yet were absent from the third. Samples from the first two years were also small and data from these winters are pooled. Winters were divided into two periods; November & December, and January & February.

The calculated ratios were plotted against the time of day the animals were killed, expressed as a percentage of the total daylength from sunrise to sunset. Thus one shot at dawn would have a time value of 0%, one at about noon 50%, and one at sunset 100%.

Data was in this way obtained for four periods:

i) November & December 1970 & 71;

ii) January & February 1971 & 72;

iii) November & December 1972;

iv) January & February 1973.

The results can be seen in Figure 19, daylength being divided into 10 equal periods.

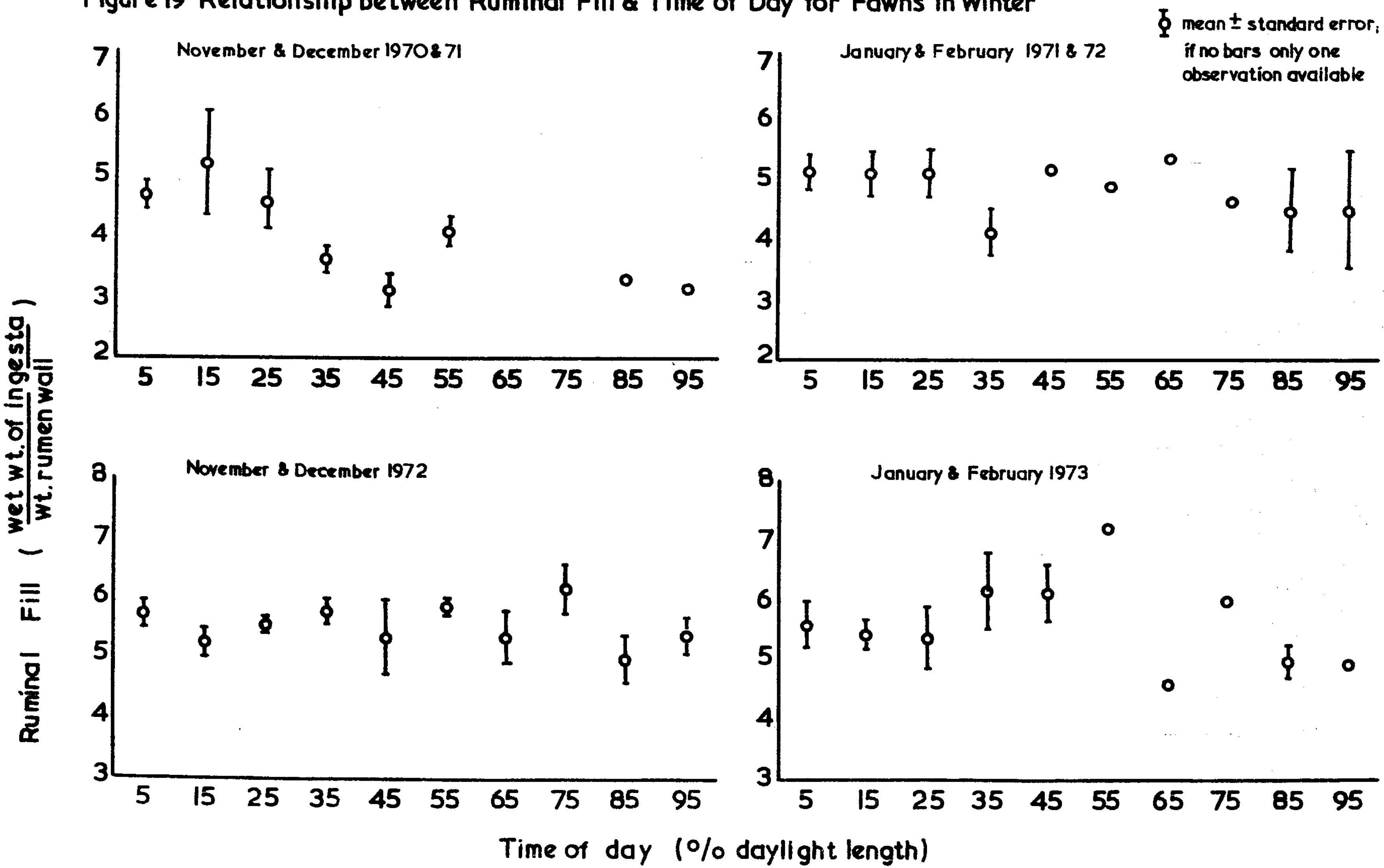
From these it can be seen that only in the case of November and December 1970 & 71 is there any apparent fall in the fullness of the rumen during the course of the day. However when the data was treated by analysis of variance for all four cases, there was found to be no significant relationship between the fullness of the rumen and the time of day at the 5% significance level.

It is often stated in general works that wild fallow deer feed mainly at dawn, dusk & during night, (Prior 1965; Chapman & Chapman 1970; van den Brink 1967) and are seldom seen during the course of the day unless disturbance is minimal (Page 1962; 1971; Cadman 1966).

From the evidence from these studies of the fullness of the rumen, fallow fawns in the New Forest as a whole regularly feed at intervals throughout the day during the winter months.

It has further been shown in sections 5.5. & 5.6. that fawns normally stay with their dams and that the food taken by small deer from the one herd is the same, implying that all the individuals comprising that group show synchronised feeding and resting periods. Hence it can be assumed that all small deer will normally feed throughout the day

Figure 19 Relationship between Ruminal Fill & Time of Day for Fawns in Winter



in winter. This was also supported by the findings of the field observation (section 7.1.). The situation with male deer herds could not be investigated using ruminal fill due to a paucity of samples.

5.8.2. Amounts of Food in the Rumen in Winter (November to February)

The mean values of the ruminal fill ratios were calculated separately for fawns and for adult does for four periods, namely:-

1. November and December 1970 & 71;
2. November and December 1972;
3. January and February 1971 & 72;
4. January and February 1973.

The results are presented in Table 58. The values obtained were compared between periods and between fawns and does and were tested for statistical significance at the 5% level. These can be seen in Table 59.

From these analyses several interesting facts arise. Firstly in both does and fawns the amounts of food present in the rumens in November & December was greater in the poor acorn year (1972) than in the previous two. Acorns and mast are a rich food compared with the other winter foods (de Nahlik 1959) and Hosley (1956) has shown that deer may compensate for the poor quality of their food by increasing their intake. This may be the case here but it is also known that coarser foods, such as those taken in this period in the third winter, tend to remain in the rumen for longer periods than more readily digestible material does (Bergerud & Russell 1964; Jensen 1968). It is therefore uncertain whether the deer actually ingested more food in the early winter of 1972 or if the observed increase in ruminal fill can be explained in terms of differential digestion rates.

In fawns an increase in ruminal fill is also apparent in period 4 compared with period 2. The foods at both times of the year are essentially the same (see section 5.1.2.) and climatic conditions were

Table 58. Mean Ruminal Fill Ratios $\left(\frac{\text{wet weight of ingesta}}{\text{weight of rumen wall}}\right)$ during the Winters

Period	Fawns mean	Fawns n	Does mean	Does n
1. Nov/Dec,1970 & 71	4.48	28	3.96	14
2. Nov/Dec,1972	4.88	43	4.20	31
3. Jan/Feb,1971 & 72	5.52	54	5.45	10
4. Jan/Feb,1973	5.60	29	4.65	9

Table 59. Tests for Significance at the 5% level of Ruminal Fill Ratios for Fawns and Does for Various Winter Periods

Comparison		t	^{o}f	P	
Fawns	Period 1:2	1.59	57	0.1-0.2	NSD
	Period 3:4	0.40	97	0.6-0.7	NSD
	Period 1:3	4.95	80	0.001	1 < 3
	Period 2:4	3.00	70	0.001-0.01	2 < 4
Does	Period 1:2	0.82	43	0.4-0.5	NSD
	Period 3:4	1.62	17	0.1-0.2	NSD
	Period 1:3	2.24	22	0.02-0.05	1 < 3
	Period 2:4	1.23	38	0.2-0.3	NSD
Does: fawns	Period 1	1.60	41	0.1-0.2	NSD
	Period 2	2.88	73	0.001-0.01	doe < fawn
	Period 3	0.27	63	0.8	NSD
	Period 4	2.47	37	0.02	doe < fawn

^{o}f = degrees of freedom

NSD = no significant difference(at 5% level)

comparable in all 3 winters. Such an increase was not found in adult does nor was there any significant difference in fawns or does between the ruminal fill in the first and last two months of the winter.

The reduction in food intake in male deer during the rut is well documented (Page 1962; Juon 1963; Cadman 1966; Chapman & Chapman 1970; Horwood and Masters 1970) but Mottl (1957) & Juon (1963) both found that an obvious regression in grazing intake occurred in roe deer in late winter. Voluntary reduction in food consumption during midwinter is also known to be a natural phenomenon in North American deer of all ages fed on experimental diets (French, McEwen, Ingraam & Swift 1955; Cowan, Woods & Kitts 1957; Long, Cowan, Strawn, Wetzel & Miller 1965; Ozoga & Verme 1970). However from the present studies there appears to be no such adaptation in fallow deer in the New Forest and it should be remembered that the cases mentioned above were in areas with harsh winters characterised by prolonged & extensive snowcover.

When the amounts of food in fawns are compared with does it can be seen that during periods 1 & 3 there was no significant difference. Yet in periods 2 and 4, the late winter months, fawns had a significantly higher ruminal fill.

The diets of both are the same (section 5.6.) but as stated previously their metabolic needs may differ. In fawns the growth rate during the winter is slow and the body weights of animals culled often fell in late winter although the skeletal size increased (section 6.3.). Growth in does will be minimal compared with fawns but factors such as pregnancy and lactation also affect them. It has been shown in Table 53 that lactation normally continues until mid-January for does with fawns; Armstrong et al. (1969) have shown that 95% of all adult females (3 years or more old) in the New Forest were pregnant. The relative metabolic needs for growth, lactation and pregnancy and the basic metabolic rate for fallow fawns and does are not known and it is therefore impossible to explain the observed differences in ruminal fill on the basis of our present knowledge.

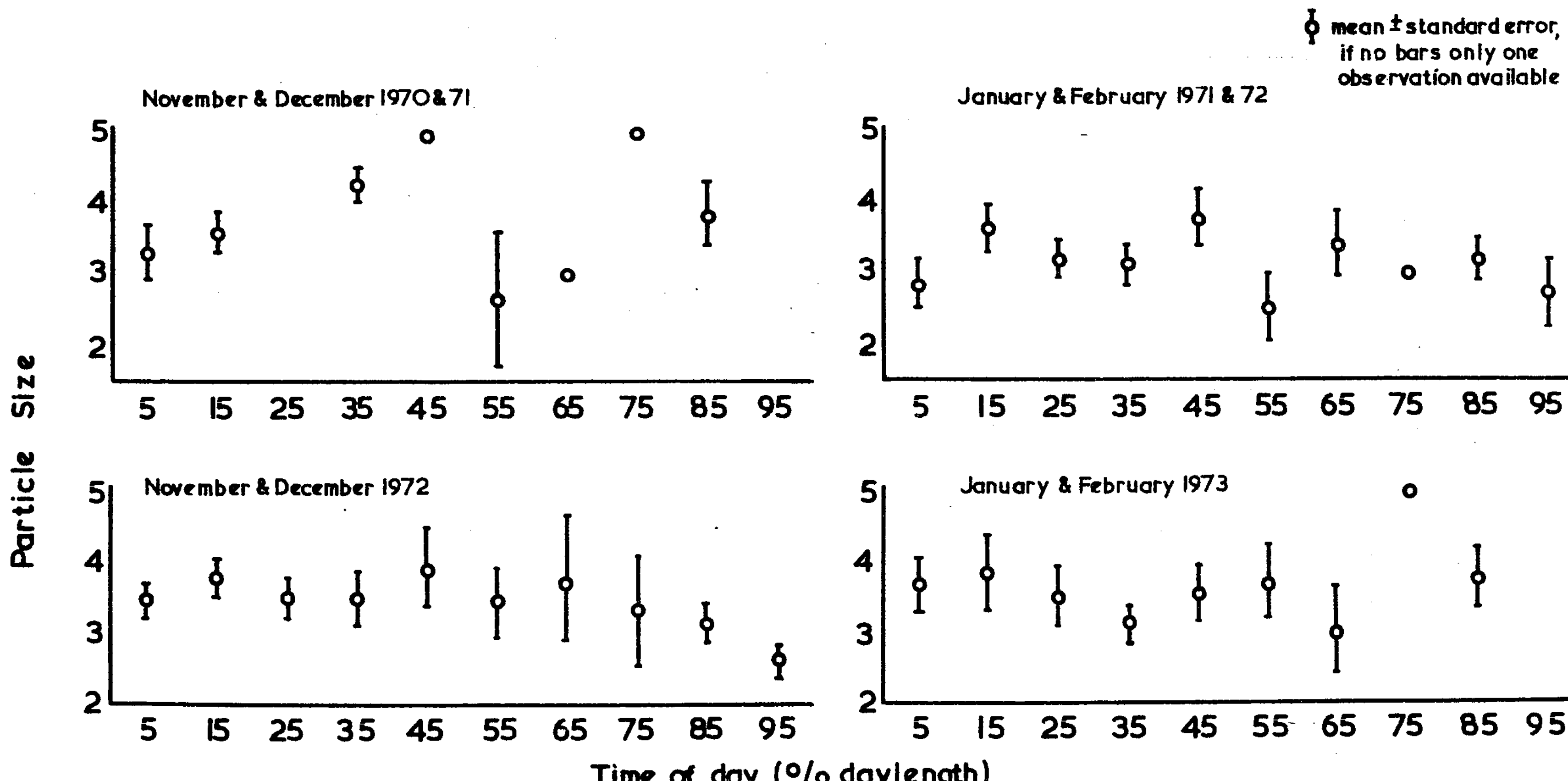
5.9. Comparison of the Size of Food Particles with the Time of Day

The comparative size of the food particles in the viewed rumen contents were assessed on a subjective scale of 5 (large) to 1 (small) as outlined in section 3.3.3. If an animal had been feeding for some time the particular size in the rumen can be expected to be large; conversely if it had been ruminating and resting for some time they would be small. By plotting the average size of the particles in rumens of animals killed during the course of the day trends in feeding periods might be established. As in the previous section meaningful results could only be obtained in the winter months when sample sizes were adequate and the same four periods were considered. Results for all deer were pooled, the mean particle size and standard error calculated and plotted against the time of day shot as expressed as a percentage of the daylength from sunrise to sunset. These are presented in Figure 20 and it is evident that no clear trends can be established. This therefore supports the results from the ruminal fill ratios expressed in Figure 19 and it can be concluded that fallow deer in the New Forest feed throughout the daylight hours during the period from November to February.

5.10. Water

During the course of field observations fallow deer were never seen to drink. Streams, ditches and pools were checked for signs of regular watering places but none were found. Cadman (1966) also states that these animals are very rarely seen to drink. It therefore appears that on Area A deer obtained their water requirement from the food and its adherent moisture. In winter, roe deer may select species of

Figure 20 Relationship between Ingesta Particle Size & Time of Day during Winter



browse with a high water content (Juon 1963). This might be a factor influencing the selective browsing of conifers and avoidance of available hardwoods during the winter (sections 5.1. & 5.2.).

Chapter 6. SIZE, WEIGHT & CONDITION

6.1. Introduction

The size, weight and physical condition of deer in different areas is often a reflection on the quality and quantity of the various foods present. For instance, Adams (1960) states that at a given population density the individual body growth and mature weight of white-tailed deer were indicative of the fertility of a habitat and of the quality of the food. McEwan et al. (1957), also working on this species, showed that food directly affected both the body and antler growth rates of young animals, both being greater when the food supply was both large and nourishing. With black-tailed deer in Oregon, Einarsen (1946) found that those from a habitat of mixed forest types and glades were larger and healthier than those from areas of closed canopy forest where food was scarce and of poor quality. Klein & Strandgaard (1972) studied the differences in growth and body size of roe deer in four areas of Denmark and found that the quality and quantity of food was an important regulatory factor. Reimers (1972) noted a difference in both body weight and jaw length in two populations of reindeer in Norway and attributed this to the differences in the range qualities.

In the present study, three indices were available which could be used to try to determine the effect of food on the physical size and condition of fallow deer in the New Forest. They were:-

1) Fat Deposits; the kidney fat index (weight of the fat surrounding the kidney expressed as a percentage of the kidney weight) and the visceral fat index (combined weights of the fat on the omasum/abomasum and the mesenteric fat and connective tissue expressed as a percentage of the weight of the rumen wall), (section 3.2.3.);

2) Skeletal size; as estimated by mandibular length (section 3.2.4.);

3) Body weights; dead, gralloched and butchered weight (sections 3.2.1. & 3.7.).

6.2. Fat Deposits

The metabolic needs of deer will vary not only with the time of year but also for instance with their sex, age and reproductive state. In red deer Mitchell (1971) has shown that yeld (barren) hinds have greater fat deposits than do milk animals. Similarly the rigours of the rut deplete the fat reserves of red (Mitchell 1971) and sika stags (Horwood 1971). It is therefore essential to treat each class of animals separately. For the purposes of this study the following classes were recognised:-

a) fawns - animals less than one year old;

b) young does - aged between one and three years;

c) young males - aged between one and three years;

d) adult does - aged four to nine years;

e) adult males - aged four to nine years;

f) old does - aged ten years or more;

g) old bucks - aged ten years or more.

Due to the manner of culling, small sample sizes and the irregularity of receiving material the only really useful data obtained was that from fawns in the winter months.

Two measurements of the amount of fat present were taken, namely the kidney fat index (K.F.I.) and visceral fat index (V.F.I.). The validity of using the former index has recently been questioned by Batcheler & Clarke (1970) who showed that in red deer in New Zealand the kidneys weights may fluctuate seasonally, hence biasing the results differentially during the course of a year. However since the kidneys of fawns are still growing and data was only used for the four months from November to February it was valid to use the K.F.I. in the present work.

The considerable variation that does occur in the amount of perinephric fat is illustrated in Plates 24-27.

The variation in the amounts of fat around the kidneys and its use as an index of condition is illustrated in Plates 24-27, arranged in a series from animals with heavy deposits to those with lighter ones.

Plate 24. Kidney from an animal in prime condition, completely surrounded in thick, deep fat.

Plate 25. Kidney still covered in fat but to a lesser depth.

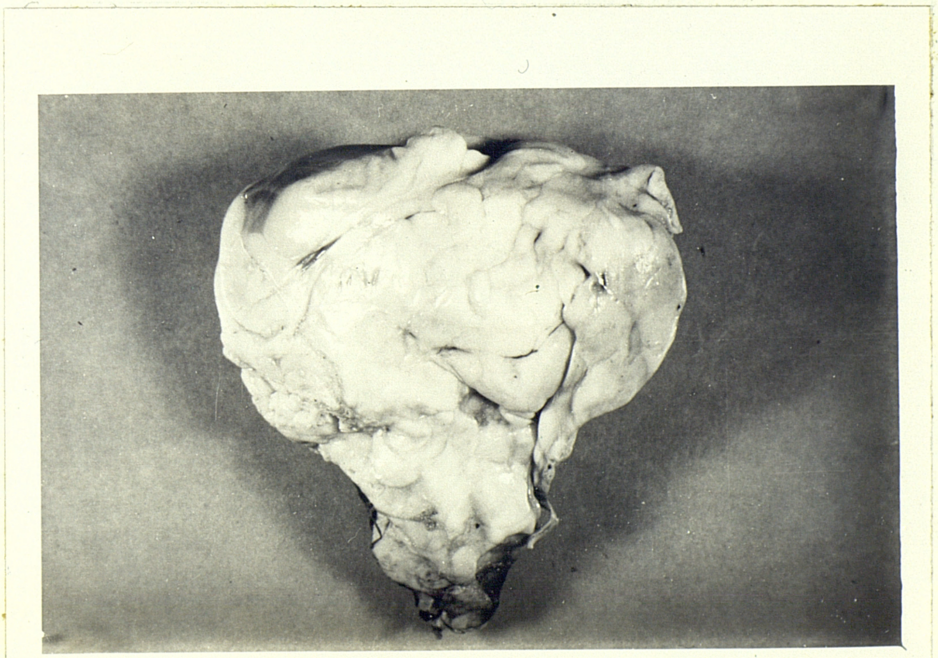
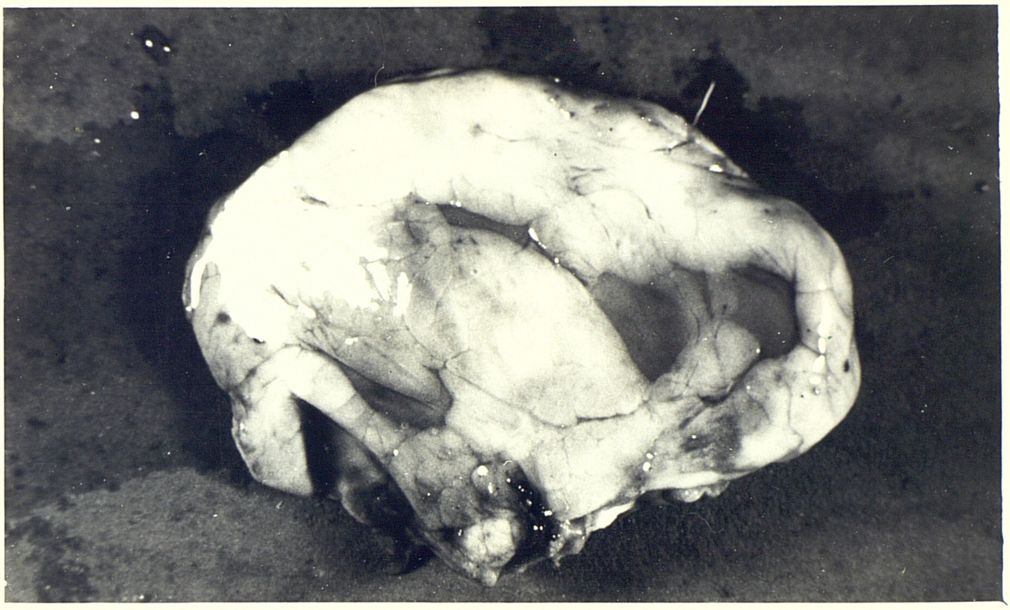
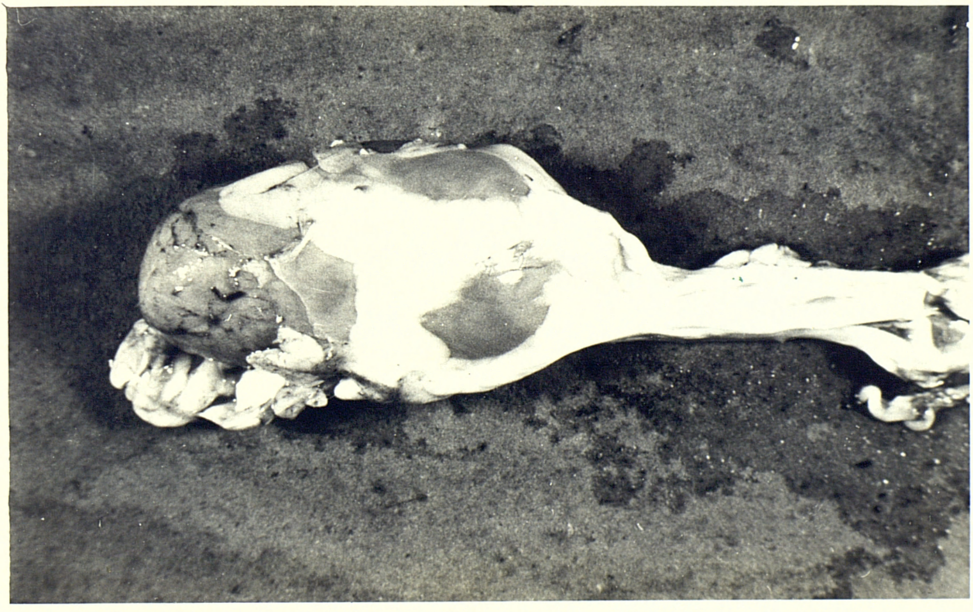


Plate 26. Parts of the kidney are now visible.

Plate 27. Little fat remains on the kidney in this specimen.





When the results of the K.F.I. and V.F.I. values obtained from a series of animals were compared it was found that a linear relationship existed between them (Fig.21). These two fat deposits appear to be laid down and utilised at similar rates. Hence it was only necessary to take one of the two indices as indicative of an animal's condition. The K.F.I. was used.

Eight cases arose in the fawns where the kidneys and encasing fat were not available but the V.F.I. was known. The K.F.I. in these deer was obtained by extrapolating from Figure 21.

The mean value for the K.F.I. for fawns for each month in each winter was calculated (Table 60). Results for the same month in different years and for consecutive months in each winter were tested for similarity at the 5% level using the t test for small samples (Bailey 1969) (Tables 61 & 62). Differences between the three study areas, A, B & C were also tested for significance wherever possible and are given in Table 63.

From Table 62 it was apparent that in the first winter, 1970-71, the values for the K.F.I. increased from November, reached a peak in December and January and fell off rapidly by February. In 1971-72 there was no statistically significant difference between the values obtained for the first three months of the winter but again K.F.I. were much lower in the last month. During the final winter, 1972-73, fawns were in their best condition before Christmas and began to fall off again in February.

If the comparisons between winters are studied (Table 61) it can be seen that the results from November to January in 1970-71 did not differ statistically from those of 1971-72; those of 1972-73 were significantly lower however. The results from February indicate that there was no significant difference in the K.F.I. values in that month between the three winters.

Figure 21 Relationship between Visceral & Kidney Fat Indices

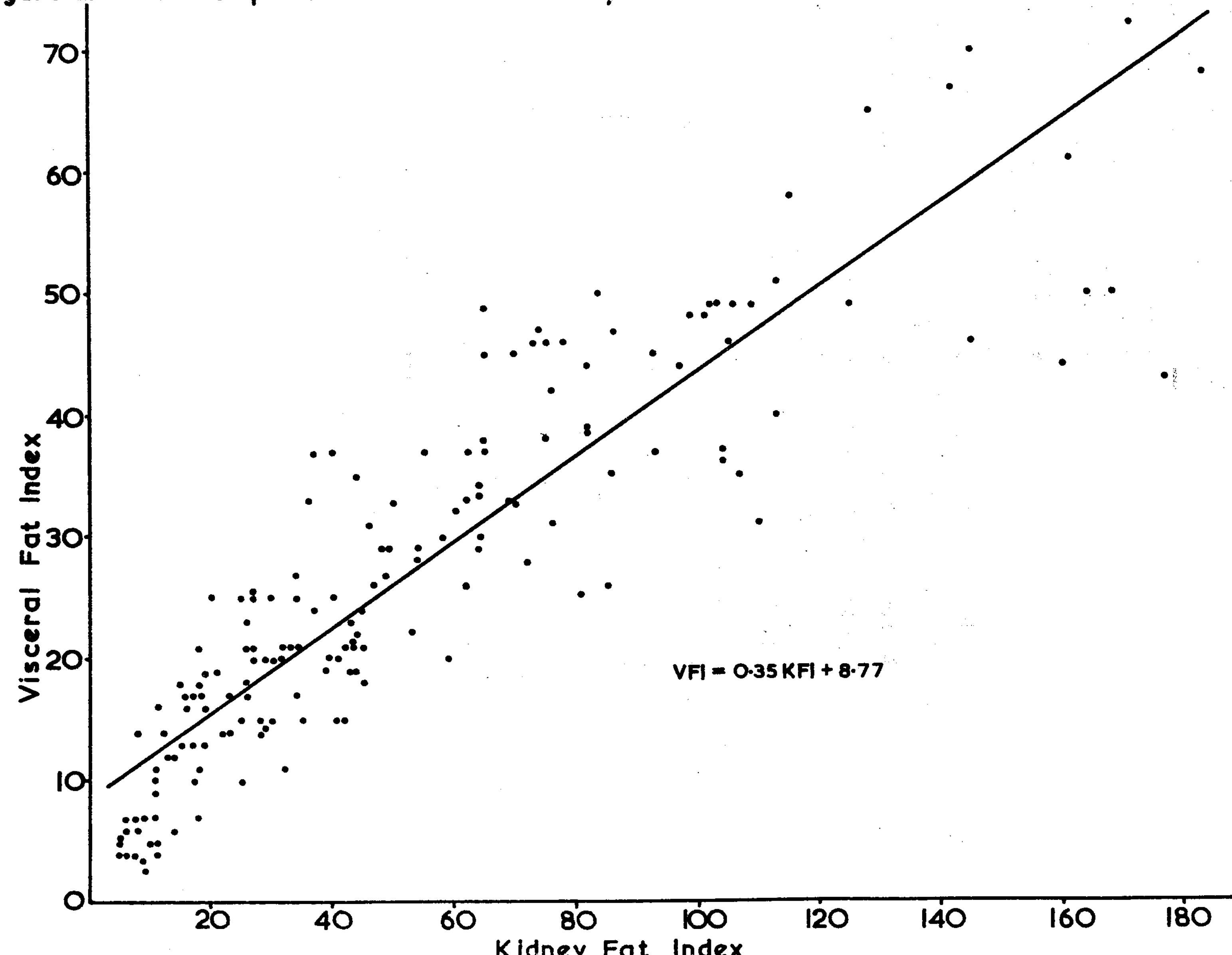


Table 60. Kidney Fat Indices obtained for All Fawns in each Winter

Month		Winter 1970-71	1971-72	1972-73
Nov	$\bar{x}$	74.3	94.6	37.5
	n	10	8	37
	sd	13.2	40.8	20.5
	R	63-99	44-160	8-104
Dec	$\bar{x}$	126.4	88.1	38.1
	n	7	8	21
	sd	49.2	24.1	22.4
	R	55-202	45-115	14-80
Jan	$\bar{x}$	102.4	76.8	24.9
	n	14	9	17
	sd	58.3	33.1	11.2
	R	34-230	29-113	5-43
Feb	$\bar{x}$	33.8	35.3	21.5
	n	8	8	15
	sd	30.5	24.8	11.5
	R	14-103	11-64	6-48

$\bar{x}$ = mean n = sample size R = range

sd = standard deviation

Table 61. Comparisons of the Mean Kidney Fat Indices for Fawns from the Same Month in Different Winters

Comparison	°f	t	P	
Nov 70:71	16	1.41	0.1-0.2	NSD
Dec 70:71	13	0.91	0.3-0.4	NSD
Jan 71:72	21	1.11	0.2-0.3	NSD
Feb 71:72	16	0.17	0.9-1.0	NSD
Nov 70:72	43	5.15	< 0.001	70 > 72
Dec 70:72	26	9.31	< 0.001	70 > 72
Jan 71:73	29	5.40	< 0.001	71 > 73
Feb 71:73	21	1.37	0.2	NSD
Nov 71:72	41	4.01	< 0.001	71 > 72
Dec 71:72	27	5.27	< 0.001	71 > 72
Jan 72:73	24	5.13	< 0.001	72 > 73
Feb 72:73	22	1.83	0.05-0.1	NSD

Table 62. Comparison of Mean Kidney Fat Indices for Fawns in Consecutive Months in each Winter

Comparison	°f	t	P	
Nov 70:Dec 70	14	3.07	0.001-0.01	Nov 70 < Dec 70
Dec 70:Jan 71	19	0.93	0.3-0.4	NSD
Jan 71:Feb 71	20	3.08	0.001-0.01	Jan 71 > Feb 71
Nov 71:Dec 71	14	0.38	0.7-0.8	NSD
Dec 71:Jan 72	15	0.37	0.7-0.8	NSD
Jan 72:Feb 72	13	2.89	0.01-0.02	Jan 72 > Feb 72
Nov 72:Dec 72	46	0.09	0.9	NSD
Dec 72:Jan 73	36	2.21	0.02-0.05	Dec 72 < Jan 73
Jan 73:Feb 73	30	0.85	0.4	NSD

°f = degrees of freedom

NSD = no significant difference (at 5% level)

Table 63. Values and Comparisons of Kidney Fat Indices for Fawns from Study Areas A, B, and C

Date		Area A	Area B	Area C	Comparison
Nov 70,71	$\bar{x}$		81.6	63.4	t=3.23,P=0.001-0.01
	n		5	5	B > C
	sd		13.7	4.5	
	R		70-91	58-70	
Dec 70,71	$\bar{x}$		107.5	124.1	t=0.55,P= 0.6
	n		5	5	NSD
	sd		47.6	48.6	
	R		48-176	70-202	
Jan 71,72	$\bar{x}$	82.9		54.5	t=1.31,P=0.2-0.3
	n	8		5	NSD
	sd	40.5		32.9	
	R	42-113			
Feb 71,72	$\bar{x}$	90.2		33.7	t=3.59,P=0.001-0.01
	n	6		8	A > C
	sd	26.9		30.6	
	R	47-116		17-103	
Nov 72	$\bar{x}$	39.8	35.6	30.8	A:B t=0.22,P=0.8-0.9;NSD
	n	14	5	11	A:C t=1.24,P=0.2-0.3;NSD
	sd	19.6	14.0	15.6	B:C t=1.58,P=0.1-0.2;NSD
	R	9-83	14-49	11-154	
Dec 72	$\bar{x}$	41.3	26.5		t=1.61,P=0.1-0.2
	n	11	8		NSD
	sd	21.7	16.5		
	R	12-80	14-65		
Jan 73	$\bar{x}$	27.7	15.5	25.4	A:B t=3.74,P=0.001-0.01;A>B
	n	7	5	5	A:C t=0.36,P=0.7-0.8;NSD
	sd	10.4	8.0	11.5	B:C t=1.58,P=0.1-0.2;NSD
	R	11-43	5-27	8-40	
Feb 73	$\bar{x}$	22.2	13.1	20.0	A:B t=2.03,P=0.05-0.1;NSD
	n	6	6	5	A:C t=0.36,P=0.7-0.8;NSD
	sd	9.9	4.9	10.1	B:C t=1.50,P=0.1-0.2;NSD
	R	11-36	5-19	10-31	

$\bar{x}$ = mean KFI n= sample size R = range

NSD = no significant difference(at 5% level)

From this data it can be concluded that the fawns were in better condition, as measured by the K.F.I., in the first two winters of the study period than in the third but that in February the values were comparable.

It is difficult to draw any firm conclusions from the data presented in Table 63 of the comparisons of the K.F.I. values in any one month between fawns from the three study areas.

6.3. Skeletal Size

The skeletal size of an animal may be a reflection of the quality of the habitat in which it lives (Klein & Strandgaard 1972; Reimers 1972).

In order to see whether there was any significant difference between the skeletal size, as indicated by jaw length, of the fawns in each winter the monthly means were first calculated separately for males and females. In many cases it was necessary to pool the results from November with December and those of January with February for adequate sample sizes to be obtained for use statistically. The results for buck and doe fawns were compared using the t test for small samples (Bailey 1969). The data and comparisons are presented in Table 64 from which it can be seen that males were usually slightly larger skeletally than female fawns. In view of this the two sexes were treated separately in all subsequent analyses.

During the winter of 1972-73 mandibles were obtained from beats North 4 & 5 and South 3, as in previous years, and also from North 2 & South 1 (Map I). The results from the first three beats were combined and compared, as before, with those from the other two. The results are given in Table 65 and it is apparent that the values obtained from the two regions are very similar. It can therefore be taken that fawns from beats North 4, 5 and South 3 were representative of those elsewhere

Table 64. Comparison of Jaw Lengths (mm) of Female and Male Fawns

Date	Female				Male				t	P	
	$\bar{x}$	n	s.d	Range	$\bar{x}$	n	s.d.	Range			
Nov & Dec 70	144.2	6	8.3	135-158	156.0	11	3.0	150-159	4.32	<0.001	male longer
Jan & Feb 71	154.5	10	7.2	144-169	157.7	17	7.6	148-169	1.30	0.2	NSD
Jan 71	156.7	6	7.4	150-169	157.7	10	5.3	148-165	0.35	0.7-0.8	NSD
Nov & Dec 71	152.2	6	2.5	148-155	151.5	6	5.6	141-157	0.32	0.7-0.8	NSD
Jan & Feb 72	152.8	8	3.5	151-161	152.1	8	6.0	142-159	0.25	0.8	NSD
Nov 72	147.1	20	5.1	138-155	150.9	16	5.1	142-157	2.22	0.02-0.05	male longer
Dec 72	149.0	8	3.0	145-152	150.9	10	6.7	138-158	0.74	0.4-0.5	NSD
Jan & Feb 73	151.4	15	5.0	143-160	157.1	14	4.1	152-164	3.33	0.001-0.01	male longer

$\bar{x}$ = mean jaw length n = sample size s.d = standard deviation

NSD = no significant difference (at 5% level)

Table 65. Comparison of Jaw Lengths (mm) of Fawns from Beats North 4,5 and South 3 with those from Beats North 2 and South 1

Date	Sex	N 4,5 and S 3				N 2 and S 1				t	P	
		$\bar{x}$	n	s.d	Range	$\bar{x}$	n	s.d	Range			
Nov & Dec 72	F	147.6	28	4.6	138-152	148.2	20	5.0	138-154	0.4	0.7	NSD
Nov & Dec 72	M	150.9	26	5.6	138-158	152.3	7	5.9	143-162	0.7	0.9	NSD
Jan & Feb 73	F	151.4	15	5.0	143-160	151.6	8	6.6	143-162	0.1	0.9	NSD
Jan & Feb 73	M	157.1	14	4.1	152-164	157.4	7	4.7	152-164	0.4	0.7	NSD

$\bar{x}$ = mean jaw length

n = sample size

NSD = no significant difference (at 5% level)

in the New Forest. Data from beats North 2 and South 1 were combined with those of the other three for the winter of 1972-73.

Differences between jaw lengths of fawns in the same months of different years were tested for significance at the 5% level as before. The results are shown in Table 66. No significant differences occur between data from the first winter and the last. Female fawns in November and December 1971 had longer jaws than those from the previous year but the converse was true of males. Mandibles of buck fawns culled in the New Year of 1971 were larger than those from 1972. Doe fawns in November and December 1971 were larger than those in 1972. However in both cases the value of P is 2-5%, only just below the level of significance here.

It would therefore seem that fawns may be considered to be the same size skeletally in all three winters.

The mean mandibular lengths were calculated separately for males and females for each of the age classes described in section 3.2.4., and the results are shown in Table 67. The means of the same age classes for bucks & does, and those of increasing age for each sex were tested for similarity as previously (Table 68). From these results it appears that from the areas studied:-

(i) male deer are significantly larger than females of the same age;

(ii) in does the jaw is still growing in three year olds;

(iii) in males the jaw is still growing in animals of 4-5 years of age.

The relationship between mandibular length and age can be seen for all male and all female deer, including fawns, in Figures 22 & 23.

The jaw lengths of does of four years or more in age were compared for four areas; the three study areas A, B & C (section 2.3.) and beat North 5 in the east of the Forest (Map I). Means were calculated and

Table 66. Comparison of Jaw Lengths (mm) of Fawns from the Same Months in Different Winters

Comparison	Sex	^{o}f	t	P	
Nov 70:73	M	20	1.8	0.05–0.1	NSD
Dec 70:72	M	15	2.0	0.05–0.1	NSD
Jan 71:73	M	20	1.0	0.3–0.4	NSD
Nov & Dec 70:72	F	33	1.4	0.1–0.2	NSD
Nov & Dec 70:71	F	11	2.3	0.02–0.05	longer in 1971
Nov & Dec 70:71	M	16	2.2	0.02–0.05	longer in 1970
Jan & Feb 71:72	F	17	0.6	0.5–0.6	NSD
Jan & Feb 71:72	M	24	2.3	0.02–0.05	longer in 1971
Nov & Dec 71:72	F	33	2.3	0.02–0.05	longer in 1971
Nov & Dec 71:72	M	31	0.3	0.8	NSD
Jan & Feb 72:73	F	24	1.3	0.2	NSD
Jan & Feb 72:73	M	31	0.4	0.6–0.7	NSD

^{o}f = degrees of freedom

NSD = no significant difference (at 5 % level)

Table 67. Jaw Lengths (mm) of Female and Male Fallow Deer of the Same Age Class

Age class (years)	Female $\bar{x}$	s.d	n	Range	Male $\bar{x}$	s.d	n	Range
3	185.7	5.5	7	178-194	202.1	6.6	10	192-210
4-5	195.6	6.1	16	184-204	209.4	3.6	15	204-213
6-7	196.4	4.3	8	189-201	213.2	2.9	6	210-217
8-9	198.0	5.7	12	184-206	212.8	4.3	4	207-217
10+	199.8	1.3	4	198-201	214.0	2.9	4	210-217

$\bar{x}$ = mean jaw length (mm) s.d = standard deviation
n = sample size

Table 68. Comparison between Jaw Lengths (mm) of Different Age Classes of Adult Female and Male Deer, and between Sexes of the Same Age Class

Comparison Sex	Age	t	^{o}f	P	
F	3:4-5	3.7	21	0.001-0.01	4-5 year olds longer
F	4-5:6-7	0.3	22	0.7-0.8	NSD
F	6-7:8-9	0.7	18	0.5-0.6	NSD
M	3;4-5	3.6	23	0.001-0.01	4-5 year olds longer
M	4-5:6-7	2.3	19	0.02-0.05	6-7 year olds longer
F:M	3	2.9	15	0.01-0.02	Male longer
F:M	4-5	6.5	29	0.001	Male larger
F:M	6-7	8.8	12	0.001	Male larger

NSD = no significant difference (at 5% level)
^{o}f = degrees of freedom

Figure 22 Relationship between Jaw Length & Age in Male Fallow

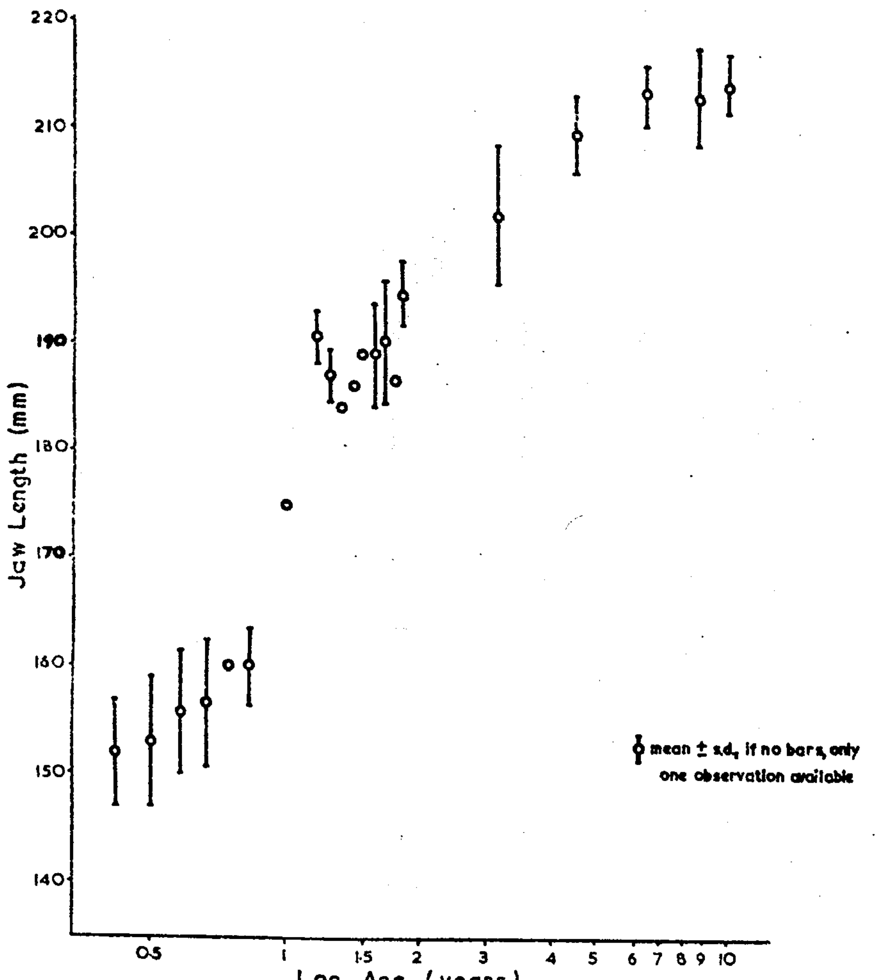


Figure 23 Relationship between Jaw Length & Age in Female Fallow

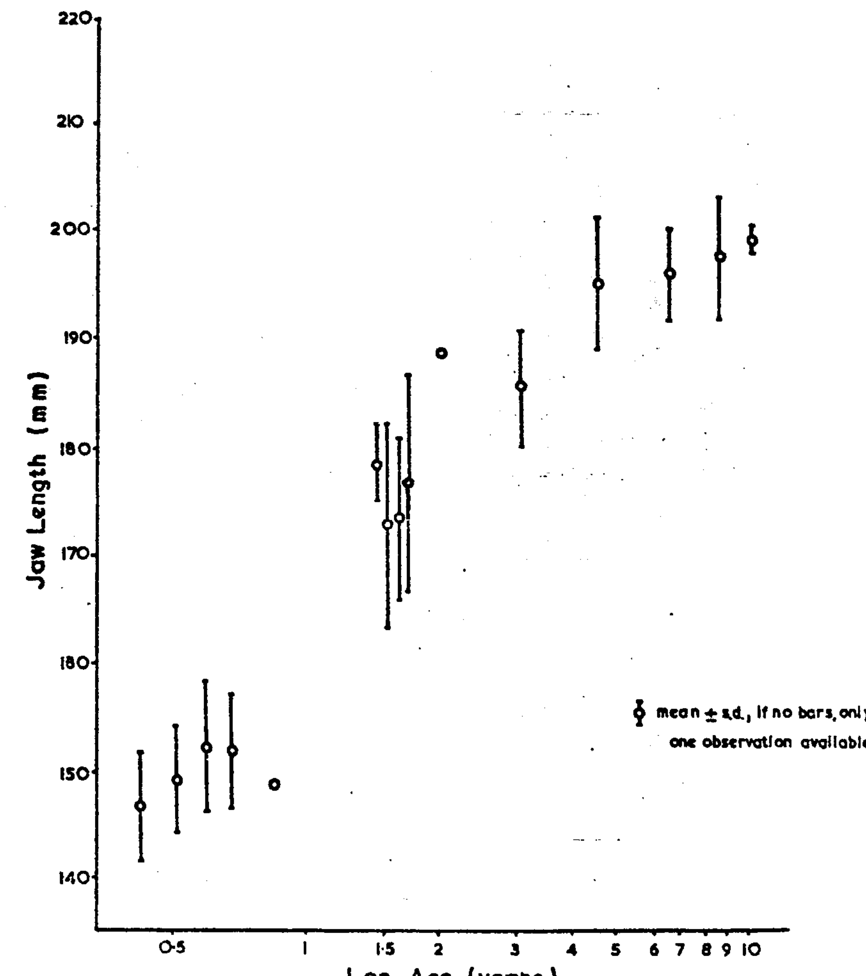


Table 69. Jaw Lengths (mm) of Does Aged 4 Years or Older from Selected Locations.

	Study Areas A	B	C	Beat North 5
$\bar{x}$	195.2	192.0	194.5	200.8
sd	5.5	3.8	5.2	3.4
n	20	22	12	6
R	188-204	184-200	184-201	197-206

$\bar{x}$ = mean jaw length (mm) sd = standard deviation

n = sample size R = size range

Table 70. Comparison of Jaw Lengths of Does Aged 4 Years or Older from Selected Locations.

Comparison	^{o}f	t	P	
Study area A:B	40	2.2	0.02-0.05	A > B
Study area A:C	30	0.4	0.7-0.8	NSD
Study area B:C	32	1.6	0.1-0.2	NSD
Area A:beat North 5	24	2.4	0.02-0.05	N5 > A

^{o}f = degrees of freedom

NSD= no significant difference (at 5% level) compared for each place as before and the results are presented in Tables 69 and 70. Does from Area A were significantly larger than those in B (at the 5% level) and those from beat North 5 were larger than any of the other three areas. Caution should be exercised when interpreting these results as culling is selective, poorer animals being taken whenever possible. The efficiency with which this is carried out may vary from keeper to keeper, hence biasing the results, although this is thought unlikely.

6.4. Body Weights

Three measurements of weight were available:-

i) dead weight - that of the animals as shot;

ii) gralloched weight - that of the entire animal minus all the alimentary tract except the oesophagus;

iii) butchers weight - that of the animal minus all internal organs, except the kidneys, and with the feet and head removed but not the skin.

The standard weight was taken to be butchers weight. Ideally however the best value to have taken would have been that of the entire animal minus both the alimentary and reproductive tracts. The weight of the viscera may vary with season, time of day and the metabolic needs of the animal (section 5.8.2.); the weight of the uterus and contents in adult female deer with increase greatly during the eight month gestation from November to June. In male deer testicular weights also vary seasonally (Bramley 1970; Chapman & Chapman 1970b; Lincoln 1971) but is small compared with the body weight.

From October 1971, the butchers weights were available for all deer shot in the New Forest but prior to this data was only kept for animals culled on beats North 3, 5 and South 3.

The relationship between dead and gralloched weight and gralloched and butchers weight was investigated by regression analysis from the data supplied from different beat keepers for the small-deer culled during the winter months. The equations of the lines are given in Table 71 and data from beat South 3 is presented in Figures 24, 25 & 26. It is then evident that:

i)strong correlation exists between dead and gralloched weight, and between gralloched and butchers weight, individual variation being small;

ii) that the equations of the regression lines obtained from different keepers are very similar and it would therefore appear valid, if needed, to pool results from different beats;

iii) that during the winter of 1972-73 the proportion of the dead weight of the animals that the viscera form is greater than in the previous two years.

The same relationships existed for male-deer, the equations of the regression lines being:-

Gralloched Wt. = 0.90 Dead Wt. - 5.81 (kg)

Butchers Wt. = 0.70 Gralloched Wt.+ 1.29 (kg)

It has been shown for red deer (Dzieciolowski 1970a) and roe (Prior 1968) that the body weight of a deer may still alter after the initial rapid growth phase of the young animal has been passed. The butchers weights for bucks and does of three years of age or more are shown in Table 71. The majority of male-deer are shot in March & April and August & September when their weights are not directly comparable with winter-shot does. However it can be seen that male-deer are considerably heavier than does but that both show an increase in weight with age, reaching a peak at about 8-9 years of age, and falling off rapidly after this.

The average butchers weight of male and of female fawns was calculated for each winter month (November-February) for each small-deer

Table 71. Relationships between Dead, Gralloched and Butchers Weights for Winter-Culled Small-Deer determined by Linear Regression

Dead Weight (DW) against Gralloched Weight (GW)

Beat	Winter	Equation of Line (kg)
South 3	1970-71 & 71/72	GW = 0.84DW -1.79
North 3	1970-71 & 71/72	GW = 0.81DW -1.47
South 3	1972-73	GW = 0.77DW -1.88
North 3	1972-73	GW = 0.72DW -0.41

Gralloched Weight (GW) against Butchers Weight (BW)

Beat	Winter	Equation of Line (kg)
South 3	1970-71	BW = 0.70GW +1.53
South 3	1971-72	BW = 0.71GW +0.95
North 3	1971-72	BW =0.71GW +1.20
South 2	1971-72	BW = 0.69GW +1.01
South 3	1972-73	BW = 0.68GW +1.24
North 3	1972-73	BW = 0.73GW +0.61
South 2	1972-73	BW = 0.69GW +1.01

Figure 24 Relationship between Gralloched & Dead Weight for Small Deer from Beat South 3, Winters 1970-71 & 71-72

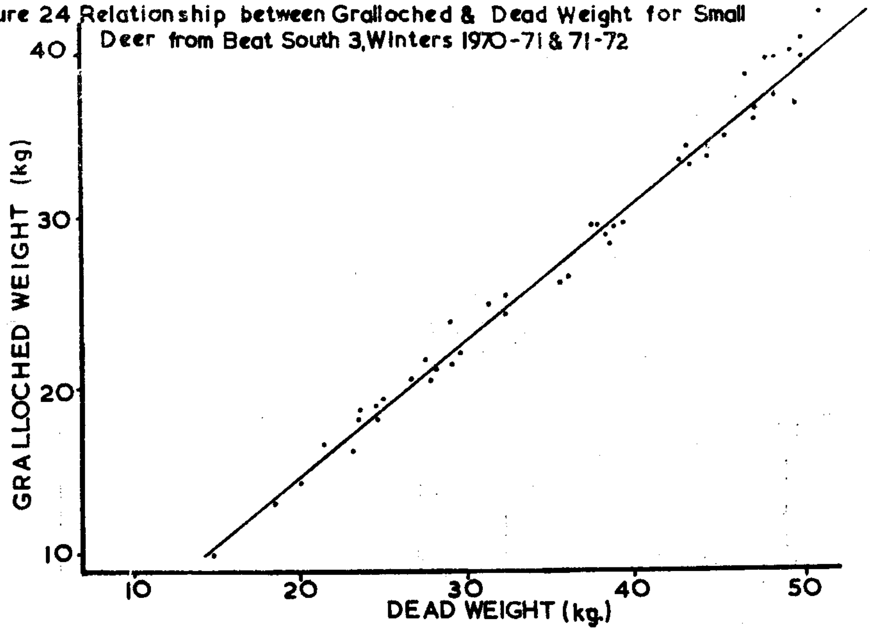


Figure 25 Relationship between Gralloched & Dead Weight for Small-Deer from Beat South 3, Winter 1972-73

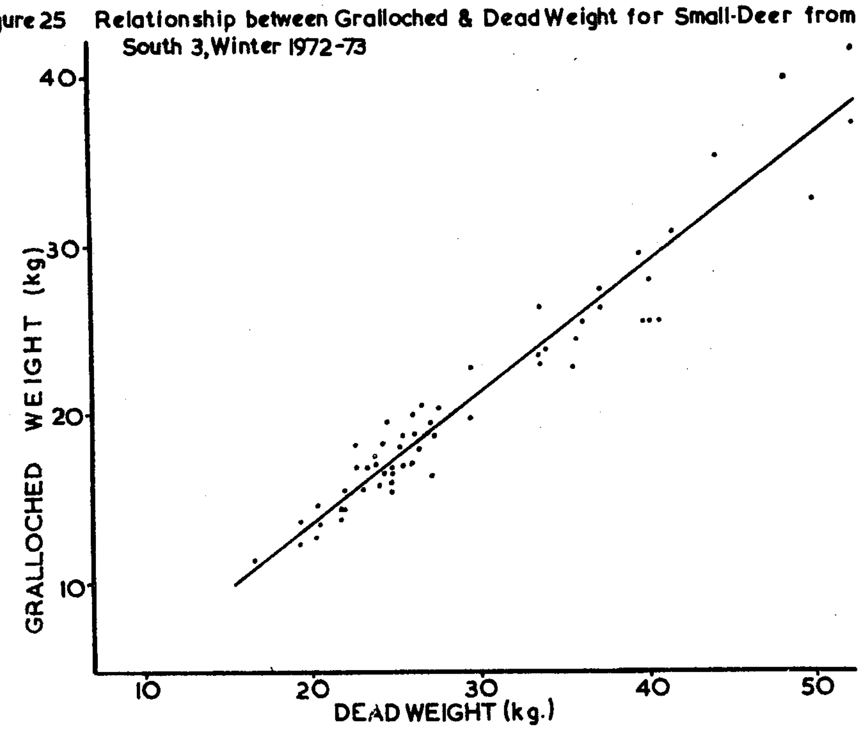


Figure 26 Relationship between Butcher's & Gralloched Weight for Small-Deer from Beat South 3, Winters 1970-71 & 71-72

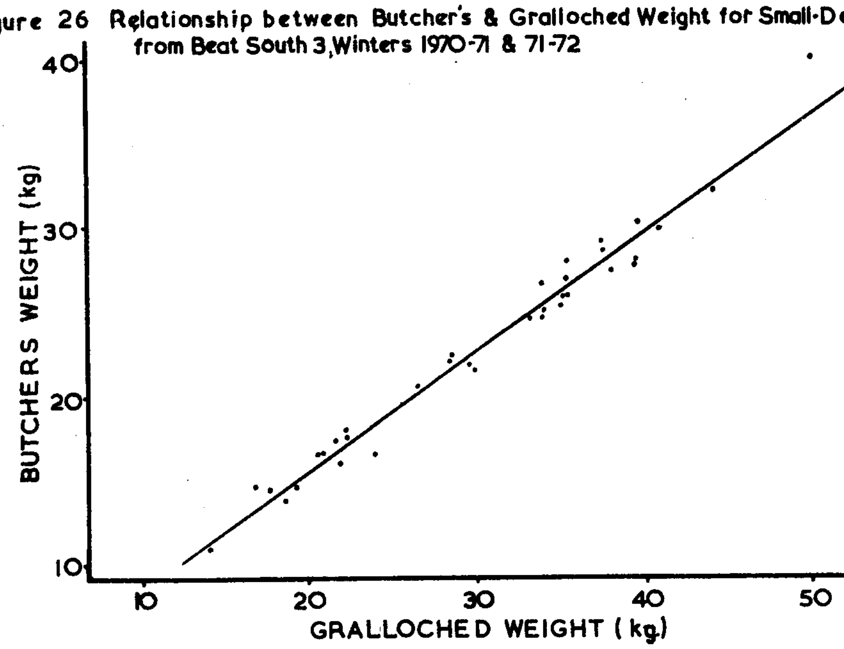


Table 71b Variation of Butchers Weight with Age in Adult Fallow Deer

Sex	Age class (years)	Mean BWt kg	Mean BWt lbs	s.d kg	s.d lbs	Sample size
	3	31.8	70.1	3.0	6.6	13
	4-5	36.5	80.4	1.6	3.6	15
Male	6-7	47.2	104.0	1.3	2.9	8
	8-9	48.1	106.0	2.0	4.3	4
	10+	29.9	65.9	1.3	2.9	7
	3	21.3	47.0	3.4	7.4	6
	4-5	24.5	53.9	4.3	9.4	16
Female	6-7	24.5	53.9	4.3	9.4	8
	8-9	27.3	60.1	1.6	3.6	12
	10+	21.8	48.0	3.2	7.0	3

s.d = standard deviation

BWt = butchers weight

cull and were compared using the t test for small samples. Data was available from beats North 3, 5 & South 3 for all three winters and was pooled. Results from the remaining beats on the Forest were only available for 1971-72 & 72-73 and were again pooled but treated separately from the previous ones (Table 72).

Comparisons could be made in twelve instances (Table 73); ten of these showed no statistical difference at the 5% level whereas in two cases male fawns were larger than females. The range in butchers weights of fawns shot in any one month was considerable (Table 72) and because sample sizes were also small any small differences between the two sexes became obscured. However it was felt valid to combine the values for both sexes of fawns.

The mean butchers weights from fawns obtained monthly in the winters of 1971-72 & 72-73 from beats North 3, 5 & South 3 were compared with those from beats North 2 & South 1 using the t test. The results are shown in Table 74. There is no significant difference at the 5% level of probability between the values for the two regions in seven of the eight cases. In January 1972, deer from the second region were found to be statistically heavier than those on the first. However it appears that from the butchers weight values, all fawns in the New Forest can be considered to come from one population.

The values for the butchers weight of male and female fawns were combined for each month of each winter and were statistically compared with those from the same month in different years. The results are given in Table 75. For beats North 3, 5 & South 3, the values for all months of the first winter, 1970-71, were not statistically different from those of the second, at the 5% probability level. Similarly no difference existed between January 1972 and 73 or in any of the three Februarys. However the weights for both November & December 1970 & 71

Table 72. Butchers Weight (kg) of Fawns during the Winters 1970-71, 71-72 and 72-73

Date	Beats	Female				Male				All			
		$\bar{x}$	n	s.d	Range	$\bar{x}$	n	s.d	Range	$\bar{x}$	n	s.d	Range
Nov 70	N 3,5;S 3	12.5	5	1.4	10.4-14.1	16.9	5	1.8	14.5-19.1	14.7	10	2.8	10.4-19.1
Dec 70		15.3	3	3.3	12.7-19.1	16.7	7	2.0	14.5-19.5	16.2	10	2.4	12.7-19.5
Jan 71		14.6	6	3.1	10.9-18.1	15.8	12	2.9	11.3-19.1	15.4	18	2.9	10.9-19.1
Feb 71		12.5	6	2.4	9.5-15.0	14.4	10	2.9	10.9-19.5	13.7	16	3.0	9.5-19.5
Nov 71	N 3,5;S 3	16.0	6	1.3	14.1-17.7	14.8	7	2.7	9.5-17.7	15.4	13	2.2	9.5-17.7
Dec 71		14.1	2	0.6	13.6-14.5	16.7	7	4.5	14.5-18.6	16.1	9	2.1	13.6-18.6
Jan 72		13.9	7	2.5	10.4-16.3	12.5	4	5.6	5.4-19.1	13.4	11	3.7	5.4-19.1
Feb 72		12.5	5	3.9	7.3-17.7	10.0	3	2.5	7.3-17.7	11.6	8	3.5	7.3-17.7
Nov 72	N 3,5;S 3	12.4	21	2.3	7.3-16.3	13.6	15	1.9	9.1-15.9	12.9	36	2.2	7.3-16.3
Dec 72		11.4	9	1.6	9.1-12.7	12.7	12	2.0	10.4-14.5	12.2	21	1.9	10.4-14.5
Jan 73		10.8	5	3.1	7.7-15.9	12.8	12	1.8	9.5-15.9	12.2	17	2.3	7.7-15.9
Feb 73		11.6	12	2.0	9.1-15.4	14.4	3	1.1	13.2-15.4	12.2	15	2.1	9.1-15.4
Nov 71	N 1,2,4;S 1,2	13.6	2	1.3	12.7-14.5	15.9	3	1.6	14.1-17.2	15.0	5	1.8	12.7-17.2
Dec 71		17.4	5	3.8	12.7-22.7	17.2	13	2.4	13.6-20.0	17.3	18	2.7	12.7-22.7
Jan 72		16.0	10	1.8	14.1-18.6	16.8	2	3.2	14.5-19.1	16.1	12	0.9	14.1-19.1
Feb 72		13.3	12	2.1	10.9-17.2	13.6	2	1.9	12.3-15.0	13.3	14	2.0	10.9-17.2
Nov 72	N 1,2,3;S 1,2	13.4	20	1.7	10.0-15.9	14.4	10	1.6	12.2-17.2	13.7	30	1.7	10.0-17.2
Dec 72		12.0	13	2.4	6.8-15.9	13.7	11	2.0	11.3-17.2	12.8	24	2.4	6.8-17.2
Jan 73		12.1	11	2.1	9.5-15.4	14.8	9	2.0	10.4-17.2	13.3	20	2.4	9.5-17.2
Feb 73		11.9	7	2.6	7.7-15.4	13.8	6	2.7	10.0-16.3	12.8	13	2.7	7.7-16.3

$\bar{x}$ = mean butchers weight   n = sample size   s.d = standard deviation

Table 73. Comparison between Butchers Weights of Female and Male Fawns.

Date	Beats	$^o f$	t	P	
Nov 70	N 3,5;S 3	8	4.3	0.001-0.01	males heavier
Jan 71		16	0.9	0.4-0.5	NSD
Feb 71		14	1.3	0.2-0.3	NSD
Nov 71		11	1.0	0.3-0.4	NSD
Nov 72		34	1.6	0.1-0.2	NSD
Dec 72		19	1.6	0.1-0.2	NSD
Jan 73		15	1.7	0.1-0.2	NSD
Dec 71	N 1,2,4;S 1,2	16	0.1	0.9	NSD
Nov 72		28	1.3	0.2-0.3	NSD
Dec 72		22	1.9	0.05-0.1	NSD
Jan 73		18	2.9	0.01	males heavier
Feb 73		11	1.3	0.2-0.3	NSD

$^o f$ = degrees of freedom
NSD = no significant difference (at 5% level)

Table 74. Comparison between Butchers Weights of All Fawns on Beats North 3,5 and South 3 with those on North 1,2,4 and South 1,2.

Date	$^o f$	t	P	
Nov 71	16	0.4	0.7-0.8	NSD
Dec 71	25	1.2	0.2-0.3	NSD
Jan 72	21	2.3	0.02-0.05	N 1,2,4;S 1,2 heavier
Feb 72	20	1.5	0.1-0.2	NSD
Nov 72	64	1.7	0.1-0.2	NSD
Dec 72	43	0.9	0.3-0.4	NSD
Jan 73	35	1.4	0.2-0.3	NSD
Feb 73	26	0.7	0.5	NSD

$^o f$ = degrees of freedom
NSD = no significant difference(at 5% level)

Table 75. Comparison of Butchers Weights of Fawns from the Same Months in Different Winters

Date	Beats	^{o}f	t	P	
Nov 70:71	N 3,5;S 3	21	0.7	0.5-0.6	NSD
Dec 70:71		17	0.2	0.8-0.9	NSD
Jan 71:72		27	1.6	0.1-0.2	NSD
Feb 71:72		22	1.6	0.1-0.2	NSD
Nov 71:72	N 3,5;S 3	47	3.5	0.001	1971 heavier
Dec 71:72		28	4.9	0.001	1971 heavier
Jan 72:73		26	1.1	0.3	NSD
Feb 72:73		21	0.5	0.6	NSD
Nov 70:72	N 3,5;S 3	44	2.2	0.02-0.05	1970 heavier
Dec 70:72		29	5.1	0.001	1970 heavier
Jan 71:73		33	3.6	0.001	1970 heavier
Feb 71:73		29	1.6	0.1-0.2	NSD
Nov 71:72	N 1,2,4;S 1,2	33	1.5	0.1-0.2	NSD
Dec 71:72		40	5.7	0.001	1971 heavier
Jan 72:73		30	3.5	0.001-0.01	1972 heavier
Feb 72:73		25	0.5	0.6-0.7	NSD

^{o}f = degrees of freedom
NSD = no significant difference (at 5% level)

were significantly heavier than for 1972 as was that of January 1971 compared to 1972. In the case of beats North 2 and South 1, where data was only available for the last two winters of the study period, December 1971 and January 1972 were significantly higher than the corresponding months a year later but there was no difference between November 1971 & 72 or February 1972 & 73.

It can therefore be concluded that the butchers weights (and hence also gralloched and dead weights) were generally higher in the November and December of the first two winters than in the third, and were also slightly greater in January. In February the weights were the same in all three years.

The mean monthly butchers weight of does aged 4-9 years were calculated for each winter (Table 76) and were compared as before (Table 77). Comparisons were also made between consecutive months in each winter. It was apparent that the results for the butchers weights of does (and hence gralloched and dead values too), parallel those for fawns. The values for 1970-71 were comparable with 1971-72 and were significantly higher than those of 1972-73. There was found to be no statistical difference between the weights for November 1971 and 72 in the does for the combined beats North 2 and South 1. Similarly no difference existed between the butchers weight of does or of fawns shot in February 1971 compared with 1973.

Mitchell (1971) has shown that for red deer on Rhum the weights of yeld (barren) hinds were greater than of milk animals. However up to 40% of that population were yeld whereas Armstrong et al. (1969) demonstrated that 95% of adult does in the New Forest were pregnant and the animals here can be considered as one group.

Table 76. Butchers Weights of Does in the Three Winter Culls

Month		1970-71		1971-72		1972-73	
		kg	lbs	kg	lbs	kg	lbs
November	$\bar{x}$	25.4	56.0	23.7	52.2	22.1	48.7
	s.d	1.7	3.7	3.0	6.7	2.9	6.3
	R	24.0-28.1	53-62	17.2-27.2	38-60	14.5-30.8	32-68
	n	5		13		40	
December	$\bar{x}$	26.5	58.4	24.5	54.0	21.4	47.2
	s.d	1.3	3.0	2.7	5.9	3.0	6.6
	R	24.9-28.6	55-63	18.1-28.1	40-62	14.5-27.2	32-60
	n	5		23		26	
January	$\bar{x}$	24.7	54.5	25.1	55.3	22.1	48.8
	s.d	3.4	7.5	2.7	5.9	2.8	6.2
	R	15.9-29.5	35-65	19.1-28.1	42-62	18.1-30.4	40-67
	n	12		37		21	
February	$\bar{x}$	20.9	46.0	24.0	52.8	20.1	44.4
	s.d	4.8	10.7	2.8	6.2	2.7	5.9
	R	13.6-24.9	30-55	19.1-27.7	42-61	15.4-24.5	34-54
	n	7		16		14	

$\bar{x}$ = mean   s.d = standard deviation   R = range   n = sample size

Table 77. Comparison between the Butchers Weights of Does in Various Winter Months

Comparison	^{o}f	t	P	
Nov 70:Dec 70	10	1.14	0.2-0.3	NSD
Dec 70:Jan 71	17	2.10	0.05	NSD
Jan 71:Feb 71	19	3.87	0.001	Jan 71 heavier
Nov 71:Dec 71	36	0.85	0.4	NSD
Dec 71:Jan 72	60	0.79	0.4-0.5	NSD
Jan 72:Feb 72	53	1.42	0.1-0.2	NSD
Nov 72:Dec 72	66	0.95	0.3-0.4	NSD
Dec 72:Jan 73	47	0.86	0.4	NSD
Jan 73:Feb 73	35	2.11	0.02-0.05	Jan 73 heavier
Nov 70:Nov 71	18	1.18	0.2-0.3	NSD
Dec 70:Dec 71	28	1.60	0.1-0.2	NSD
Jan 71:Jan 72	49	0.37	0.7-0.8	NSD
Feb 71:Feb 72	23	1.93	0.05-0.1	NSD
Nov 70:Nov 72	45	2.51	0.01-0.02	Nov 70 heavier
Dec 70:Dec 72	31	3.69	0.001	Dec 70 heavier
Jan 71:Jan 73	33	2.31	0.02-0.05	Jan 71 heavier
Feb 71:Feb 73	21	0.46	0.6-0.7	NSD
Nov 71:Nov 72	53	1.72	0.05-0.1	NSD
Dec 71:Dec 72	49	3.83	0.001	Dec 71 heavier
Jan 72:Jan 73	58	3.98	0.001	Jan 72 heavier
Feb 72:Feb 73	30	3.79	0.001	Feb 72 heavier

^{o}f = degrees of freedom

NSD = no significant difference (at 5% level)

6.5. Conclusions

From the data obtained on condition and body weight it can be concluded that from November to January in the winters of 1970-71 and 1971-72, fawns were heavier and had larger visceral and perinephric fat deposits than in the same period of 1972-73. However the values for all three Februarys were not statistically different. Changes in the body weights of does paralleled those seen in fawns. No difference in skeletal size existed between the three winters in fawns.

It has been shown in Chapter 5 that the diet in the autumn and early winter of the first two years was characterised by the considerable quantities of acorns, and to a lesser extent mast, which were absent in 1972-73. It is concluded that it was this abundance of rich food which accounted for the increased fat deposits and body weights observed.

Skeletal size was the same in all three periods (section 6.2.) yet body weights were low in 1972-73 (section 6.3.). Hence the carcass quality was also better in the first two years.

Differences in the condition of fawns and skeletal sizes of does between areas also suggests that certain regions offer a better quantity or quality of forage. However sample sizes used were small and variation was great and it would be unwise to draw firm conclusions on this until more data has been obtained.

The percentage of the dead weight which the grallochs comprised was greater in the final winter (section 6.4.) and it has been shown in section 5.8.2. that the ruminal fill in 1972-73 was higher than in the corresponding period in the previous two years.

Chapter 7. FEEDING ACTIVITY & BEHAVIOUR, AND FACTORS AFFECTING IT.

7.1. Feeding Activity

From the results obtained during direct field observations, the mean number of deer seen per visit was calculated for each hour of the daytime for bimonthly periods between May 1971 and October 1972. Data amassed prior to this has not been included as it is insufficient to be meaningful. The percentage of all deer seen each hour which were feeding was also found and the two sets of results are shown in Figures 27 & 28.

From the former it can be seen that the greatest number of animals were seen early and late in the day, with the exception of September/ October 1971 and March/April 1972. The results for the first and last hours of daylight were generally lower than for the second and penultimate ones which is thought to be due to the fact that visibility at these times was poorer because of mist and lack of light. From Figure 28 it was evident that the majority of all individuals observed throughout daylight hours were feeding.

Fallow were in poor physical condition by late February (sections 6.2.,6.4.) and from March onwards graminids became increasingly important in their diet as the new spring growth or "bite" appeared (section 5.1.,5.2.). The increased activity seen in spring was attributable to the animals taking this new herbage. Marauding damage by fallow to pastureland is also particularly prevalent at this season (Cadman 1966;pers.obsv.).

September and October are both months when rutting is intense and it might be expected that a greater number of individuals would be seen then (Page 1962; Cadman 1966; Chapman & Chapman 1970). However although large numbers were seen throughout the day during this period in 1971 when acorns were an important food (section 5.2.), in September and October of 1972 the diet paralleled that of the preceding summer months as did the activity patterns (Figure 26). It is suggested that in the

Figure 27 Number of Fallow Seen per Visit per Hour of the Day on Area A, May 1971 - October 1972

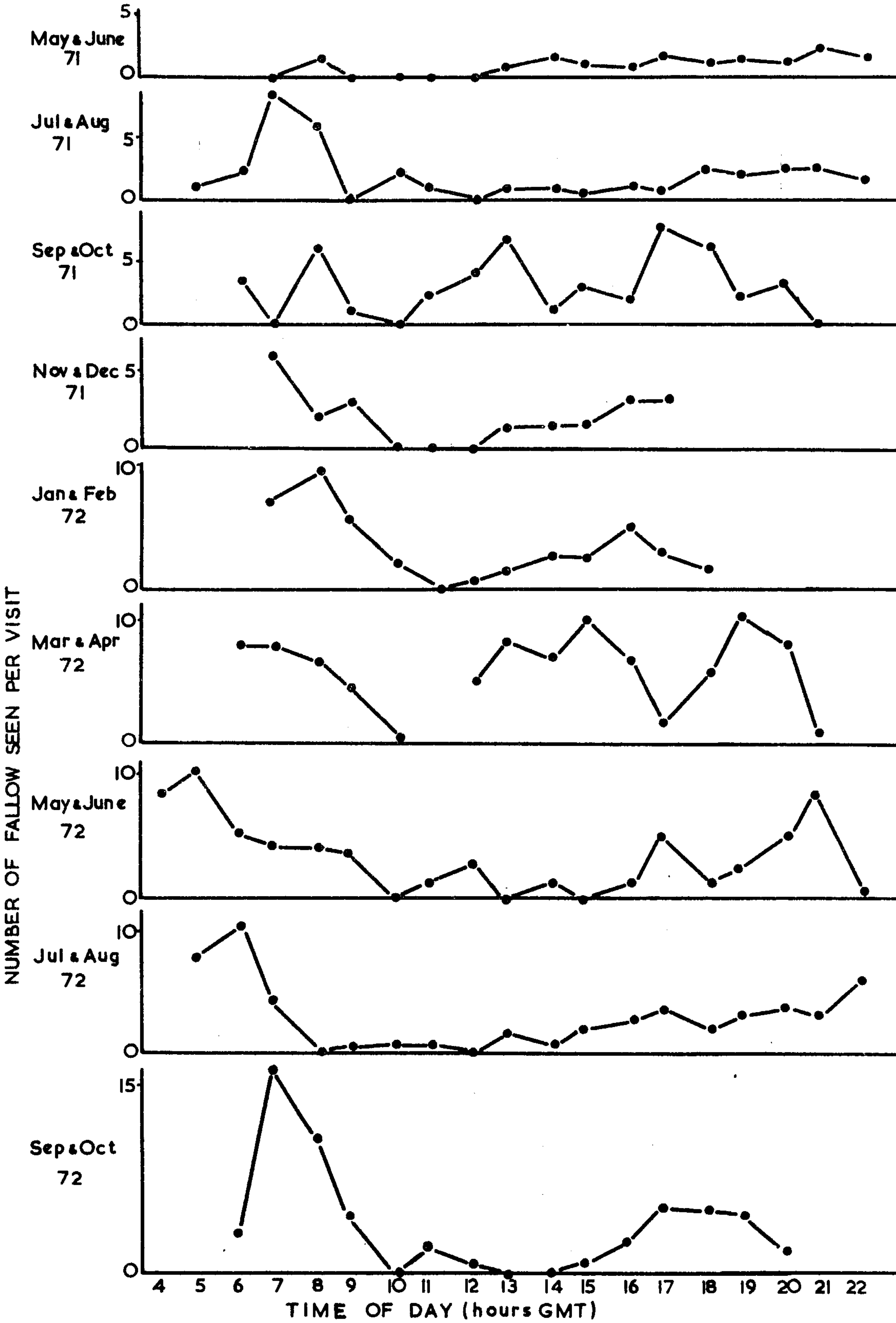
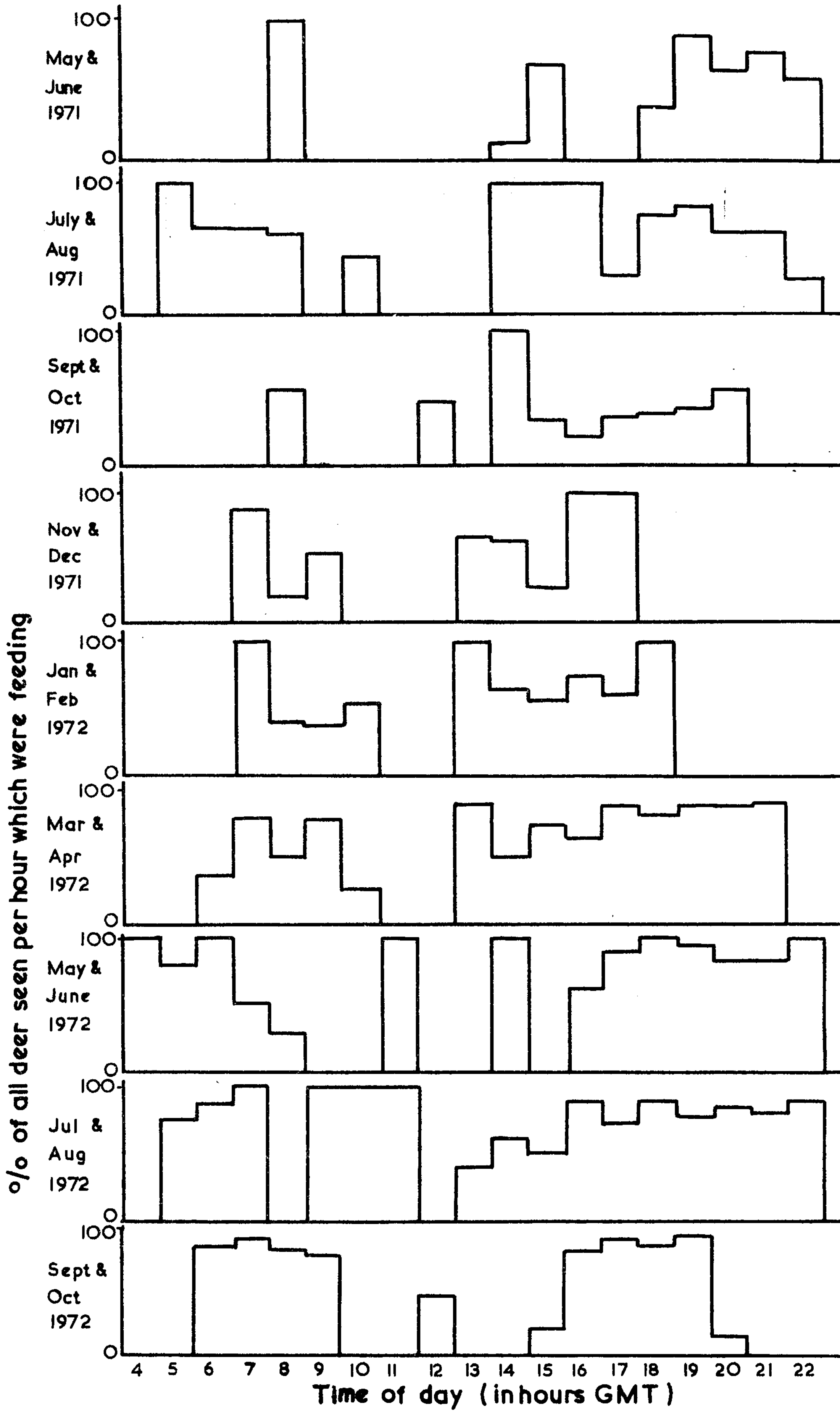


Figure 28 Percentage of All Deer Seen which were Feeding at Different Times of the Day on Area A from May 1971 to October 1972



first year, when the fallow frequented mature hardwood areas (Chapter 8), they could feed undisturbed throughout the day as such habitats offer greater cover than do the plantations favoured during the corresponding period in 1972.

In sections 5.8.1. & 5.9. it was shown that the results of the studies on ruminal fill and ingesta particle size in the winter suggested that feeding occurred throughout the day : this is supported by the data presented here. Deer were seen feeding during the late morning and early afternoon throughout study Area A and were not confined to any one particular location.

It can be concluded that the fallow deer on study Area A are easiest to observe early and late in the day, except during the spring and in autumn of rich acorn years, when considerable numbers may be encountered at all hours. The animals do feed at all times of the day but the relative importance and duration of such feeding periods cannot be assessed from the present data.

If undisturbed, most Cervidae show a regular daily pattern of feeding and rumination (Taylor 1956; Mottl 1957; Bubenik & Casnocha 1963; Lochman 1965; Michael 1970; Ozoga & Verme 1970). Lochman (1965), for example, found that in forests in central Europe red deer showed seven peaks of browsing activity during twenty four hours and roe eleven. The intensity of these feeding periods may vary (Bubenik 1960). The habitat itself may affect the animals activities. Andersen (1961) found that roe living on heathland in Denmark fed at regular intervals during daylight hours. When some of these same deer were transferred to a woodland habitat their feeding routine altered and within three months they fed regularly only in the morning and evening.

The results from the present work are comparable with the findings of other authors in Great Britain. Cadman (1966) writes that although fallow feed mainly at dusk, night and dawn, in places where disturbance is slight they may be found feeding in both late morning and the afternoon. Page (1962) states that "dawn & dusk are the usual feeding times but when deer (fallow) are undisturbed they may feed at regular intervals throughout the day. This tends also to be the pattern of behaviour in winter when food is not so readily found".

The situation regarding the nocturnal feeding activities in fallow were not systematically investigated in the present study.

7.2. Types of Feeding Behaviour

From watching fallow deer in the field, both on Area A and elsewhere in the New Forest, five main modes of feeding were recognised in this study namely:-

(a) grazing
(b) browsing
(c) quartering
(d) barking
(e) pushing through

(a) Grazing

Grazing was the normal activity when deer fed on small soft rooted vegetation such as graminids and small herbs where they formed the dominant ground flora layer. The animals were observed to move slowly along with heads lowered, selecting vegetation & looking up occasionally. This can be seen in Plates 28 & 29.

(b) Browsing

Browsing was distinct from grazing in two respects. Firstly it was usually carried out at a higher level from the ground than grazing and secondly the food plants were normally springy or woody in nature so that the vegetation moved away when the deer pulled at it. It was seen on such types of plant as deciduous trees, conifers, holly, bramble and rose, Calluna and ferns. When deer were utilising foliage from felled

Plate 28. Herd of small-deer, in winter coat, grazing at Backley Plain, March 1973. Note the close cropped sward and that the animals show a distinct direction of movement when grazing.

Plate 29. Herd of male-deer, in summer coat and with antlers in velvet, grazing in the fields at Bolderwood Farm, July 1973.

or fallen trees this was also considered to be browsing.

The normal method of feeding in Cervidae is to grasp the plant material between the mandibular incisiform teeth and the pad of hard tissue in the upper jaw and wrench it off, no functional maxillary incisors being present. However when feeding in winter on small bushed hollies and on the new soft growth of gorse on old browsed bushes in the summer, it was noted that leaves and shoots were pulled off using the side of the mouth in the region of the first premolar teeth. It is believed this modification is to protect the nose from being damaged on such types of heavily browsed prickly food plants.

On four occasions deer were seen to rear up onto the hind legs to reach low hanging foliage on deciduous trees.

A doe was also watched feeding on low oak on the edge of ride 90/95 in Denny Lodge Inclosure (Map II,6) in August 1972 whilst holding down a branch by keeping it under her chin. The same animal then repeated this behaviour on two other small branches.

(c) Quartering

This activity was seen to occur when deer were searching the ground for a specific scattered food such as acorns, mast, fallen fruit, ground or trailing ivy, and certain species of dead leaves such as ash, rowan and guelder rose. The animals moved slowly around with heads lowered and moving slowly from side to side. When deer were grazing or browsing a definite direction of movement was evident but when quartering the individuals in a herd moved in a random manner, constantly crossing and recrossing the area.

(d) Barking

Deer were only seen in the act of taking bark on three occasions; one doe on ivy creepers, one buck on holly and one doe on Scots pine. However examination of barked trees & creepers and of particles in the rumens of culled deer yielded supporting evidence as to this mode of feeding. Examples of barking have been shown in Plates 20-23.

In all three cases where deer were watched taking bark the lower incisors were dug into it and used to lever up a small piece which was then gripped between the front teeth and the fibrous pad in the upper jaw and pulled off with an upward jerk of the head and neck. The process was then repeated. The size of the particles taken will vary with the type taken. Holly and ivy were chipped off in small pieces some 2 by 1 cm in size, those of Scots pine were up to 5 cm in length and 1 cm in width and trees with loose barks such as birch and western hemlock frequently had large strips torn from them. Strips of up to 12 by 2 cm were isolated from the ingesta.

(e) Pushing through.

This type of feeding activity was noted when deer were actively pushing through other vegetation to reach food. For example when individuals were taking herbs such as vetches they often pushed through *Molinia* clumps to reach them or underneath dead bracken to obtain frost free grass and bilberry.

Although it was occasionally difficult to classify a particular feeding action into one of the five categories above, these types typify the major ways of obtaining food observed in this study.

7.3. Social Factors in Relation to Feeding

Social factors may be of some importance in governing the feeding ecology of Cervidae. In certain species for example the sexes may live in separate herds which utilise different geographical areas and the diet might vary accordingly. In deer showing dominance hierarchies within groups or territorial behaviour for all or part of the year, the food of an individual may vary with its social status. The size and composition of herds may alter seasonally and reflect changes in the feeding habits. The possible effects of social factors in relation to the feeding ecology of fallow deer in the New Forest were studied during the course of field observations with data obtained on the following aspects:-

i) herd types;

ii) dominance hierarchies;

iii) differential use of areas by herd types;

iv) herd sizes.

7.3.1. <u>Herd Types</u>

During the course of field observation on Area A, three main types of herd were recognised, namely

(a) small-deer herd;

(b) male-deer herd;

(c) mixed herd.

(a) Small-deer herds

Small-deer herds consisted of adult and yearling does and fawns of either sex. Prickets were considered to be small-deer when found with female deer, male fawns, singly or with other yearling males.

(b) Male-deer herds

These were composed of one or more male fallow older than two years, together with any accompanying prickets.

(c) Mixed herds

Mixed herds were those containing both small and male-deer.

The numbers of each herd type seen per month are given in Table 78 and it can be seen that on Area A for the greater part of the year only herds of types (a) and (b) were present. Mixed herds were recorded at two times of the year; firstly from September to early November, associated with the rut, and secondly on five occasions in late winter and early spring.

Most authors are in agreement that in fallow separation of the sexes in adults is normal for at least part of the year. Heidemann (1971) found that in Germany this segregation was evident from April until the

Table 78. Number of Different Herd Types seen per Month on Study Area A

Date	Herd Type SMALL	MALE	MIXED
March 1971	11	1	1
April	34	2	1
May	34	3	0
June	35	6	0
July	61	7	0
August	59	12	1
September	73	15	1
October	95	31	12
November	33	6	1
December	37	6	0
January 1972	52	2	0
February	53	8	1
March	65	5	2
April	63	1	0
May	80	5	0
June	86	3	0
July	93	6	0
August	85	4	0
September	79	9	1
October	96	23	8
Total	1224	155	29

commencement of the rut and Southern (1965) states that it occurs in summer. Cadman (1966), Harris & Duff (1970) and Chapman & Chapman (1970) believe that after the rut, separate male and small-deer herds reform by midwinter. The views of Page (1962) parallel those of the present work in that apart from the rut mixed herds are encountered only in late winter and early spring.

This is the period when food is scarcest (Cadman 1966) and one might expect that deer would move more in search of food. Daytime activity increases in March and April (section 7.1.). Heidemann (1971) believed that besides sexual attraction, security requirements by males led to the formation of mixed-sex groups in open country, which would therefore explain the appearance of such herds in late winter and early spring on Area A.

7.3.2. <u>Dominance Hierarchies</u>

Dominance hierarchies exist in herds of fallow deer (Page 1962; Gilbert & Heidemann 1966; Gilbert 1968) and the diet of an individual might be expected to depend on its social status. Aggression was seen within feeding herds of small-deer and manifested itself in three ways:

(1) the dominant animal approached another with head lowered and neck stretched forward, no contact being made;

(2) the dominant animal nudged another with the nose, usually in the hind flank region;

(3) the dominant animal bit another individual.

Gilbert (1968), working on semi-wild, penned fallow also observed "pawing" between individuals using the forefeet but this was never observed here.

Threats of types (1) & (2) were observed on many occasions and occurred in three main situations:-

(a) during feeding when the dominant animal forced another to move off a particular site and then fed there itself;

(b) when danger threatened and the dominant individuals way was blocked by another deer;

(c) when an injured deer was present in or adjacent to a herd it was constantly threatened by other members. This was seen constantly in Parkhill Inclosure towards a doe with a malformed foreleg who could walk but was lame.

Similar behaviour was also noted in male-deer herds where aggression was found to be either of type (1) or alternatively the dominant animal tilted its antlers forward as if to engage those of the other individual. Sparring with the antlers was observed between individuals of comparable antler and body size both on Area A and at the deer sanctuary at Boldrewood Farm on a total of thirty six times outside the normal rutting period. This was also noted by Page (1962) who believed it to be important in deciding precedence within a herd.

In section 5.6. it was demonstrated that the composition of the ingesta of two deer shot from the same herd were alike quantitatively. The nutritional value, digestibility and palatability of available plant material may vary from species to species, seasonally, with the age of the plant, with site factors such as light & soil, between individuals and even from leaf to leaf (Cook & Harris 1950; Swank 1956; Dietz 1965; Short, Dietz & Remmenga 1966; Miller 1971). Deer are highly selective in their choice of food being capable of selecting the most nutritious forage (Swift 1948) and for certain substances such as tannine & essential oils (Juon 1963; Klotzi 1965). The occasions when aggression in feeding were seen always involved one animal moving another off a favoured feeding site. The dominant animal might thus obtain better quality forage than others in the herd, although quantitatively their diets may be alike.

7.3.3. Differential Use of Areas by Herd Types

Segregation of the sexes occurs in several species of deer and herds may occupy different geographical areas. In Great Britain the distribution of red deer in the Highlands is traditional (Edwards 1962). Stags are found on the highest ground in summer and the lowest in winter whilst hinds and followers occupy the middle zones. Horwood (1969,71) demonstrated in sika in Dorset that apart from the rut the sexes live separately and in different locations.

Such a differential distribution is found in fallow in the New Forest. Certain locations are recognised as being male-deer areas where small-deer are seldom seen and the converse is also true. In other places both types are found but do not normally form mixed herds except during the late winter & early spring and the rut.

In the annual census (section 2.2.), 65 subareas or units were recognised. The number of small and male-deer in each of these units was known and the following data was calculated:-

(1) the number of male deer in each unit expressed as a percentage of their population for the whole Forest;

(2) the number of small deer present in each unit expressed as a percentage of their total Forest population;

(3) the percentage of the total head in each unit which were male-deer.

Units were then grouped according to their relative distance from their centres to the nearest accessible agricultural land and the mean values for (1), (2) & (3) calculated. The results are shown in Figures 29 & 30 from which it can be seen that there is a tendency for male-deer to be found in closer proximity to agricultural land than are small-deer herds. No male-deer are found on deer inhabited areas furthest from fields.

It should be remembered that the figures used were obtained in

Figure 29 Relationship between Relative Distance of Areas in the New Forest from Fields & Percentage Ratio of Male to Small Deer there, April 1973

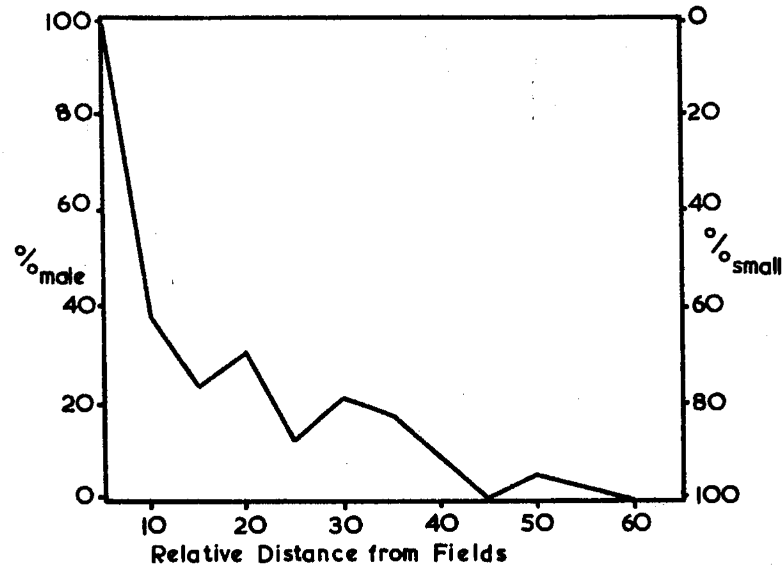
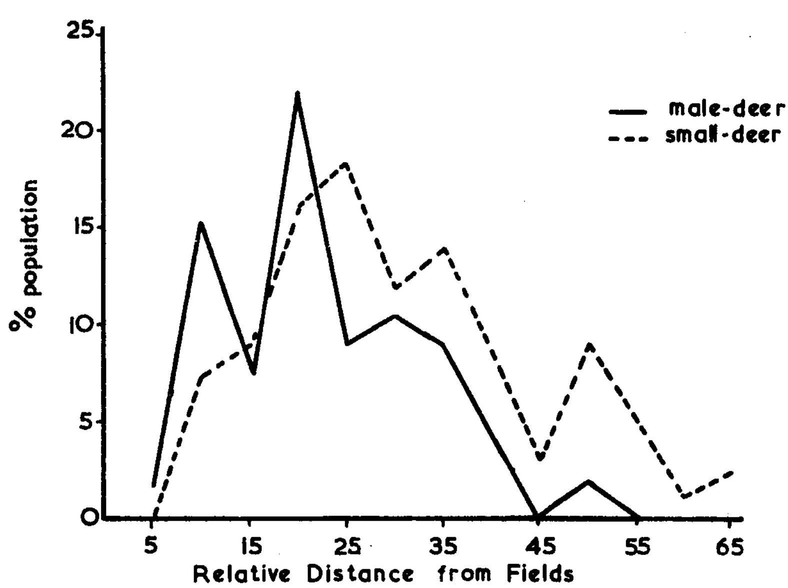


Figure 30 Distribution of Total Male & Small Deer Populations in the New Forest in relation to their Relative Distances from Fields, April 1973



April when the small-deer population will be at its lowest having been culled heavily during the previous winter. Grasses were an important food from March until September (sections 5.1.1. & 5.2.) but it has been shown in section 5.4. that the quantitative diets of male and small-deer are comparable. Consultation with keepers revealed that during this period bucks remained close to fields. The situation during autumn and winter is confused, being influenced by the rut and the abundance of the acorn crop which tends to hold deer in deciduous woodland habitats (Chapter 8) in good years until early January.

The location of all male-deer herds seen on Area A during field observations are shown for the periods August to November and December to July in Figure 31. It is evident that during the rut bucks are found throughout A yet their distribution for the rest of the year is localised, being centred on Denny Wood and Denny New (Map II, 3 & 4). Figure 32 shows the small-deer distribution in May/June 1972 and September/October 1972 which are representative of their distribution patterns. From this it is apparent that although small-deer are seen in the western half of Denny New they were rarely seen in Denny Wood itself.

With such a spatial separation it might be expected that the diets of bucks might differ from that of does and followers but this is not so (section 5.4.).

7.3.4. <u>Herd Sizes</u>

The numbers of deer in a herd may fluctuate seasonally due to a variety of causes including reproduction, disturbance and adverse food or weather conditions. The numbers in small-deer herds on Area A per calendar month are shown in Figure 33. Clear seasonal variations in herd size can be seen which parallel those described by other authors (Page 1962; Cadman 1966; Heidemann 1971).

During May the small-deer herds break up as adult does leave the groups a few weeks before the fawns are born about mid-June, and at such

Figure 31 Distribution of Male-Deer Herds seen on Area A

Figure 32 Distribution of Small-Deer Herds seen on Area A

times they may show some degree of territoriality (Heidemann 1971). By August the numbers in the herds increase as does and fawns join other animals. Larger herds form during the rut and increase in size during December and January, reaching a peak in late winter and early spring.

The numbers of animals in male-deer herds on Area A are shown in Figure 34. The mean herd size was smaller than for small-deer reaching maximum numbers in spring & early summer, breaking up from August onwards as the velvet was cleaned from the antlers and not reforming after the end of the rut until February.

In both male and small-deer, maximal herd sizes occur in late winter and spring (February to April), the period when deer are in poor physical condition (section 6.2.,6.4.) and food is scarcest. This phenomenon and the appearance of mixed herds would appear to be associated with food shortage. Similar increases in herd sizes in adverse conditions are known for example in white tailed (Taylor 1965; Michael 1970; Sparrowe & Springer 1970), roe (Bramley 1970; Delap 1970; Page 1971) and sika deer (Page 1971).

Herds normally acted as a distinct unit but were observed to amalgamate or to re-establish themselves on several occasions. Splitting of one "herd" into two smaller groups when deer left a feeding area and moved into denser vegetation was seen three times in small-deer and once in male-deer. Amalgamation of two groups to form one feeding unit occurred on three occasions on the reseeded grassland areas of Backley Plain (Map I,33) and Kings Garden. Large herds of up to forty small-deer were seen there in late winter and spring (Plate 30). Deer were observed to come onto the grassland and merge with other deer there, acting as one herd. These animals were chased by the observer and separation into two smaller groups achieved. Three fawns then changed from one group to the other passing within 10 m. of the observer situated between the two. Herds of the original size & composition were thus reformed and left

Figure 33 Seasonal Fluctuation in the Size of Small Deer Herds on Area A

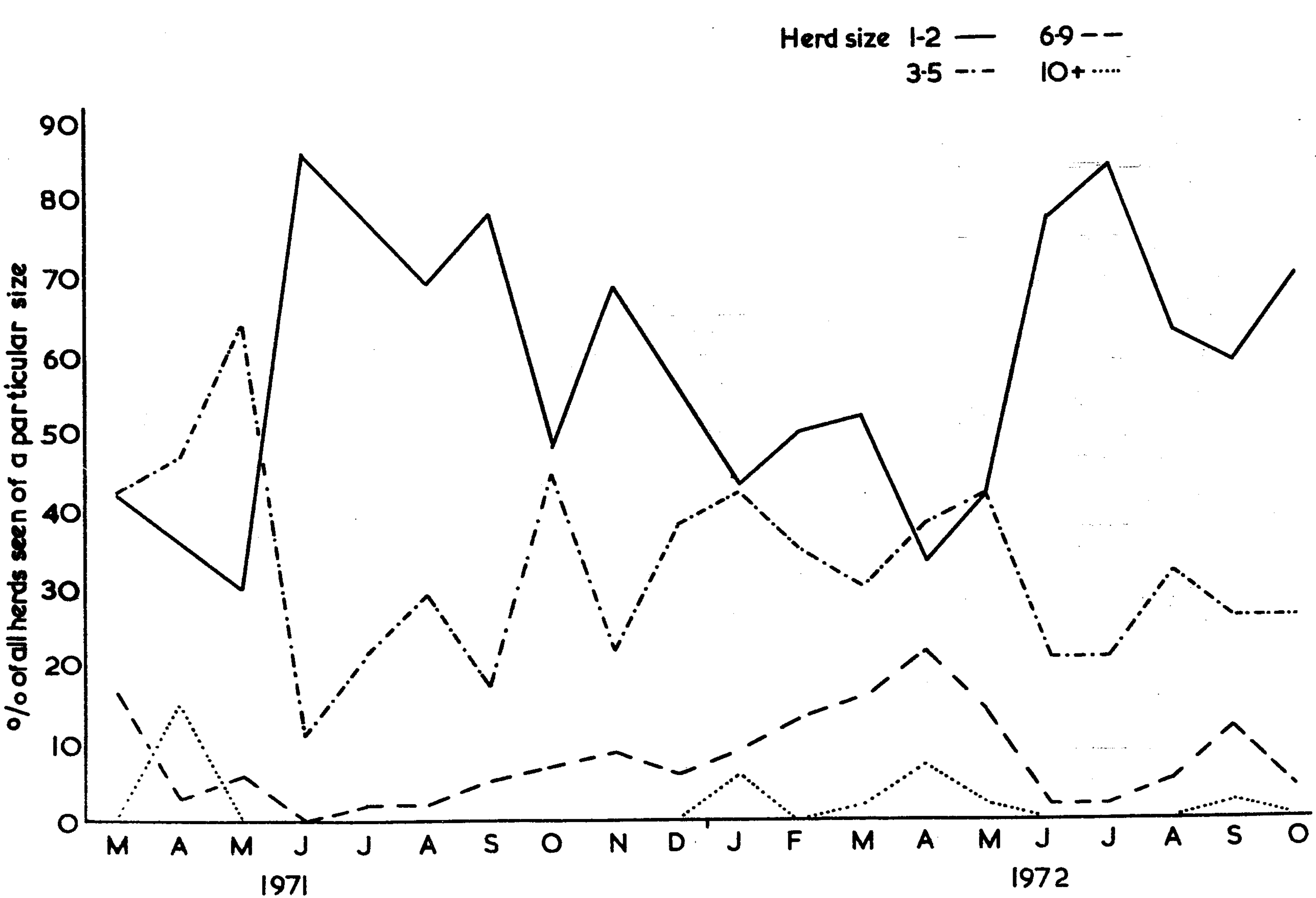


Figure 34 Seasonal Fluctuations in the Size of Male Deer Herds on Area A

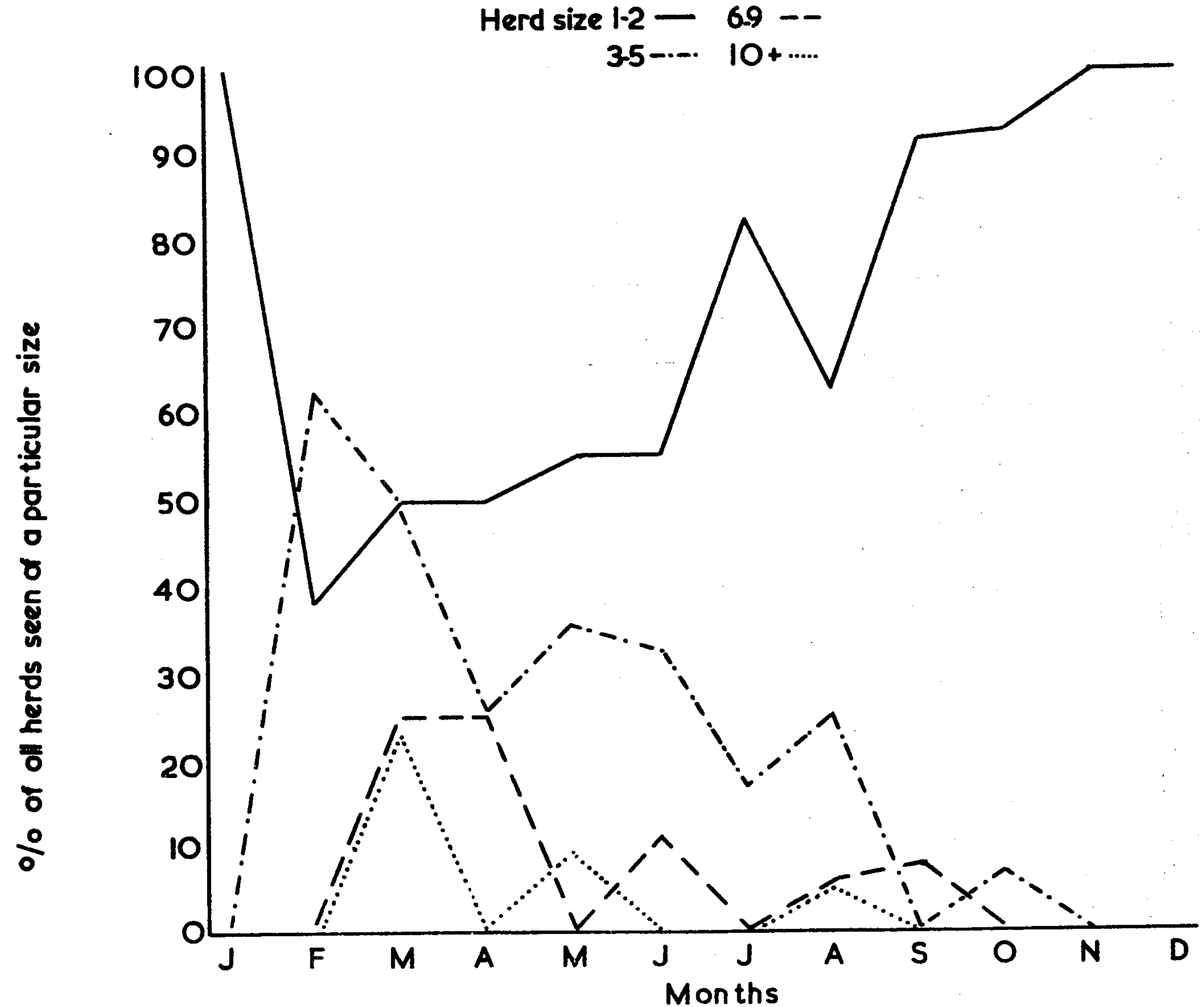


Plate 30. Large herds of Small-Deer, suck as this one at Baokley in March 1973, formed in late winter and early spring.

the grassland in opposite directions. However on a total of nine other visits two or more herds of small-deer were seen grazing on the areas yet maintained their separate identities.

On the intensive study area, twelve instances were noted when two herds of deer passed within fifty metres and within sight of one another but both groups merely looked up and resumed their previous activities.

Large herds of up to thirty male-deer used the fields at New Park Farm (Map I,71) for feeding in spring. This is believed to result from deer from Whitley Wood (Map I,72) and Poundhill (Map I,78) coming together to use a common feeding ground and forming two distinct herds when leaving the fields (pers.comm.Forestry Commission Keepers).

It therefore seems that under certain circumstances, large herds of deer may result simply through smaller groups combining to use common feeding grounds. However deer using such areas do not always merge and the results presented earlier on herd size show that large groups are still found principally in late winter and spring when food is in short supply.

Sika (Horwood 1970,71) and white-tailed deer (Michael 1970) are also known to form large feeding herds which break up when the animals have left the area to rest.

7.4. Feeding Behaviour in Relation to Climate

In some cases when dealing with Cervidae, a major factor influencing their feeding ecology may be the effect of weather & exposure. As Verme (1965) has demonstrated, areas may possess an adequate food supply yet because shelter is not available the animals will not use them. With white-tailed deer in the United States he found that although food was important in the selection of favoured sites in hard weather, the ultimate deciding factor was the shelter from exposure that they afforded. Similarly roe deer avoid strong cold winds (Robertson 1967; Chard 1970) and Cumming (1966) working in Glen Dye believed that dispersion of this species there in winter was largely determined by the protection from exposure that different locations afforded. Anderson (1972) found that 90 percent of the variation between years in natural winter mortality in red deer on the Isle of Rhum was attributable to temperature alone. Severe chilling results from a combination of cold and wind (Caborn 1965). Roe are also said to prefer sunny conditions (Eiberle 1965; Robertson 1967) and Chard (1970) states that their activity may also be affected by heat waves and approaching thunderstorms. Snowfall may alter not only the availability of food plants but also the mobility of the animals themselves (Telfer & Kelsall 1971).

Seasonal movements associated with changes in climatic conditions may also occur. For example the migration of reindeer and caribou are well documented but on a smaller scale red deer in the Highlands move to lower slopes or seek shelter in woodlands or plantations in hard weather and similar behaviour occurs in roe in upland areas (Wildash 1951; Thomson 1966).

Climatic conditions in the New Forest are far less severe than those found in the winter in either North America, Scotland or central & northern Europe. Snowfall is rare, mean monthly temperatures are above zero and ground frosts only occur on one day in two during the winter (section 2.1.2.).

During the course of field work records were kept on each visit of cloud cover, wind velocity and precipitation although data was not available on temperature. The number of deer seen varied seasonally and with the time of day (section 7.1.) and had to be taken into account when considering the possible effects of weather on the feeding habits of the fallow deer. All three winters were mild (section 2.1.2.) and adverse conditions such as periods of snow & intense cold occurred only rarely and were of short duration. Thus insufficient data was available for the effects of adverse winter climatic conditions on deer to be analysed statistically and the following conclusions reached are subjective although based on observations from 279 separate days.

a) Wind. Fallow were found in sheltered conditions such as rides running through thickets or mature trees when winds were strong. The animals fed furtively looking around frequently.

b) Sunshine. This seemed to promote activity in fallow. Basking in the sun was observed on 25 occasions.

c) Rainfall. The deer were averse to heavy rain. In heavy showers they were found in sheltered conditions such as the lee of tall trees or in ditches or banks. In all five instances when deer were feeding on a plantation when heavy rain started they moved off into shelter. After heavy rain of short duration (less than two hours) deer seen were dry. However they were observed to feed in heavy continuous rain.

d) Thunderstorms. Deer were watched feeding on Area A on three occasions prior to thunderstorms and their behaviour was normal.

e) Drought. Conditions in the New Forest often lead to a drought during the late summer (section 2.1.2.) and changes in food selection may occur (section 5.1.1. & 5.2.).

f) Snowfall. Heavy snow fell on only one day of the intensive study period, namely on 31.1.72 when approximately 20 cm fell between 08.00 and 12.00 hours. Study Area A was extensively walked between 15.00 and 18.15 hours, it being impossible to use a vehicle, and Denny Lodge, Woodfidley, Stubby Copse, Denny Wood and the eastern section of Parkhill Inclosures were all visited. Only one herd was seen being comprised of four does and three fawns on compartment 96 in Denny Lodge Inclosure. These deer were watched feeding for 15 minutes and browsed exclusively on tall Calluna having first pushed the snow off with their noses. When deer feed in snow the foods taken can usually be identified (Ahlen 1965; Dzieciolowski 1967b) but only two such sites were located and in both sweet grass had been taken from areas of less than thirty centimetres square where the snow had been scraped clear, presumably using the forefeet. Snow did not cover the ground under mature holly and closed canopy Douglas fir and it was not possible to tell whether deer had fed in these areas.

From counts of tracks in snow covered areas activity of deer was small but it was impossible to distinguish between those made by fallow and those of roe. When several fallow move they do so in file (Page 1962; Cadman 1966;pers.obsv.) and it is difficult to ascertain how many animals are present in a herd of more than three or four beasts (Telfer 1970).

Accounts obtained from Forestry Commission personnel on the behaviour of fallow in the winter of 1962-63 when snow cover persisted for nearly three months indicate that they frequented areas such as mature holly and Douglas fir where the snow was shallow. Cadman (1966) states that they feed principally on holly & gorse in such conditions.

It is concluded that the effects of climatic conditions on the feeding habits of the fallow in the New Forest will be negligible except under exceptionally adverse circumstances.

7.5. Disturbance

7.5.1. Introduction

Fallow are often reported to be the most wary of the species of deer in Great Britain (de Nahlik 1959; Page 1962; Prior 1965) and one might therefore expect that the amount of disturbance they were subject to would alter their habits accordingly. Disturbance may affect not only the times at which these animals feed (Page 1962; Cadman 1966; Chapman & Chapman 1970) but also the potential availability of different food types. Excessive disturbance on potentially rich feeding sites may result in their being used only to a limited extent and the deer may then have to take less acceptable foods elsewhere. Many of the reseeded areas and lawns in the New Forest are examples of this, being comparatively rich in food, especially in spring, yet because they are often much frequented by visitors and may be situated some distance from cover they may not be as fully utilised by fallow as are poorer sites close to shelter.

Most Cervidae show a regular daily pattern of feeding and rumination (Taylor 1956; Mottl 1957; Bubenik 1960; Lochman 1965; Michael 1970; Ozoga & Verme 1970). When these rhythms are upset the food types selected by the deer may also change. Bubenik & Casnocha (1963) demonstrated that browsing by red deer in woodlands in central Europe increased if their feeding periodicities were upset. If natural browse is not available then they may turn to taking economically important trees in afforested areas. It is also thought that one of the multiple reasons for bark stripping by deer may be because they are placed under stress conditions (Chard 1966; van de Veen 1973).

An undisturbed routine may also lead to a more efficient digestion in ruminants. For example reindeer _Rangifer tarandus_ L. gain weight more rapidly when left to graze with minimal interference than when intensively herded (Reimers 1972).

Against the background of this information it was considered relevant to study various disturbance factors which might cause changes in the feeding behaviour and area utilisation in fallow deer in the New Forest. The effects of the following factors were examined:-

(a) day visitors & campers;

(b) culling;

(c) hunting & riding;

(d) vehicles, aircraft & trains;

(e) forestry practices;

(f) other animals.

7.5.2. Day visitors and Campers

Information has been given in section 2.1.3. on the number and patterns of use of the New Forest by day visitors and campers and it was concluded that considerable disturbance will result in all areas during the summer months. This will be at a peak on weekend afternoons in fine weather. The majority of the reactions of deer to people on foot were obtained from Area A. It has been shown in section 2.3. that four camp sites are present in or adjacent to this area which is also used for a wide variety of other recreational pursuits.

No quantitative procedure was used to assess scientifically the reactions of the animals to people or the intensity of the stimulus on each occasion and the conclusions reached were therefore subjective. However during the course of field work on Area A the reaction of deer to other pedestrians were recorded on fifty-four occasions and to myself a further 203 times.

Fallow were found to react to the sight, sound and scent of humans. The behaviour shown was dependent on the distance between them and the people, and between the deer and the nearest available cover. Their initial reaction was to adopt an alert position as shown in Plate 31. If the disturbance was only minor, such as people walking by at a distance of fifty metres or more, the animals resumed their previous activity. Milder disturbance resulted in them walking off towards or into thick cover. Should they be approached closely or disturbed suddenly the deer moved off rapidly using the bouncing stiff legged gait described by Page(1962, 1971), Cadman(1966), & Chapman & Chapman (1970). When severely disturbed at very close quarters the animals ran off immediately.

On fourteen occasions when the observer remained motionless a peering, foot stamping and vocal response was elicited, described by Chapman & Chapman (1970) as being used if they are unsure of a strange object.

Plate 31. Small-deer herd at Baokley showing the characteristic alert position.

People using Area A tend to follow the network of gravel roads & rides (pers.obsv.) which can be seen from Map II to be extensive. During the peak visitor period the main food of the deer is graminids & associated herbs (section 5.2.) and the majority of grazing is done on rides and plantations (section 8.2.). Although few people go onto plantations these are readily visible and offer only a limited amount of cover, mainly through the bracken. It would therefore seem that during the summer months disturbance by pedestrians is generally detrimental to the feeding by the deer on Area A.

In parks the daily activity & behaviour of fallow vary with the amount of disturbance and contact with humans. Those living in parks to which the public have access may come to accept people and take little notice of them, although this is not always universally true (Chapman & Chapman 1970). In areas of intensive human activity visited, notably Bolderwood Farm (Map AI,36) & study Area B, deer could be approached closer than on Area A before any fright response was shown. On the reseeded area of Backley Plain deer were observed feeding during the day on two occasions whilst three people were using it as a golf driving range. However it is difficult to judge to what extent the fallow may become accustomed to the increasing number of visitors to the New Forest.

7.5.3. Culling

Culling is carried out in the New Forest in two ways, Firstly keepers may work individually, stalking on foot or shooting deer from high seats. This causes little general disturbance in an area, except to any remaining members of the herd from which the animal has been culled. Twice deer were being watched feeding in compartments immediately adjacent to those in which an animal was shot and in neither case did they react to the rifle report in any discernable way.

The second practice is for several men to co-ordinate in moving deer slowly towards prepositioned marksmen in high seats who cull animals selectively as they pass nearby. This procedure does cause disturbance on a fairly extensive scale as the areas driven are usually of thick cover such as thicket stage favoured by the deer as resting places (Cadman 1966; Chapman & Chapman 1970). However the animals seem to return quickly to these areas and on days following such culling normal numbers of deer were seen.

7.5.4. Hunting and Riding

As outlined in section 2.2.1. adult male fallow are hunted by the New Forest Buckhounds at certain times of the year. Foxhunting is also carried out on two days a week throughout the season. Both packs hunt in the Open Forest and the Inclosures and are accompanied by a varying number of riders and followers in cars.

The disturbance caused to deer is great and the effects may be longlasting. An important use of the buckhound is to break up large male deer herds and move them away from areas of agricultural land susceptible to damage, such as those adjacent to Pondhead and Denny New Inclosures (Map I, 59,60 & Map II) on Area A. Four evening visits were made to the main study area following days when deer had been hunted and few were seen of any type or species in places where the hounds had passed. The feeding activity was therefore affected accordingly.

Riding for pleasure has always been popular amongst local people and although no quantitative data is available on the total numbers now using the area twenty five riding schools are established in or adjacent to the New Forest (Conservation of the New Forest 1970). During the summer months groups of as many as thirty riders were regularly encountered on study Area A, originating principally from stables at Brockenhurst and Beaulieu Road Station.

Reactions of deer to both large parties and to single riders were studied on five and four instances respectively. With large parties deer showed similar behaviour to that when disturbed by people but took little notice of single riders walking or trotting. Guided parties followed fixed routes through the study area following gravel roads and well drained rides (pers.obsv.).

7.5.5. Vehicles, Aircraft & Trains

Reactions of fallow to vehicles and trains were observed on numerous occasions and to low flying planes and helicopters in thirteen instances. As stated in section 3.4. a vehicle was widely used during direct field observation and deer were found to be unaffected by them provided that one did not approach too closely, drove only slowly and the occupant remained as silent and still as possible. Whilst watching deer feeding, fourteen instances arose when other vehicles drove by at distances as little as thirty metres from the herd but the animals only looked up then resumed their previous activity. Four similar cases were noted involving motorcycles and mopeds.

Deer were also seen feeding close to public roads both during the daytime and at night. They were also recorded lying down within twenty metres of the main A35 in Mallards Wood (Map I,58). Chapman & Chapman (1970) report that fallow will also rest within one hundred metres of motorways.

A number of deer are killed annually on roads in the New Forest and details have been given in section 2.2.1. Deer were seen crossing both gravel and metalled roads, as vehicles approached, on twenty five occasions, twelve during daylight and thirteen at night. When moving fallow normally travel in single file, follow fixed paths and are led by a specific individual (Page 1962; Cadman 1966; Chapman & Chapman 1970). Once this leading animal crossed the road the others followed despite the proximity of vehicles. Chapman & Chapman (1969) were able to identify certain accident black spots in Epping Forest & such places are found in the New Forest, notably on the A337 near New Park Farm.

Although vehicles represent a considerable hazard to deer on the roads, normal traffic does not adversely affect their routine feeding activities.

From Maps I & II it can be seen that the southern & eastern boundary of study Area A is formed by the main Southampton to Weymouth railway line which is effectively fenced throughout its length. Between the railway fence and that of Perrywood-Haseley and Woodfidley Inclosures is a grazing strip of between 30 and 45 metres in width. Fallow were seen feeding on this area on a total of forty one occasions when trains passed and in none of these cases was any change in the activity of the animals noted.

Twelve instances were experienced where low flying planes or helicopters flew overhead above feeding deer but again there was no detectable response seen. Espmark (1972) studied the effect of sonic booms from aircraft on reindeer under experimental conditions which produced only slight startle responses. Current activities were interrupted only occasionally and then only for a few seconds.

7.5.6. Forestry Practices

The disturbance effects of forestry practices such as felling, thinning, brashing, weeding and maintenance of fences, roads and ditches on the feeding habits of fallow on Area A were studied. A certain amount of disturbance was inevitable but such operations were not a major disruptive influence on the deer. Clear felling of mature trees in an area will obviously result in a rapid change of habitat and extensive thinning and brashing will also open up compartments of previously dense vegetation. However all these operations provided food for deer, notably coniferous browse in winter (section 5.1.) and in that respect were beneficial. On nine occasions deer were seen feeding in view of men working. Inspection of newly felled trees revealed that browsing started immediately confirming that this work did not disturb the deer too greatly.

7.5.7. Other Animals

The effects of interactions between deer and other large herbivores are discussed more fully in Chapter 9. Dogs were found to cause considerable alarm in fallow. During the summer months deer were bothered by a variety of Diptera, notably Muscids and Tabanids. These flies have a direct effect on the behaviour of ponies, causing them to move to certain sites known as "shades" where these insects are less numerous (Tyler 1972). However no direct change in fallow behaviour which could be attributed solely to these insects was seen.

It can be concluded that of the various disturbance factors considered, day visitors, campers, ponytrekkers and hunting all have a detrimental effect on feeding activity. Culling and forestry practices may cause short term upsets. Vehicles, trains and planes have no discernable effect on feeding ecology.

Chapter 8. HABITAT UTILISATION

8.1. Introduction

Studies of the pattern of utilisation of different habitat types by Cervidae can often be used as indicators of their dietary preferences at different seasons. This is particularly true of areas in which clear and distinct plant associations can be recognised which are dominated by only a few species of plant as is often the case in upland regions of Britain. Estimates of the relative use of different habitat types can be achieved in several ways, the most obvious being to systematically record the number of animals seen there (Lovaas 1958; Holloway 1967; Dzieciolowski 1969; Colquhoun 1971; Horwood 1971; Charles, McCowan & East in prep.). Other indices of use can be obtained by periodic counts or measures of the amount of faecal material deposited (Riney 1957; Batcheler 1960; Holloway 1967; Miller 1971; Anderson, Medin & Bowden 1972) or from counting tracks in snow (Ahlen 1965; Dzieciolowski 1969; Telfer 1970) or soil (McCafferty & Creed 1969; Kohn & Mooty 1971).

The last two methods were unsuitable for use in the present situation, snowfall being rare in the New Forest (section 2.1.2.) and track-counts in soil involving considerable preparation time (McCafferty & Creed 1969). However use was made of both faecal pellet counts, the methods for which have been described in section 3.6., and of recording the number of fallow seen in particular habitat types.

8.2. Habitat Utilisation determined from Counting Deer

Habitats in the New Forest are often complex and although certain plant associations exist which are dominated by only a few species, for example Calluna moorland or certain reseeded grasslands, others afford several different foods for deer at different seasons. For instance mature deciduous woodland is typified by oak and beech, providing nuts in autumn and browse in summer, but holly, sweet grasses and bilberry or bramble may also be present (Mark Ash West & Denny Wood, Table 24). Similar situations exist within Inclosures, particularly on newly planted compartments. Such areas may therefore offer a variety of foods eaten differentially by the fallow during the year and the numbers of animals seen there may remain constant although seasonal dietary changes may occur.

Habitat types recognised within Inclosures were:-

1) Mature deciduous woodland;
2) Mature coniferous woodland;
3) Thicket and pole stage compartments;
4) New plantations without stand oaks;
5) New plantations with stand oaks;
6) Rides & firebreaks without overhanging oak and beech;
7) Rides & firebreaks with overhanging oak and beech.

The open forest was divided into the thirteen types described in section 2.1.5.1.

During the course of watching on Area A, the exact location of all fallow seen was recorded. The number of deer observed feeding in each habitat type was found for bi-monthly periods from May 1971 until October 1972 and was expressed as a percentage of all such animals seen. The results for Inclosures and open forest are presented separately in Figure 35 & Table 79 and Table 80 respectively, together with the percentage of the total area regularly watched which each habitat type constituted. The results for each habitat type are discussed below, firstly for those in Inclosure.

(1) Mature deciduous woodland was most important in May/June 1971, when young hardwood browse was taken, and again in September/October 1971 when nuts were plentiful, forming a substantial part of the diet (section 5.2.).

Figure 35 Seasonal Distribution of Fallow Feeding on Area A in Different Habitat Types in Inclosures

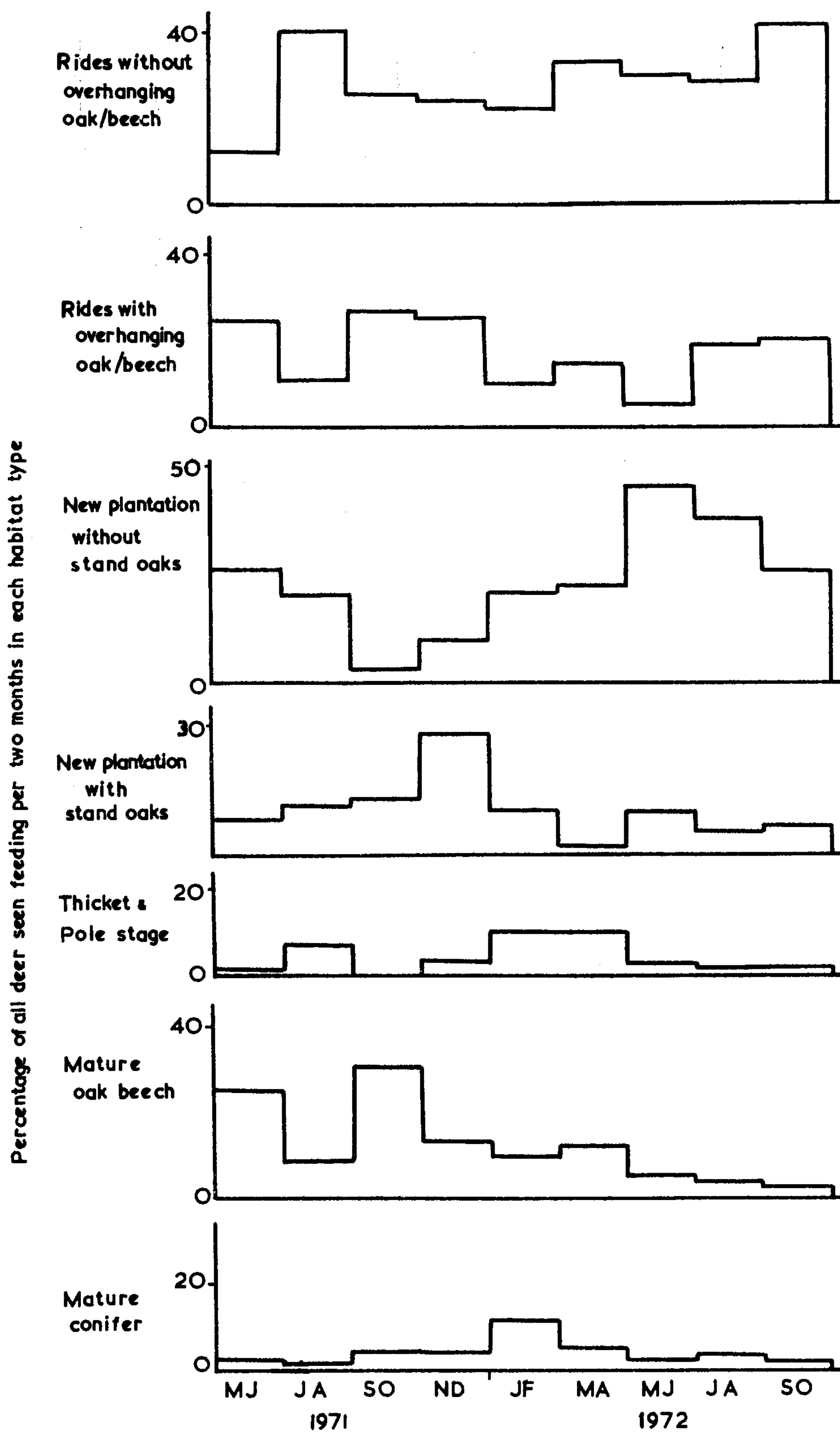


Table 79. Percentage of All Fallow Deer seen Feeding in Different Habitat Types within Inclosures on Study Area A, May 1971–October 1972

Habitat type	Period									% of total area observed
	1971				1972					
	MJ	JA	SO	ND	JF	MA	MJ	JA	SO	
1 Mature deciduous woodland	25	8	32	14	10	12	5	5	2	17
2 Mature coniferous woodland	2	1	4	4	12	5	2	3	0	9
3 Thicket and pole stage	1	6	0	3	10	10	3	2	2	31
4 New plantings without stand oaks	26	21	3	8	22	22	45	38	27	22
5 New plantings with stand oaks	8	12	13	27	11	2	10	5	7	5
6 Rides without overhanging oak/beech	13	41	24	22	23	33	28	29	42	13
7 Rides with overhanging oak/beech	24	11	25	22	12	16	6	19	20	3
Total number of deer seen feeding	99	195	272	143	185	375	339	312	396	

Table 80. Percentage of All Fallow Deer seen Feeding in Different Habitat Types on the Open Forest on Study Area A, May 1971–October 1972

Habitat type	Period 1971				1972					% of total area observed
	MJ	JA	SO	ND	JF	MA	MJ	JA	SO	
Deciduous woodland	94	44	93	100	80	0	27	50	27	32
Scots pine	0	0	0	0	0	0	0	0	0	2
Carrs	0	0	0	0	0	0	0	0	0	4
Calluna moorland	0	0	0	0	20	18	0	9	0	25
Reseeded grassland	0	0	0	0	0	58	68	16	56	2
Lawns	6	56	7	0	0	11	5	16	18	11
Acid grassland	0	0	0	0	0	3	0	0	0	1
Acid grassland with gorse	0	0	0	0	0	0	0	0	0	2
Acid grassland with bracken	0	0	0	0	0	0	0	9	0	4
Wet heath and bog	0	0	0	0	0	0	0	0	0	18

(2) Mature coniferous woodland was frequented during the course of the year by small numbers of fallow, notably in January/February when the animals took ground ivy and Brachypodium sylvaticum (section 5.2.) both of which were normally plentiful there.

(3) Thicket and pole stage compartments were used for feeding primarily from January to April 1972 when felled conifers provided an important food source (section 5.1.3.). The difficulty of watching in this habitat has been stressed (section 5.3.) and its comparative use may be underestimated.

(4) New plantations without stand oaks were rich in most foods (section 4.3.) and were frequented at most times of the year with the exception of September to December 1971, although deer fed there in the autumn of the following year when acorns failed.

(5) New plantations with stand oaks comprised only one quarter of the area of those without (Table 79) but were more important as feeding grounds from September to December 1971 when acorns formed a substantial part of the diet.

(6) Rides and firebreaks without overhanging oak and beech were important throughout the year (Figure 35).

(7) Rides and firebreaks with overhanging oak and beech were also used all the year but peak numbers of deer occurred there in May/June of both 1971 & 72, when hardwood browse was taken (section 5.2.), in the autumn and early winter of 1971 when nuts were taken, and again in July to October 1972. During the latter period conditions were very dry (section 2.1.2.), drained grasslands became parched, and fallow frequented the wetter rides in deciduous woodland, often taking quantities of the small rush Juncus bulbosus (section 5.2.).

It was therefore apparent that on Area A the pattern of habitat utilisation of feeding deer as determined by watching reflected the dietary changes found.

The numbers of animals seen during the first summer feeding on unenclosed areas was small and interpretation of the relative habitat use was therefore difficult. Habitats of types 8), reseeded grasslands and 9), lawns, were considered to be the same, being rich feeding areas dominated by similar species of sweet grasses (section 2.1.5.1.), and were important habitats during spring, summer and autumn 1972. From September to December 1971, over 90% of all deer were seen feeding in deciduous woodland when acorns & mast were important foods. Principal usage of Calluna moorland was found from January to April when rumen analysis showed this plant to be a major food (section 5.1.1. & 5.1.3.). Grasslands were used from March to October 1972 and in July and August 1971. With the exception of wet heath and bog, other open forest habitat types were not extensive and were little used (Table 80). However type 13 occupied 18% of the unenclosed area studied yet fallow were never seen feeding on it although it was extensively used by ponies in summer (Tyler 1972; Tubbs 1973; pers.obsv.).

Fallow deer on this study area did therefore use different habitats for feeding at different seasons, these changes reflecting those found from in the diet determined by both direct observation and rumen analysis.

8.3. Habitat Utilisation indicated by Faecal Pellet Counts

Faecal pellet counts were carried out in Denny New and Parkhill Inclosures (Map II, 3,12) at monthly intervals from May 1971 - September 1972 as described in section 3.6. The monthly results of the number of pellet groups found on each transect, series of transects and grand totals are given in Table 81. From this it was evident that series I was used more intensively than the other two where monthly counts were often extremely low. In subsequent treatment of data, results from series II and from series III were considered quarterly, giving a total of five sampling periods; those from series I were taken monthly.

Table 81. Numbers of Pellet groups Counted per Month, May 1971–September 1972

Location		1971 M	1971 J	1971 J	1971 A	1971 S	1971 O	1971 N	1971 D	1972 J	1972 F	1972 M	1972 A	1972 M	1972 J	1972 J	1972 A	1972 S	Total
Series I	54a	13	14	18	10	7	12	8	5	5	6	10	16	12	10	8	15	26	195
	54b	21	15	14	8	2	5	14	15	12	15	10	12	10	8	13	18	26	218
	50/54	0	1	0	1	0	0	3	1	0	0	1	0	0	0	0	2	2	11
	51a	2	2	1	0	4	9	7	1	1	0	1	3	4	1	3	4	7	50
	50	15	5	2	3	0	1	7	5	5	8	9	7	3	3	4	5	9	91
	50/51	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	4
	Total	51	37	35	22	13	27	40	27	24	29	31	39	30	22	28	45	70	569
Series II	43a/b	1	0	0	0	2	6	6	1	0	1	0	2	3	5	2	10	2	41
	43c	0	1	2	0	4	8	5	1	1	0	0	1	3	2	1	0	2	31
	43/48	0	0	2	0	0	0	0	0	0	0	1	1	0	1	1	1	0	7
	48c	-	-	11	3	0	4	5	3	3	2	2	6	9	5	3	2	5	63
	52b	-	-	1	2	0	1	1	2	3	5	4	1	0	1	1	1	0	23
	Total	1	1	16	5	6	19	17	7	7	8	7	11	15	14	8	14	9	165
Series III	30	4	4	4	4	0	0	0	1	1	3	2	12	6	10	2	4	11	68
	31a	1	4	6	5	7	5	1	1	0	4	3	1	1	3	3	4	5	54
	31b	-	-	2	1	1	1	0	2	1	1	2	0	2	5	3	2	0	23
	31e	-	-	0	1	0	0	0	2	2	5	6	1	1	1	0	1	0	20
	34c/31d	-	-	2	1	0	0	1	4	5	3	2	4	3	3	1	1	1	31
	Total	5	8	14	12	8	6	2	10	9	16	15	18	13	22	9	12	17	196
Series I, II and III	Total	57	46	65	39	27	52	59	44	40	53	53	68	58	58	45	70	96	930

The actual population on Area A fluctuated seasonally with the culling programme, birth of fawns and individuals entering or leaving the locality. It was therefore necessary to consider the distribution of droppings within each series of transects in terms of the percentage of all pellet groups counted there in each sampling period per unit area searched in order that these values could be taken as an index of the differential usage of the various habitat types. These results are shown in Tables 82 & 83 and Figures 36 & 37.

Brief descriptions of the habitats in which the transects were situated have been given in section 3.6. The results for the winter vegetational assessments (section 3.5.2. & 4.2.), which will reflect the abundance of important foods throughout the year, are given for each transect in Table 84. A visual estimate of the percentage of each of their areas covered by mature hardwoods is also given as an index of the relative potential availability of nuts in the autumn and early winter.

Before discussing the results further it should be remembered that fallow deer may utilise a particular area for one or more of a variety of reasons, namely for feeding, resting, sheltering or during the mating season. Fallow tend to use fixed sites or "stands" during the rut which are focal points of activity actively defended by mature bucks. These stands are traditional, the deer using them annually (Cadman 1966). During October and November large concentrations of deer may occur around the stands and faecal deposition might be accordingly high. When fallow move from place to place they follow regular tracks or pathways (Cadman 1966; Chapman & Chapman 1970) and care was taken when originally siting transects to avoid following the course of such routes. Julander (1958) states that deer usually defaecate where they feed but not where they bed. However although fallow were observed to void

Table 82. Percentage of All Pellet Groups counted on Series I, per Month per Unit Area, from Each Transect

Transect	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
	1971								1972								
54a	32	43	58	53	48	40	22	23	26	27	39	47	43	52	32	38	41
54b	39	35	34	32	10	13	29	52	47	51	29	26	27	31	40	34	31
50/54	0	3	0	6	41	0	8	5	0	0	4	0	0	0	0	5	3
51a	7	9	5	0	0	45	29	7	8	0	6	13	21	8	18	15	17
50	22	9	4	10	0	0	11	14	16	22	21	12	6	9	10	8	9
50/51	0	0	0	0	0	0	2	0	4	0	0	2	3	0	0	0	0

Table 83. Percentage of All Pellet Groups counted on Series II and III, per Quarter per Unit Area, from Each Transect

Transect	1971 JAS	OND	JFM	1972 AMJ	JAS
Series II					
43a/b	5	23	3	20	37
43c	22	33	4	16	11
43/48	5	0	3	4	5
48c	51	29	26	53	36
52b	16	14	65	8	11
Series III					
30	16	3	7	34	31
31a	45	25	11	7	28
31b	20	22	12	21	23
31e	5	14	40	9	5
34c/31d	15	36	30	29	14

Figure 36 Percentage of All Pellet Groups Counted on Series I per Month per Unit Area from Each Transect

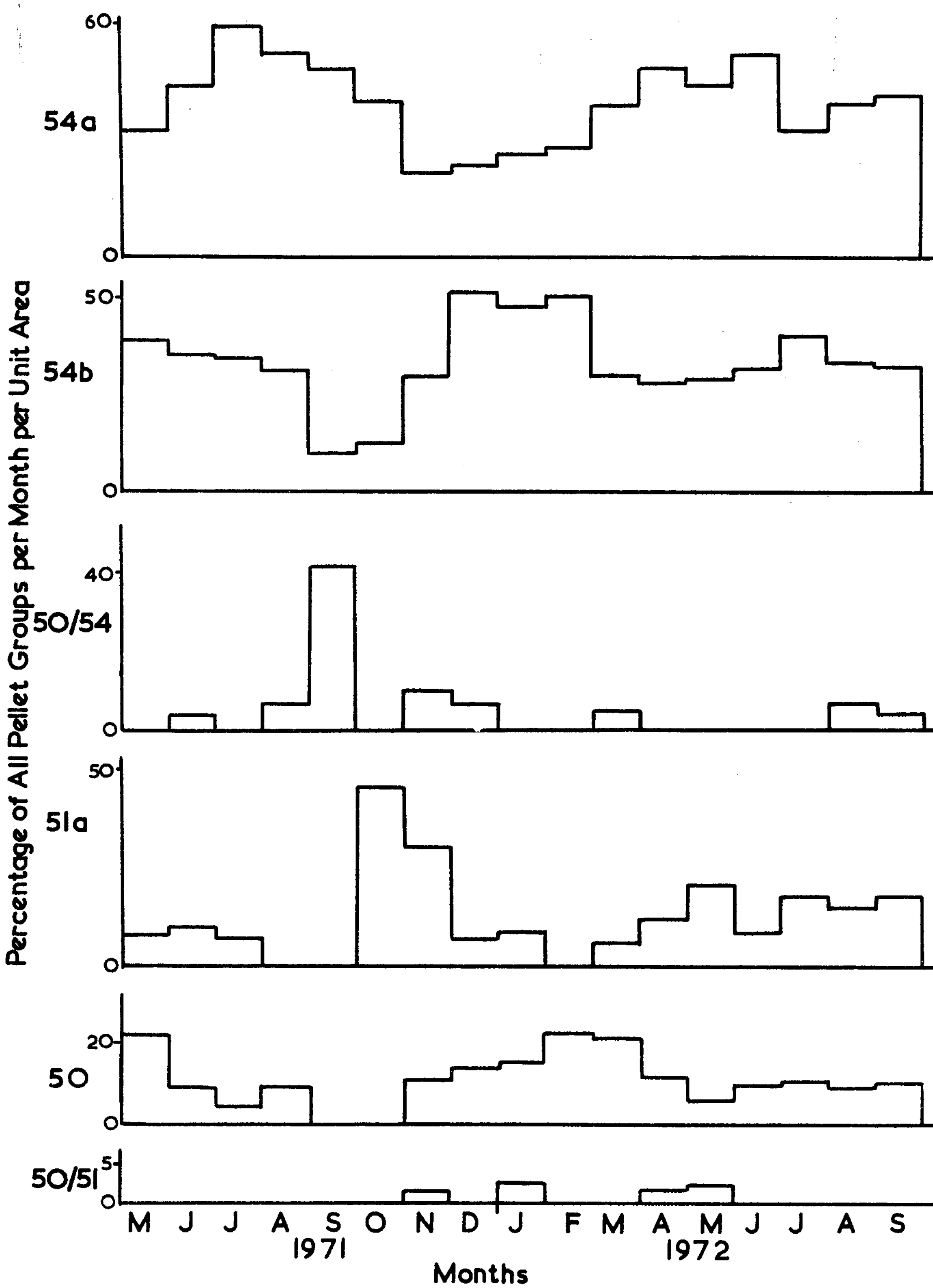


Figure 37 Percentage of All Pellet Groups Counted on Series II & Series III per Quarter per Unit Area from Each Transect

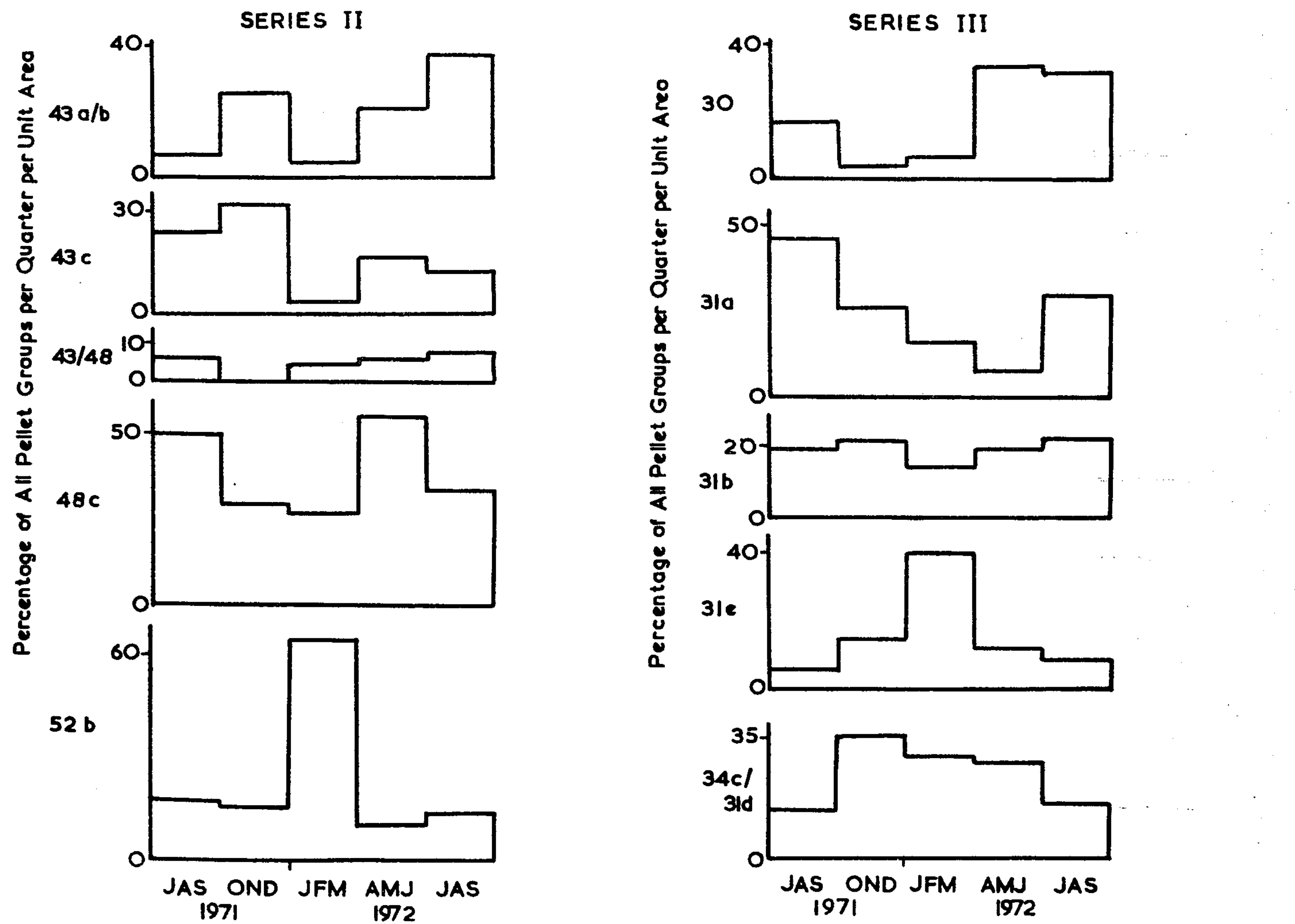


Table 84. Relative Availability of Important Foods on Transects

Transect	Winter survey cover value					% cover
	Bramble	Calluna	Sweet grass	Holly available	tree	Oak/beech
Series I						
54a	4	0	6	3	0	20
54b	3	3	3	1	0	0
50/54	2	0	9	0	0	60
50/51	1	0	9	0	0	0
51a	2	1	3	2	0	80
50	1	0	1	0	0	0
Series II						
43a/b	1	0	0	1	0	100
43c	1	0	0	1	0	100
43/48	1	0	8	0	0	60
48c	4	2	3	2	0	5
52b	1	0	1	4	3	5
Series III						
30	5	3	4	3	0	0
31a	4	1	3	5	2	75
31b	3	2	0	2	0	0
31e	5	6	0	1	0	0
34c/31d	1	4	0	0	0	0

faeces when feeding and moving, field observations here showed that they also normally defaecate as soon as they rose after a period of rest (Plate 32). The same observation was made by Cadman (1966). Concentrations of droppings around favoured resting places might thus occur, such sites sometimes being situated on feeding grounds. Hence any seasonal changes in habitat utilisation determined by pellet counts may not be due simply to a change in feeding areas; the location of lying-up places and rutting stands must also be considered.

The results obtained for each transect are discussed below.

Series I

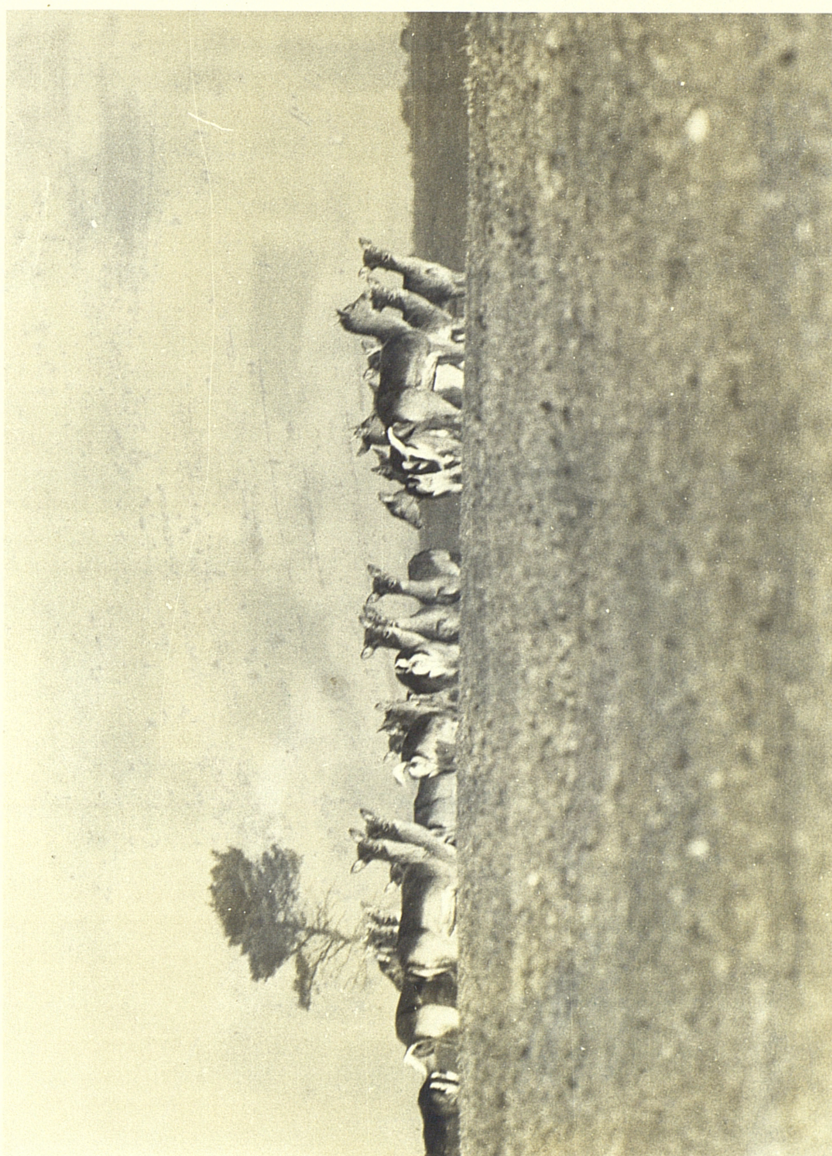
Compartment 54a. This young plantation was a potentially good feeding area, being relatively undisturbed and offering appreciable amounts of important foods (Table 84). Rutting stands occurred on the compartment. The area was used extensively, especially during the period from March until October (Figure 36).

Compartment 54b. This area was also fairly rich in bramble, sweet grasses and holly, although less so than 54a, but in contrast there was no hardwood overstorey and *Calluna* was abundant. Fallow also rutted there. 54b was relatively important in series I throughout the year, being used least in September and October 1971 when acorns were an important food (section 5.2.). Maximal usage occurred from December to February, coinciding with minimal use of 54a, and may reflect the preference for *Calluna* as a food at this season (section 5.1.3.).

Compartment 50/54. Comparative use of this transect, situated on a damp grass ride with overhanging oaks, was low except in September 1971 when the increase in relative importance of this situation (Figure 36) was attributed to the deer feeding on fallen acorns.

Compartment 51a. This transect was situated in an area being rapidly recolonised by sweet grasses and bramble; some holly was also available as was low hanging hardwood browse but *Calluna* was minimal (Table 84). Thus it was not as potentially rich in these foods as

Plate 32. On rising after a period of rest or rumination fallow deer usually defaecated. This is shown in this photograph of small-deer at Backley taken immediately the herd stood up.



54a or 54b but pellet counts showed some use throughout most of the year, maximal importance being in October and November 1971 when acorns were abundant there, originating from the stand oaks. The northern end of 51a was subject to considerable disturbance in the summer from the public.

Compartment 50. This area offered little forage for deer (Table 84) and could not normally be considered an important feeding ground. Being at the thicket/pole stage of growth it did offer considerable cover from disturbance and shelter from inclement weather; field observation showed it to be a favoured lying-up area. The position was complicated however by trees being thinned extensively in early 1971, resulting in considerable disturbance yet also providing coniferous browse which was taken extensively then (section 5.1.3.), although pellet counts indicated that fallow still frequented 50 from April 1972 onwards when this food was no longer important.

Compartment 50/51. This ride provided a good offer of sweet grasses (Table 84) which were an important spring and summer food (section 5.2.). Pellet group counts indicated however that the ride was not extensively used. Disturbance, especially during the summer, was great, the ride being visible from the gravel road (Map II, 12) and also being frequented by walkers. However field observations showed that deer frequently grazed there although normally feeding periods were of short duration and were frequently interrupted. The reason why few pellet groups were ever found was believed to be because the fallow rested in the thicket stage 50, defaecated on rising and then moved onto the adjacent ride to feed for only brief periods. Hence few pellet groups were deposited there.

Series II

The relative importance of the five habitats sampled in this series of transects in Parkhill Inclosure determined by faecal pellet counts is shown in Figure 37.

Compartment 43a/b. This transect was situated in mature closed canopy oak/beech woodland with a dense understorey of secondary beech. Major winter foods were practically absent (Table 84) and deciduous browse was not extensively taken during the summer owing to the shaded conditions (section 4.1.2.2.). The increase in utilisation of this area in relation to others in this series in October, November & December was attributed to deer moving into the compartment to feed on the acorn and mast crops. The importance of this habitat in April-September 1972 was believed to be due to its use as a lying-up area.

Compartment 43c. This habitat was similar and adjacent to the previous one; a rutting stand was also present. Maximal use occurred from September until November 1971 (Table 81), corresponding to the period when acorns were plentiful and the rut occurred.

Compartment 43/48. This was a wet ride, running through mature hardwoods. It was of comparatively little importance as a habitat and no autumnal peak associated with the mast crop was recorded unlike ride 50/54 in Series I.

Compartment 48c. This newly planted compartment offered reasonable amounts of bramble, <u>Calluna</u>, sweet grasses and holly but mature oak or beech were practically absent. The area was heavily utilised by deer in the vicinity of Series II especially during the summer. Disturbance was moderate there during the holiday period. A small rutting stand was also present.

Compartment 52b. In this mature coniferous stand ground flora was sparse although holly was moderately plentiful (Table 84). Peak usage occurred in the first quarter of the year when holly was of limited importance as a food but deer also took ivy and <u>Brachypodium sylvaticum</u> at this season (section 5.2.), both of which were locally abundant in this habitat.

Series III

Series III consisted of five transects situated in adjacent habitat types in Denny New Inclosure (Map II,3). The comparative importance of these five types is given in Figure 37.

Compartment 30. From Table 84 it can be seen that this recently replanted area was adequate in all the main foods with the exception of oak and beech. The road on the eastern edge of the planting was much frequented by people, especially during the holiday periods. Maximum importance was assumed from April until September and minimum in October to December 1971 when nuts were a major food (section 5.2.). However bramble and Calluna were both abundant and as they were found in sizeable amounts in the diet after Christmas a greater intensity of use of this habitat by fallow would be expected.

Compartment 31a. This habitat was rich in bramble, sweet grasses, holly and mature hardwoods (Table 84). The canopy was not completely closed and lateral light reached the area from both east and west. Seasonal usage by deer was difficult to explain simply in terms of food preference and availability. Although pellet counts were comparatively high in July to September and October to December, use from January to June was minimal although foods important at these times were abundant there.

Compartment 31b. Although in this stand of mature Scots Pine some bramble, Calluna and holly were available, the dominant ground flora was Molinia which was not a favoured food (section 5.2.). The importance of this area in Series III was constant throughout the year and the site was used for lying-up.

Compartment 31c. Bramble and Calluna, both important winter foods, were comparatively abundant on this plantation which was used principally in the first quarter of the year.

Compartment 34c/31d. The only important food found in this habitat was Calluna (Table 84), other vegetation being dominated by Molinia. Where the trees had reached the thicket stage, little ground flora was present but such sites offered shelter for deer in inclement weather. Maximum use of 34c/31d was recorded from October to June and from December to March this could be equally attributable to the deer frequenting it to take Calluna or to use it as a lying-up area.

Various sources of error are known to occur when employing faecal pellet group counts. The rate of pellet decomposition varies according to the season in which they are produced, the density of the vegetation, the degree of overhead shade and the dampness of the site (Eberhardt & van Etten 1956; Patric & Bernhardt 1960; van Etten & Bennett 1965). When counts are carried out at three or six month intervals as in some studies, decomposition of pellets may have occurred thus biasing the results. With a sampling interval of one month as used here this problem will not arise. Wallmo, Jackson, Hailey & Carlisle (1962) showed that pellets may be physically removed by heavy rainfall, especially in bare mountainous zones, but in the New Forest precipitation was low (section 2.1.2.) and the terrain on study Area A was only gently sloping. Eberhardt & van Etten (1956) considered that the effect of diet and the age of the deer on pellet production was of no practical significance. The rate of subsequent faecal deposition by deer was unaffected by clearance of old pellets (Rogers, Julander & Robinette 1958).

In the present study it was found that during the summer searching for pellets in areas of long, rank vegetation such as Molinia, bracken and bramble, was extremely exacting and despite thorough searching the possibility that a small percentage of groups were missed, especially as observer fatigue increased, cannot be excluded. Trampling of faeces by both deer and ponies was noted on three occasions but enough readily identified material remained for them to be positively identified as being roe or fallow droppings. During leaf fall in autumn and early winter considerable difficulty was experienced in counting the number of pellet groups in deciduous woodland; thorough searching of the litter was needed to avoid underestimation.

From the study of habitat utilisation using the faecal pellet counts it is apparent that the deer within a locality did frequent types differentially during the year. In some cases, such as those on Compartments 54a, 54b, 51a and 31e, these changes could be directly attributed to seasonal fluctuations in food preference or availabilities and often paralleled those seen in section 8.2. Unlike direct observation however, this method could not always be used to distinguish between changes in habitat utilisation due to alterations in feeding grounds from those due to the rut or variations in preferred resting places.

Chapter 9. RELATIONS AND COMPETITION WITH DOMESTIC STOCK AND OTHER SPECIES OF DEER.

9.1. Introduction

The term competition can assume a variety of ecological meanings but that used by Milne (1961) was followed here, who stated that "competition occurs when animals of the same or different species endeavour to gain a common resource which is in short supply". For the majority of grazing ungulates the critical resource is the forage available. Miller (1967) divided competition into interference: "an activity which either directly or indirectly limits the competitors access to a necessary resource"; and exploitation:"the utilisation of a resource once access to it has been achieved".

Although an animal of one species may actively defend an area around itself against individuals of its own species e.g. roe (Cumming 1966; Bramley 1970), muntjac (Dubost 1970) and mule deer (Linsdale & Tomich 1953), and dominance hierarchies may exist within herds (Lowe 1966; Gilbert & Hailmann 1966; Gilbert 1968), direct conflict between species is rare (Colquhoun 1971). Competition by interference will occur between species if they both utilise the same plants on the same area at the same time.

The main species of large wild and domestic animals in the New Forest have been outlined in section 2.1.6. & 2.2. Of these, ponies, cattle, fallow and roe are numerous throughout the year; pigs may be abundant during pannage; few donkeys, sika or red deer are present.

The feeding habits of fallow have been described in detail in Chapters 5 & 7. Little scientific work has been published on the diet of other species of large mammal in the New Forest but subjective accounts of the foods utilised by commonable animals are plentiful and well informed as it is relatively simple to approach and observe feeding animals at close range (Tyler 1972). The possible competition between fallow and other species is discussed below.

9.2. <u>Ponies</u>

At present there are approaching 3,000 head of ponies depastured on the open forest. A number of these are taken off in winter whilst others may be supplied with hay at this time. Tyler (1972) studied the behaviour and social organisation of ponies in the New Forest between October 1965 and 1968, spending some 4,000 hours observing them. Her two main study areas were centred at Balmer Lawn and Hollands Wood (Map I,70 & III), adjacent to the western edge of study area A, and Backley Plain (Map 1,33). Fallow frequented both regions, particularly the latter, but only one interaction was recorded by Tyler when a yearling filly threatened a doe that moved too close to her. Vesey-Fitzgerald (1966) states that deer do not object to ponies and may play with them. He records an instance of a party of fallow passing through a herd of ponies, neither species taking any notice of the other.

During the course of the present study, fallow and ponies were observed feeding within fifty metres of one another on thirty eight occasions on Area A and the reseeded grasslands at Backley, Kings Garden and Withybeds (Map I,47), but herds of the two species remainded discrete. In six instances when ponies approached fallow during the course of feeding or moving the deer gave way readily and then resumed grazing. Linsdale & Tomich (1953) recorded similar behaviour between mule deer and horses. Direct interference between ponies and fallow in the New Forest is therefore rare.

Information on the diet of ponies was compiled from Tyler (1972), Tubbs (1968,73) and personal observations, and is outlined below using the same food types categories as for fallow (section 3.3.2.).

1) Conifers. Browsing on conifers was not extensive on either standing or felled trees.

2) Broadleaf trees. In contrast to fallow, browsing of these trees and shrubs was principally confined to the winter months when oak and beech were the major species selected.

3) Dwarf shrubs. Calluna vulgaris and Erica spp. were of minor importance in the ponies diet, despite the large areas covered by these plants (section 2.1.5.). However the large gorse, Ulex europaeus, and to a limited extent the smaller U.minor were one of the most important winter foods being taken extensively between October and May. Gorse brakes were also important as shelter from wind and rain. In woodland, bilberry was often grazed down to a mat level but to what extent this was attributable to ponies or to deer was uncertain.

4) Graminids. During the summer the bulk of the food is believed to be the purple moor grass, Molinia caerulea, which is abundant in valley bogs and wet heaths (section 2.1.5.1.). It is taken mainly at night at all stages of its vegetative growth. Burning of heathland in March (section 2.1.5.1.) may stimulate early growth of this grass which is then taken by ponies. On acid grassland, Molinia is preferred to bristle beat, Agrostis setacea, throughout the summer and the latter is not taken until the winter. Grazing also occurs on reseeded areas, lawns and roadside verges throughout the year but although the sward quality is high it is cropped hard as soon as the spring bite appears. It is thought that any single animal could only consume a very small amount of grass from such sites during the course of the day. Shoots of rushes are taken by ponies. Most sedges are also grazed.

5) Herbs. Most small herbs were taken by ponies with the exception of the poisonous ragwort, Senecio jacobaea & S. aquatica, and some of the large thistles.

6)7)8) Ivy; fungi; bryophytes. These foods are all taken by ponies in small quantities.

9) Ferns. Bracken may be taken in some quantity. During the summer ponies grazing on grassland may move into clumps of Pteridium which they browsed for periods of up to thirty minutes before returning to their original feeding place; several such periods may occur during the course of the day.

10) Bark. Removal of bark by ponies feeding was not recorded.

11) Fruit & nuts. Acorns are known to be taken by ponies and some individuals may become addicted to them. Ingestion of large numbers of prematurely fallen green acorns in early autumn causes poisoning and death in small numbers of ponies (New Forest Veterinary Surgeons Consultative Committee 1964; Garner & Papworth 1967).

12) Holly. During winter holly is an important food and many ponies live in close association with holms. Foliage may be removed up to a height of eight feet.

13) Bramble & Rose. Leaves and shoots of these plants were freely taken during the winter months.

14) Dead Leaves. The importance of these as a food is unknown but they have never been recorded as being sought after by the animals.

15) Other Foods. Although feeding of ponies by the public is officially prohibited in the New Forest, small amounts of food are still obtained by certain animals.

By comparing the diets of ponies and fallow deer it is evident that a certain amount of competition does occur for certain foods such as sweet grasses, bramble, holly and acorns, often at such crucial times of the year as late winter and early spring when food is scarce and animals are in poor condition. However although some ponies do sometimes gain access to Inclosures, the feeding areas there will be utilised primarily by deer and competition for food will not occur.

On seven occasions when watching ponies and fallow deer feeding in close proximity in areas of rank vegetation it was noted that the latter were exceptionally "nervous". Ponies were noisy animals and this may have accounted for the deers' reactions, a similar "nervousness" being seen when conditions were windy (section 7.4.).

9.3. Cattle

Since the forage requirements of cattle are believed to parallel those of ponies on the New Forest it therefore seems likely that competition for certain foods at certain times will occur between them and fallow. Tyler (1972) states that direct competition occurs between cattle and ponies for food but most of the former, both dairy and beef animals, are generally taken on to the smallholdings or farms for the winter. Vesey-Fitzgerald (1966) believed that deer avoided cattle but in the present work the two species were watched grazing on common areas in separate groups with as little as twenty metres between them on fourteen occasions on the reseeded areas. No interactions between the two were ever recorded.

9.4. Pigs

Large numbers of pigs, sometimes approaching two thousand, may be turned out on to the New Forest at pannage each autumn (section 2.1.6.). The pigs feed mainly on acorns and mast and are thus in direct competition to a certain extent with the fallow for this food which has been shown to influence the body weight and condition of the deer (sections 6.2. & 6.4.). Only one social interaction was observed between the two species when a mixed herd of five fallow moved away when a sow with piglets approached them.

9.5. Other Species of Deer

Various authors believe that antipathy or antagonism appears to be the mechanism whereby the relative abundance of one species often correlates with the scarcity of another. Carne (1954) stated that sika and fallow were a powerful deterrent to roe deer. He showed that where fallow had increased in an area, the roe population had decreased, often to extinction. Delap (1955) wrote firstly that antipathy existed between fallow and roe, which was confirmed by Carne (1955), but secondly that roe and red or red and fallow could "associate happily". Batcheler (1960) studied the relationships between roe, red and fallow deer with special reference to Drummond Hill Forest, Perthshire, and concluded that of the several factors which may determine the relative abundance of these species the stage of growth of the afforested habitat was more important than interspecific competition; roe were most abundant in young plantations, red in pole stage ones and fallow in mature woodlands & high forest.

In the New Forest, mixing between sika and fallow occurs only on beat South 4, notably in New Copse Inclosure (Map I,96), but no systematic study was made of the Cervidae there. Fallow and roe are found widely over most of the remainder of the Forest (section 2.2.). During the course of field observations the two species were observed on common feeding grounds on a total of forty one occasions; no form of aggression or other social interaction was noted except that both responded to each other's alarm reactions.

Some degree of competition for important foods available in limited amounts is thought to take place. From field observations and analyses of the ingesta of roe it is evident that the most important food on area A is bramble which comprises a large part of the diet throughout the year. Other foods taken at the same time in the same places as by fallow include deciduous and coniferous browse and acorns; grass is of less importance and <u>Calluna</u> is taken but in comparatively small amounts.

A variety of different aged stands are present in most Inclosures (section 2.1.5.2.) and the changes in deer species with increasing maturity in afforested areas shown by Batcheler (1960) in even-aged forests will not be as evident in the New Forest.

The feeding habits of the small scattered population of red deer in the New Forest are unknown. However, with the exception of the deciduous woodland, much of the natural vegetation on the open forest parallels that of richer areas of the Scottish Highlands. The diet of red in these places has been investigated recently by Holloway (1967), Staines (1970), Colquhoun (1971) and Charles, McCowan & East (in prep.). The exact proportions of different foods in the diet may vary over even a short distance but one can draw broad conclusions as to the seasonal importance of the main forages of red in Scotland. During summer the grazing of various graminids provides the bulk of the food and is also important to a lesser extent during the winter. *Calluna* is taken in sizeable amounts from September until May. On the continent of Europe, where red are often found in woodland habitats, deciduous and coniferous browse are also important (Ahlen 1965; Dzieciolowski 1967a,b, 70b; Jensen 1968).

In the New Forest, red deer have never been successful despite various augmentations of their stock (Whitehead 1964) and at present number only about forty head. The reason for this is unknown but it is tentatively suggested that the diet of red in the New Forest might be expected to closely parallel that shown for the fallow. Direct competition for food may result in which fallow are the more successful species.

Some competition for food in the form of exploitation would seem to happen between fallow and most other species of large mammals in the New Forest, especially during the period from September to March or early April.

Chapter 10. DISCUSSION.

The feeding ecology of the fallow deer in the New Forest has been shown to be complex, being affected by a wide variety of factors. The diet during the year can be divided into three main phases, the importance, duration and timing of which may vary annually, with locality and with climate. From about March until September, graminids are the principal food whilst herbs and broadleaf browse are also of minor importance. This period may extend into early November in poor acorn years but in good ones nuts are the primary food from September until approximately Christmas, the exact duration being dependent on the abundance of the crop. Winter foods of importance include bramble, bilberry, graminids, holly, ivy and felled coniferous browse; gorse is not taken to any appreciable extent in mild winters. This third phase lasts from the end of feeding on acorns until the appearance of the new "bite" of grass appears in March or later on moorland regions or in late springs.

A certain amount of damage to forestry by fallow browsing and barking trees does occur, together with fraying and thrashing associated with cleaning of velvet from the antlers and the rut. Barking of standing trees of economic importance was largely confined to western hemlock which occurred primarily in spring when the quality of the diet improved rapidly as deer took the new growth of graminids. Bark from this species will inhibit celluloysis (Prins & Geelen 1968) and may have a regulatory effect by slowing digestion. Similar behaviour has been recorded with red deer in the Netherlands (Veen 1975). Browsing of conifers was selective; certain species such as Norway spruce and larches grown in open areas being susceptible to damage whereas others such as Corsican pine were not taken.

Fencing of new plantings is supposedly not carried out unless necessary in the New Forest. Such protective measures are extremely expensive and also deprive the deer of the natural foods shown to be most abundant on these areas, especially those where oaks were the previous crop. Deer also keep down bramble and regenerating scrub to a large extent as can be seen by comparing fenced and unfenced plots. These animals therefore substantially reduce the need for weeding on the former areas. This beneficial aspect of deer ecology is often neglected.

If it is essential to exclude deer from certain young compartments, how long it is necessary to maintain the fences? On plantings where most trees had attained a stature so that the apical buds and much of the foliage were above the browsing height of fallow it was observed that the small percentage of trees within reach of the deer would shortly die or remain stunted as their near neighbours branches met and the canopy closed. Such trees are of little use to forestry and consequently any browsing of them is of no economic consequence. On fenced plots approaching this thicket stage certain important winter foods, notably bramble, were still abundant. If these areas were opened at this growth stage it is suggested that any browsing which occurred would be of little economic significance but that the extra forage made available would improve the deer habitat. Damage which might otherwise have occurred elsewhere, particularly by herds entering farmland, might also be alleviated.

As a result of the present work it has been shown that graminids, especially sweet grasses, form an important part of the diet throughout the year. The improvement of rides in plantations by application of fertiliser or sowing known favoured grass species would improve both the quantity and quality of this crucial food in areas from which domestic stock are excluded and disturbance is less than that on the open forest. Personal observation suggests that all rides are not used equally and that the aspects, drainage, available light, disturbance, food species availability and proximity to cover are all important in deciding preferred feeding areas. These sites can be determined by field observation and improvements should initially be centred there. It is also essential to ensure adequate natural browse is available to provide ballast needed by deer for efficient digestion. Mowing of rides in summer or planting with grass species which flower late may both be of value as Cervidae prefer lush new growth (Eygenraam & Pieters 1966).

Fallow have been shown to take coniferous browse extensively only in winter, material from felled trees being an important food, and hardwoods only in summer. If it were possible to alter the forestry working plans so that softwoods were felled only in winter months and deciduous trees only in summer then the amounts of these foods available at times when they were acceptable to the fallow deer would increase. Furthermore beech was taken principally in early summer whilst oak was important at a later date so that selective felling of different hardwood species could also be practised.

Fallow were found to use habitats differentially for feeding during the course of the year. On the open forest the only type not used at all was that of wet heath and bog although this was an essential feeding area for ponies and cattle. Plant associations dominated by bracken were of limited value, providing minimal acceptable herbage although deer did take grasses growing amongst the fronds when conditions were dry and swards elsewhere became scorched, and again during cold weather when the dead <u>Pteridium</u> protected other plants from frost. Gorse brakes were not used to any extent for feeding during the study period. Within Inclosures, stands of pole and thicket stages were of minimal importance as feeding grounds, except where brashing or thinning provided browse. However such compartments were still vital to the ecology of the deer by providing both cover and shelter.

Considering the present situation in the New Forest, two questions were commonly asked. Firstly how many fallow deer should the New Forest be allowed to support and secondly are there too many of them there at present. These questions can be answered in a variety of ways because of the wide spectrum of attitudes of man to these animals. From the point of view of certain farmers, commoners and foresters, fallow are considered pests doing damage to crops and trees besides competing with stock for the available food on the open forest. Their numbers should therefore be kept to a minimum and certainly maintained below a level where damage is economically unacceptable. From the venison production angle, both the numbers and types of deer should be kept at an optimum level for different regions although this does not imply that there should be as many deer as possible. Fallow also have aesthetic, recreational and educational values, all of which are highly regarded in the New Forest and are becoming increasingly important with the emphasis now being placed on conservation.

The strength of these various factions does fluctuate. The increasing recreational demands and the high price for venison both justify the maintenance of populations approaching the upper feasible limits.

The population of fallow in the New Forest in the springs of 1971-73, approaching one thousand animals, was the highest recorded since the 1851 Deer Removal Act. Similarly the numbers of commonable animals depastured on the unenclosed areas are nearly as high now as they have ever been since accurate records were first kept in the late 1870's. There is much local controversy as to whether the New Forest is now overstocked. If this is so we might expect that either the condition of the animals themselves or of the range or both would deteriorate. The questions of the quantity and quality of present foods, deterioration in pasture types and similar factors which indicate that the range standard is falling were not within the scope of the present study. Similarly it is difficult to judge with any certainty whether the "quality" of the fallow has dropped during recent years. Reproductive rate is often an index of the "quality" of a particular area, animals in better regions becoming sexually mature earlier and producing more viable young than those in poorer situations. However the only records of value for the New Forest were those obtained for the winter cull of 1965-66 by Armstrong et al. (1969) who found that 95% of adult does (three years or older) were pregnant. During the winter culls in the present study period, reproductive tracts were examined from eighty three does, following the techniques outlined by these workers; of these 94% were pregnant. No dramatic reduction in fertility has therefore occurred in recent years.

Reliable measurements of body weights, size or condition were not available for years prior to 1970 and hence no comparisons can be drawn. Results from the present work however show that although condition and body weights of small-deer were better in good acorn years in early winter, there was little difference between years by the end of February. All three winters studied were mild yet in the majority of both does and fawns fat deposits around the viscera and the kidneys had been exhausted. Other fat stores such as the bone marrow may still be utilised at this stage and it is not known how close these animals were to obtaining a nutritionally inadequate diet. Body weights also fell off in February. Natural winter mortality in the New Forest is minimal but this may be due in part to the vigilance of the keepers in taking poor or sick animals. The average values obtained for the fat indices and body weights might be accordingly low but by the end of the winter poor animals were much in evidence, notably from Area B.

If we hypothesise conditions of late summer drought, failure of the nut crop and a hard winter followed by a late spring delaying the new "bite", it is suggested that with a fallow population approaching one thousand head, starvation levels would be reached, especially in poorer areas. Damage to forestry, gardens and agricultural land might also then increase. Gorse might also become an important food but as this is already freely taken by domestic stock, direct competition would result.

Amongst future predictable trends in the New Forest, two factors are likely to influence the feeding ecology of the fallow deer. Firstly the clear felling policy for hardwoods in Inclosures adopted until recently provided deer with many excellent feeding grounds, which they use at present, although depriving them of the autumnal nut crops. Within a decade, young trees planted on these areas will have reached the thicket stage which has been shown to offer minimal food for deer. Extensive felling of conifers will continue but although their cut foliage is an important winter food, the acidic nature of their litter leads to poor feeding grounds on felled compartments compared with those where hardwoods were the previous crop. In deciduous woodland, felling is now restricted to plots of one acre. It has been demonstrated that fallow are highly selective feeders, preferring plants grown in good light conditions. Foods on these small plots, surrounded by mature trees,will therefore be less acceptable than that found on plantations because the incident light will be lower although by careful siting of these areas by rides or other edges this problem could be alleviated .Therefore with the present policies in Inclosures both the quality and quantity of preferred foods available will decrease.

Secondly the number of daily visitors and their accessibility to the New Forest are now being governed to some extent by restrictions on vehicle parking. However it is anticipated that the total numbers using the region will still increase, especially outside the present peak periods when the New Forest often reaches "saturation point" now. These increases will be associated with greater leisure time and the improved access which will be created by the completion of the M3 and M23 extensions. The effect of visitors on fallow is generally detrimental. In certain locations such as Backley Plain and Kings Garden, fallow have become tolerant to people although their basic feeding routine is severely disrupted and the animals have to graze poorer grassland where there is less disturbance or restrict their feeding to more limited periods. Severe disturbance can also result in increased browsing and barking damage, and to poor digestion of the limited food taken. Bucks at Bolderwood Farm take little notice of the public but unlike the previous two areas people are excluded from the fields there. Male-deer are also reportably more tolerant of humans than are small-deer.

Therefore it is probable that in the foreseeable future the amount and quality of the foods actually available to the fallow deer in the New Forest will decrease.

However agricultural land in or adjacent to Crown Land offers rich food and minimal disturbance by the general public. But once fallow deer enter these fields they can be legally shot by the landowner provided that the provisions of the 1963 Deer Act are observed. In the past a high proportion of local farmers have tolerated deer from neighbouring forest land entering their meadows. But since the price of venison has increased approximately threefold over the past three years it appears that stocks of fallow, especially bucks, which frequented fields have been culled heavily by the landowners. Information on the actual numbers and types taken are not readily available.

If the population of fallow deer in the New Forest is to be maintained in a healthy condition and at its present level it is suggested that in view of the evidence presented here habitat improvement is necessary. This might be achieved by the establishments of "game-meadows" similar to those used now in both continental Europe and several forests in Great Britain. It is envisaged that these would be areas of several acres in extent specifically designated and maintained to provide good feeding grounds for deer throughout the year. A multitude of factors would have to be considered in the selection, establishment and management of such places. It is hoped that the results of the present work may serve as a basis to assist in the understanding of the feeding ecology of fallow in order that such game-meadows might prove successful. In the New Forest they would assist in improving the quality of the animals, draw herds away from afforested areas of high damage potential and prevent marauding and the subsequent shooting of deer on agricultural land. The efficiency of both censusing and culling would be improved and the opportunity would exist for members of the public to visit the meadows under guidance.

Various aspects of the feeding ecology of the fallow still call for substantial amounts of research to be completed on them. The nocturnal activities of this species are little known; their daily and seasonal movements to and from feeding grounds should also be studied in much greater detail; little information was obtained on the physical condition of male-deer at any season or of small-deer outside the winter cull. Although considerable data was collected on the diet and the quantitative importance of the various foods were determined, the quality and digestibility of them was not studied here. This is essential before the information on diet can be used fully in their management - for example food A may form 50% of the food intake quantitatively but may only be as important in terms of its nutritive value as food B which constituted 20%.

As a result of the present work it is hoped that a scientific and administrative framework has been established on which future studies on both fallow and other cervid species in the New Forest might be based.

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