THE DIET OF SCOTTISH BLACKFACE SHEEP

BEING A THESIS PRESENTED TO

THE

UNIVERSITY OF GLASGOW

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

BY

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ACKNOWLEDGEMENTS

The work described in the following pages was carried out at the West of Scotland Agricultural College, Glasgow.

The author wishes to express his thanks to Professor John Walton of the University of Glasgow for acting as his supervisor during the course of the study.

To Professor William Fletcher of the West of Scotland Agricultural College the author acknowledges his sincere thanks for his helpful supervision, guidance and interest, and for the use of the facilities of the Botany Department in that College.

Acknowledgement is made also to the Principal and Governors of the College for their interest and for College facilities granted by them.

Thanks are due to the Director of the Hill Farm Research Organisation and particularly to the Manager and Staff of the Lephinmore Hill Farm, Argyll.

To Professor Kenneth Braid the author expresses his gratitude for his interest and for many helpful suggestions. Dr. David Finney, F.R.S., of the A.R.C. Statistics Unit, Aberdeen University, gave valuable comments on the statistical work included in this investigation.

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PART I

GENERAL INTRODUCTION

MATERIALS AND METHODS

GENERAL INTRODUCTION

Plant epidermis consists of cuticularised cells forming the greater part of the epidermis and of other more highly differentiated cells such as cork cells, silica cells, asperities and the guard and subsidiary cells of stomata.

In the Monocotyledon genera the less differentiated cells are, in general, elongated and in a linear arrangement. In Dicotyledon genera these cells are variable in shape and placement.

The size, frequency and distribution of the various differentiated cell types over the epidermis allows its identification to at least specific level in many plants, as has been shown by Prat (1932,1948), Metcalfe (1960) and Borrill (1967).

The epidermis is covered with a layer of cutin which is resistant to digestive enzymes. In 1952 Professor Walton suggested to the Scottish Hill Farming Research Committee that, as cuticles are indigestible, they might be used for the specific identification of the plants eaten by sheep.

The diet of sheep is at present imperfectly known/

/known due to the fact that it is almost impossible to determine with precision the species which an animal has grazed when it is on completely free range.

Visual methods of diet analysis have failed to produce consistent results because of the variable impurity of open pasture where very few clumps of herbage consist of a single plant species.

It has been shown that accurate qualitative analyses of the plants eaten can be gained from an examination of rumen samples (Norris 1943) but such a method implies slaughter of the animal or permanent rumen fistulation for long-term investigation.

Faecal samples provide another source of material suitable for the qualitative investigation of the diet. Phillipson (1952) has shown that 32 % of faecal material from ruminant animals is composed of the residue of the plants ingested. The plant material in ruminant faeces consists of portions of the outer wall of the epidermal cells, with the cuticle attached and of lignified tissues. These latter tissues have no characteristics which make them of value in determining from which species of plant they are derived but, as indicated above, the epidermal fragments can, by their structure, be specifically identified.

Analyses of sheep diet utilising fragmentary plant material in rumen and faecal samples were carried out by the present author (Martin 1955). It was shown that faecal samples contained plant fragments which were as easily identified as those in rumen samples, that qualitative results from both types of samples were comparable and that faecal samples were more freely obtainable.

Hercus (1959) confirmed that this method of diet analysis was of value in determining the self-selected diet of sheep. In her investigations the experimental animals were on free range on hill pasture in New Zealand.

The present study is of the diet of Blackface ewes and lambs on hill pasture in Argyllshire, Scotland, on the basis of the qualitative and quantitative analysis of identifiable plant fragments in faecal samples.

The experimental animals were part of the hill flock at Lephinmore Hill Farm, Argyll ($56^{0}5'$N : $5^{0}14'$W). Half of the animals were able to graze a full range of the flora available from sea level to about 1100 feet. The other half were on a range which was restricted due to afforestation, fencing and natural barriers. These latter animals could only graze on the flora available from 600 to 1500 feet.

There was a difference in the flora of the two hirsels*, the full range hirsel (Barnacarry) being predominantly a Festuca/Molinia/Juncus community, whereas the restricted range hirsel (Low End) was Calluna/Eriophorum/Juncus in type.

Faecal samples were taken direct from the rectum of selected ewes grazing on the two hirsels and were supplemented by fresh faeces which were collected at times of visits to the area. Lamb samples were similarly collected.

To enable accurate identification of the plant fragments in the faeces, epidermal material for the purposes of comparison was prepared from about 60 species of the plants growing on the areas, using adaxial and abaxial leaf surfaces and stem surfaces.

The investigation was primarily one of the analysis of the qualitative diet of the ewes and the lambs on the two hirsels. Under the conditions prevailing/

* In the present context the term 'hirsel' is applied to an area of land bounded by natural or artificial barriers, and over which part of the complete flock grazes.

/prevailing there were the alternatives of the ewes and their lambs on any one hirsel selecting a more or less similar diet or of the lamb diet differing from that of the ewes.

The effect of the difference in flora available on each hirsel combined with the selective grazing habits of the animals was also of interest, in that the diet of the animals might be affected by factors which compensated for the differences in herbage available on the hirsels, even to the point where the ewes, or the lambs, grazed almost the same diet on Barnacarry and Low End.

MATERIALS AND METHODS

The material examined consisted of epidermal preparations from plants growing on the two hirsels, Barnacarry and Low End, and of fragmentary epidermis and cuticles in faecal samples obtained from the experimental animals and others on these hirsels.

1. Epidermal Preparations

To enable accurate identification of the fragments in the faecal samples, comparison material (from plant specimens collected on the grazing areas) was prepared by one or more of the following methods.

A. Chemical Maceration

(1) Nitric acid. The specimens collected were cut into 2 cm. lengths and a very thin strip removed from each edge to facilitate separation of the upper and lower epidermis. The pieces were then macerated in 50 % nitric acid in a water bath. The use of a water bath was found to be essential in order to reduce to a minimum the convection currents set up in the acid as it was found that these currents were capable of breaking the epidermis into fragments which were too small to be of value. Moreover, a greater/

/greater degree of control over the rate and extent of maceration was possible.

The maceration liquid, complete with epidermis and the internal tissues of the leaf, was then transferred to a petri dish and the acid removed by gentle washing. Each epidermis was then separated from the other when necessary.

On examination of the epidermal preparation it was invariably found at this stage that some of the palisade tissue, together with fibres or vascular tissue, was still attached. Where staining was to be employed in order to make the epidermal structure clearer, it was necessary to remove these tissues.

A second maceration for this purpose usually had the effect of completely disintegrating the epidermis and the only suitable method was found to be that of carefully brushing away the unwanted tissues with a camel-hair brush.

The cleaned epidermal preparations were then taken through an ethyl alcohol series and stained in acid fuchsin or stained in 1 % safranin and taken through the same alcohol series. They were then transferred to an equal mixture of 95 % ethyl and butyl alcohols, washed in 95 % butyl alcohol and mounted in Euparal.

(ii) Lactic Acid. The method of Clarke (1960) has been used. The material was placed in boiling water for a few minutes and then decoloured in 70 % ethyl alcohol. It was then cleared and softened in 80 % lactic acid heated by means of a water bath. Fresh material required some 7-15 minutes in the acid while herbarium material, which was occasionally used, required 20-25 minutes. The material was then cleaned by removing the excess palisade tissue, vascular tissue and mesophyll with forceps and by brushing.

Where staining was necessary this was done in 1 % lactophenol/cotton blue for 20 minutes. The material was then destained slightly and mounted in lactic acid.

(iii) Ethylene Diamine Tetra-Acetic Acid. The method of Letham (1958) for the maceration of apple tissue using the above acid was attempted, and although suitable for the maceration of parenchymatous tissues proved of little value for clean epidermal preparations.

B. Bacterial Maceration

(i) The preparation of epidermal material was attempted by placing fresh plant material in sheep rumen extract under anaerobic conditions at sheep blood/

/blood heat (104°F) according to the method of Louw et al. (1949).

(ii) Similarly, a pure culture of Clostridium rosea was used as a macerating agent under the same conditions (Skoss 1955).

Neither of these methods gave usable epidermal preparations and were abandoned.

C. Scraped Material

By placing leaf material on a glass slide, flooding with household bleaching solution and scraping with a new razor blade it was possible to remove the uppermost epidermis, mesophyll and palisade tissues. Vascular tissue was removed as far as possible with needles. The remaining epidermis was then brushed clean, rinsed and stained as before. The process was then repeated for the other epidermal layer.

This method was also useful for stem epidermis preparations, the stems being split and flattened before treatment.

This method was similar to that used by Prat (1948), Davies (1959) and Metcalfe (1960).

D. Contact Films

By using cellulose acetate films (North 1956) it is possible to obtain impressions of the epidermal characters./

/characters. Damage was frequently caused to the epidermal surface with this material and it was found that low melting point paraffin wax made a superior substitute. This method was not frequently used since in specimens with hairs or papillae the characters were not accurately transferred to the wax or cellulose acetate.

E. Herbarium Material

Dried herbarium specimens provided excellent epidermal peels in many cases, after treatment with boiling water for about an hour. Davies (1959) has shown that immersing herbarium material in alcohol for several hours also allows epidermal peels to be taken from it.

F. Faecal and Rumen Material

Large fragments of epidermal material are occasionally found in analysis samples, and these fragments after identification can be utilised as reference material. They are suitable for this purpose as the action of the rumen bacteria tends to make the cell characters more obvious.

2. Reference Collection

From specimens obtained by one or more of the above/

/above methods a reference collection of the epidermis of known species was prepared.

Photomicrographs of the specimens were made on Kodak Microfile film. It was found that, due to the high inherent contrast properties of this film, there was no need to stain the epidermal preparations. This was advantageous in that the stomata and asperities did not become opaque with stain.

3. Faecal Samples for Diet Analysis

On each hirsel two ewes and their lambs were selected for the investigation of their diet. The ewes were chosen at random from amongst those which could reasonably be expected to remain part of the flock during the period of the investigation and which would lamb each year.

The selected ewes each bore a single lamb in each year of the investigation.

Faecal samples were taken direct from the rectum at times of normal flock handling or during visits by the shepherd to the areas. This prevented any upset to the animals' normal behaviour by being brought out of the flock by dog and handled by a stranger.

These samples were supplemented by others gathered/

/gathered at times of visits by the author to the areas. On these occasions faeces which were seen to be freshly voided were collected and formed part of the material analysed. This was particularly the case with lamb samples on both hirsels. In such cases it was not possible to have a record of which ewe or lamb the sample came from, but the time of the year and the hirsel was noted.

These supplementary samples effectively increased the number of ewes and lambs taking part in the investigation.

The faecal samples were placed in formalin-acetic-alcohol as soon as possible after collection. They were shaken to separate the faecal pellets and to make the pellets break down into component fragments.

For analysis puposes each sample was again separated by agitation after dilution to four times its own volume with water. An aliquot was then examined under a binocular microscope.

From each sample a minimum of 100 counts were made at random of the epidermal fragments present. These counts constituted the basic results of the analyses. The plant species which were present in the original sample but not recorded in the analyses were also noted.

PART II

INTRODUCTION

ILLUSTRATIONS OF CHARACTERS

KEY TO IDENTIFICATION OF FRAGMENTS

LIST OF SPECIES AND PLATES

DESCRIPTIONS AND PLATES

INTRODUCTION

In connection with diet analyses, published literature on the subject of cuticle or epidermal features is sparse.

Morris (1917), Parkinson & Fielding (1930), Winton (1914) and Winton (1916) utilised epidermal characters in the identification of the constituents of commercial cattle foodstuffs, mainly as a safeguard against adulterants. In these cases the features were to be seen on the surface of the fragments which were mostly opaque and of comparatively large size.

In the field of palaeobotany cuticle, features have long been recognised as identification characters; Borneman (1856) and Miner (1935) , for example, have found cuticle features of value in specific identification in their palaeobotanical investigations. Harris (1945) made use of them in the identification and classification of Jurassic plants. He points out that in fossil material all cuticular structures, such as external and internal cuticle of seeds and spores, are preserved. He also (1956) notes stability of cutin as a factor of consequence in the preservation of/

/of microscopic characters of plant fossils, this material having been recovered from fossils of the oldest known plants. Epidermal cells, particularly stomatal guard cells, are noted by him as traceable in such material.

Prat (1932) states '... almost all the workers who have studied the anatomy or the systematics of the Gramineae have remarked on the characters of the epidermal cells, which attain a higher degree of specialisation in that family than in any other.'

This specialisation is indeed very marked in the Gramineae and in the different species studied there have been found specific differences in the epidermal cell types and arrangements. In the case of the Cyperaceae, Juncaceae, petalloid Monocotyledons and Dicotyledons the differences are not so well marked but are nonetheless distinguishable between genera or species.

There are many characteristics of epidermal cells which can be utilised in specific identification. Pfeiffer (1927) in an investigation on the leaves of Cyperaceae noted four types of epidermal cells, some of which appeared in a single species or were confined in distribution.

These he termed :

1. Langzellen.. long cells of the fundamental monocotyledon type.
2. Blasenzellen.. bubble-shaped, isodiametric cells.
3. Engzellen.. narrow cells, sunk below the other epidermal cells.
4. Kegelzellen.. silicified cells, containing ten distinct types of silica bodies.

He also classified four types of appendages :

1. Papillae and cuticular pegs.
2. Stachelhaare.. 1-celled, thorn-like hairs.
3. Borstenhaare.. 1-celled bristles.
4. Winkelhaare.. hairs making a right-angled bend and growing at right angles to the leaf surface.

Prat (1932) used the following characters as an aid to identification :

1. Short cells e.g. silica cells, suberose cells, exodermic cells and stomata.
2. Long cells e.g. the basic type of epidermal cell, of a length at least three times its width; bulliform cells; cells with undulating walls (cellules engrenées).

Later investigations by the same author (Prat 1948) showed that it was possible to utilise the epidermal characters of cereals in genetic and taxonomic studies. When studying a cereal or grass the first step was to recognise the structural characters i.e. the nature and shape/

/shape of the component cells of the epidermis. The shape of the silica bodies, presence or absence of bicellular hairs, cushion hairs and bulliform cells were investigated. Each genus has a definite set of epidermal cells with well-defined shapes as one of its fundamental characteristics. In all species of a genus the same types of cells with the same shapes are found but they are differently distributed over the epidermal surfaces from one species to another. The second stage of the study was to determine how the types of cells were distributed over the leaves. This gave a second category of characters, the distributive characters, which enable one to identify the species.

Metcalfe (1954) confirms and extends this view of generic (basic) and specific characters visible in epidermal preparations and found the following to be most useful for diagnostic purposes :

(A) Generic (basic) diagnostic characters:-

1. Silica and cork cells over the veins solitary, paired, in rows of 3-5 cells or in rows of more than 5 cells.

2. Shape of subsidiary cells to stomata triangular, straight sided, hemicentric or tall hemicentric.

3. The presence or absence of angled micro-hairs (Winkelhaare) which are usually but not invariably 2-celled.

4. The shapes of the silica bodies in the silica cells above the veins.

(B) Specific Diagnostic characters :

1. Occurrence and distribution of large hooks or small, rounded hooks.

2. Occurrence, distribution and types of epidermal papillae.

3. Occurrence and distribution of 1-celled hairs.

All of these characters Metcalfe considered to be important but combinations of them were still more significant.

Metcalfe (1954, 1960) also points out that similar specific diagnostic characters may exist in the epidermis of grasses which are not related and he considers that this may be due to adaptations to growth in similar environemental conditions.

Borrill (1957) was able to separate two ecotypes of Dactylis glomerata on the basis of morphologically distinct epidermal patterns.

Other workers who have utilised epidermal material in their studies have each added various points of specific identification e.g. Grob (1896), Manfeldt (1935), Church (1949), Sørenson (1953), Martin (1955), Herous (1959) and Davies (1959).

Prat (1932), confirmed by Davies (1959) points out/

/out that there is a certain amount of gradation of epidermal cell types i.e. a progressive differentiation of the epidermis in the successive leaves of the plant. Some species showed a strong gradation, the epidermis of the leaves nearest the inflorescence differing markedly from those near the vegetative tillers; others showed feeble gradation in that the epidermis of the terminal leaves resembled even that of the seedling leaves.

These variations affect mainly the suberose, silicose and subero-silicose cells, hairs and other asperities present on the epidermis. Davies (1959) concluded that the leaf sheaths of the Gramineae provided few consistent criteria for specific determination whereas leaf blades were much less subject to gradation and differentiation. Leaf blade gradation in Zea mays, for example, is so consistent that it may be used to distinguish between varieties (Prat 1948).

Davies (1959) utilised epidermal characters as a method of identifying short lengths of grass leaf in dry leafy herbage samples and in the analysis of closely grazed pasture. Using detailed cellular structure within the epidermal cells he was able to separate/

/separate *Festuca pratensis* from *F. arundinacea*; *Seiglingia decumbens* from *Poa pratensis*; and *F. ovina* from *Agrostis setacea* or *Nardus stricta*. *Phleum pratense*, *Alopecurus pratensis* and *Agrostis* species were separable on their characters of crystal clusters, nerve epidermal cells and ligular asperities.

All of the authors so far noted have been concerned particularly with genera of the Monocotyledons, but specific epidermal characters exist and can be utilised in the Dicotyledon genera.

The outstanding difference between the epidermis of Monocotyledon and Dicotyledon plants is that in the former the epidermal cells are in longitudinal rows, with straight or corrugated sides.

In Dicotyledons the cells are not in rows and the cell outline in many cases shows a jig-saw type of pattern.

These differences are due to the different ways in which the leaves are initiated. The Monocotyledon leaf arises from a meristem which encircles the apical cone of the stem and much of the leaf growth is as a result of activity in an intercalary meristem at the base of the leaf sheath. This leads to files of cells being produced from the meristem.

The/

/The major expansive growth of the Dicotyledon leaf, on the other hand, is the result of activity in linear marginal meristems, with both tangential and radial divisions occurring, giving rise to the irregular cell arrangement (Foster 1936; Esau 1953).

Watson (1942) considers that the corrugated epidermal wall may be due to the unequal plasticity of different parts of the cell wall at right angles to the surface. The hardening of the inner part of this wall followed by the continued expansion of the outer part would also lead to the wavy outline frequently formed.

Winton (1914) and Winton & Winton (1932), in volumes concerned with the identification of plant fragments in food samples, give many illustrations of leaf epidermis features in Dicotyledon families. The characters they note most commonly are :

(A) Undifferentiated epidermal cells :

1. Walls smooth or corrugated, pitted or unpitted.
2. Cutin striate, papillate or smooth.
3. Presence or absence of papillae.
4. Presence or absence of oxalate crystals.
5. Cell wall outline.

(B) Differentiated epidermal cells :

1. Stomata solitary, paired or grouped.
2. Stomata sunken or horned.
3. Hairs capitate, warty, jointed, uni- or multi-cellular.
4. Presence or absence of bladder cells.

Accorsi (1949) investigated 517 species from 108 genera of the family Rubiaceae, placing them in 24 categories based on the morphological characters of the lower epidermis. In general the characters he utilised were those applied by the investigators noted previously.

Varying environmental characters are found to affect chiefly the quantitative characters of the epidermis, namely cell dimensions and the rapidity of maturation of cell walls (Prat 1948; Borrill 1957; Davies 1959). Nevertheless these variations are not normally sufficient to obviate the accurate identification of similar species from different sites (Martin 1955).

Metcalfe (1960) discusses the epidermal characters which are useful in systematics shown by a wide range of Gramineae. He shows that there are groups of characters which are common to sub-families.

This occurs in, for example, the Festucoideae and the Poaideae. In many cases only the characters of the abaxial epidermis are considered. In the present study the characters of both surfaces have been taken into consideration.

Many of the investigators noted above have depended to a large extent on characters of the costal parts of the leaf in identification. Particularly in the Monocotyledon genera it is found that the silica-containing cells, the suberose cells and the silica-suberose couples are confined to such areas.

In faecal samples the plant fragments consist of cuticle, the outer epidermal surfaces and vascular tissue. This latter may be free in the sample or still attached to the epidermis. Thus the costal areas of leaf fragments tend to be obscured, and the frequency and distribution of the differentaited cells noted above as occurring in these areas tends to be of little value in the identification of fragments in faecal samples.

Characters of the inter-costal areas are thus of more importance in the present case, and quantitative characters, as well as qualitative, are valuable.

In many cases accurate identification of fragments can be made from very small pieces of epidermis, particularly where patterns or groups of characters are present and are highly specific.

In the present investigation the following characters have been utilised, most of them applicable to both Monocotyledon and Dicotyledon genera, except where otherwise noted:

A. Undifferentiated epidermal cells :

1. Cell outline : walls more or less parallel (Monocotyledon) or outline irregular (Dicotyledon).
2. Cell Shape : walls parallel, trapezoid or narrowing at the ends only.
3. Cell length : elongated (length more than 3x breadth) or short.
4. Cell breadth : average breadth of cells above veins (costal) and between veins (intercostal).
5. Wall type : thick, thin, corrugated, pitted.

B. Differentiated epidermal cells :

1. Stomata : frequency, distribution and size.
2. Stomatal subsidiary cells : triangular, straight-sided, hemicentric, tall hemicentric or variable.

3. Stomatal Subsidiary cells : extending or not extending below the adjacent epidermal cells.
4. Silica cells : frequency and distribution; solitary, paired or in rows of 3-5 cells or more.
5. Silica body : shape.
6. Suberose cells : as for 4.
7. Silico-suberose couples : as for 4.
8. Hairs : frequency and distribution; one-, two- or many-celled.
9. Hooks : frequency and distribution.
10. Papillae : frequency and distribution.

Illustrations of Epidermal Characters

Plates 1 and 2 (Pages 28,29) show examples of the more common epidermal characters which are used in the Key and in the Descriptions.

Plate 1

1. This example shows the undifferentiated cell structure and arrangement which is typical of the Monocotyledon genera, that is, with the cells elongated and in a linear arrangement. The cells in this case are also tapered and have thin walls.

(Poa annua; adaxial; x 70.)

2. This is the typical appearance of a Dicotyledon epidermis, with the undifferentiated cells irregular in arrangement and shape. The stomata are scattered over the epidermal surface and their pores are not orientated in any particular direction.

(Lotus corniculatus; abaxial; x 70)

3. In many of the Dicotyledons, particularly Leguminosae and Ericaceae, the type of cell pattern termed '~~jig-saw~~' is found, and is here illustrated. The cells interlock to a considerable extent.

(Vicia sepium; adaxial; x 70)

4. The walls of many species are corrugated to a greater or less degree. This example is of fine corrugations./

/corrugations. (Alopecurus praiensis; adaxial; x 280)

5. Coarse corrugations are also found as illustrated here. A similar type of structure is found in most of the Cyperaceae and Juncaceae.

(Anthoxanthum odoratum; abaxial; x 280)

6. The walls may have cellulose protuberances at which the wall frequently changes direction; such a wall is termed 'knobbed', and is frequently found in the Leguminosae. (Lotus corniculatus; abaxial; x 280)

Plate 2

7. In species such as Lolium perenne, Poa trivialis and Endymion non-scriptus the wall appears to be very thin and flexuous. (E. non-scriptus; both; x 70)

8. Striations are occasionally found on the cuticle, particularly in xeromorphic species.

(Erica cinerea; adaxial; x 750)

9. In most of the Gramineae, Juncaceae and Cyperaceae the stomatal subsidiary cells do not extend beyond the line of the adjacent epidermal cells. In other cases, as shown here, they extend below the adjacent cells.

(Poa annua; adaxial; x 280)

10. Papillae are found on the undifferentiated cells of many species. In the example shown they are single in each papillate cell. In other members of the Cyperaceae they may be paired, particularly beside the stomata/

/stomata, in which case the four papillae overarch the stoma. In Nardus stricta the papillae may reach a length of 30 μ. (Carex nigra; adaxial; x 280)

11. Silica cells containing silica bodies, and cork cells are the most frequent differentiated cells found in epidermis. They may be single, paired or in groups. The silica bodies vary in shape and size and in many cases these characters are specific.

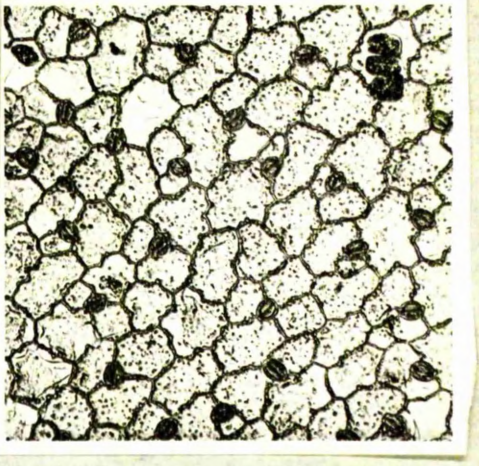
(Molinia caerulea; adaxial; x 750)

12. Micro-hairs, consisting of one cell, are frequent in many species. They may be lost in the process of digestion but the basal epidermal cell remains to show their frequency. Micro-hairs are of two cells; the distal cell is usually lost leaving the basal cell intact or the cell base visible in the epidermis. (Deschampsia flexuosa; adaxial; x 280)

PLATE 1

1.

2.



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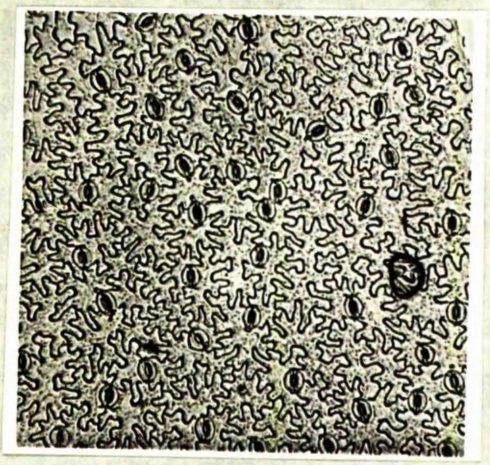

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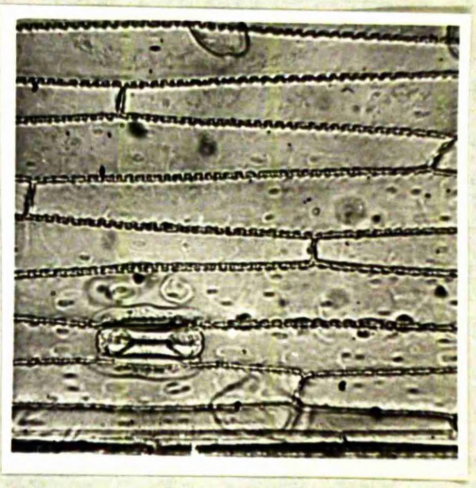

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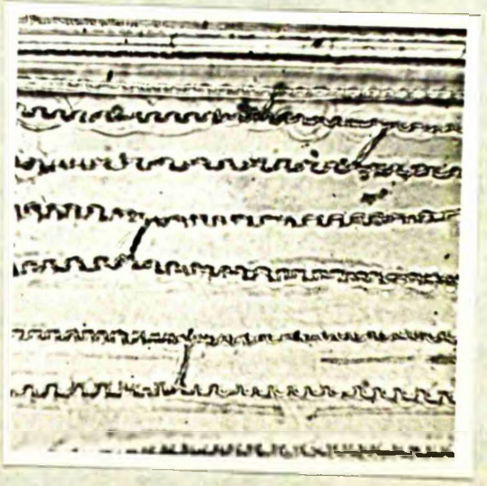

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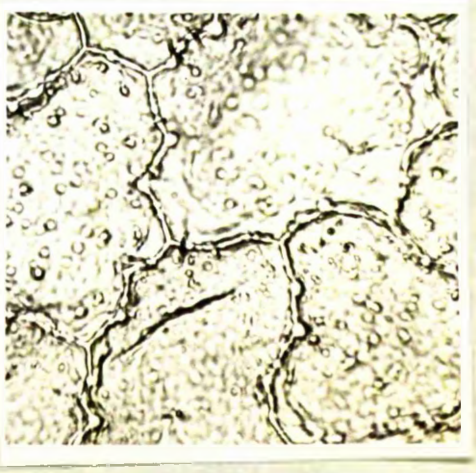
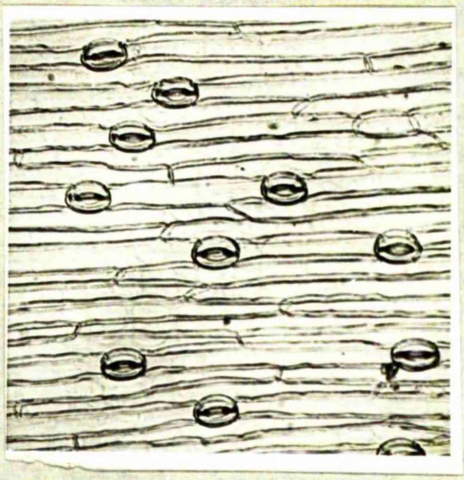


PLATE 2

7.



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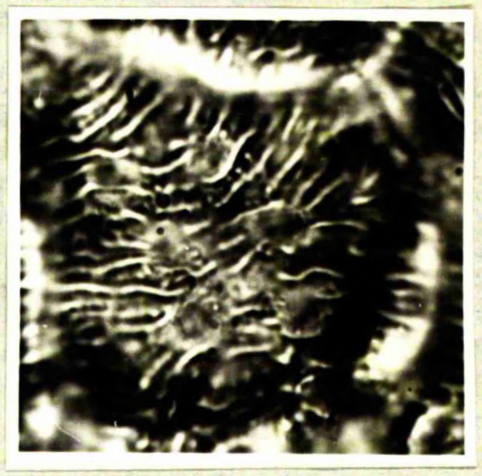
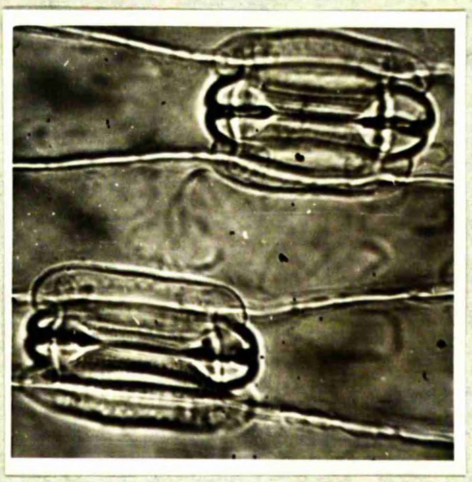


9.



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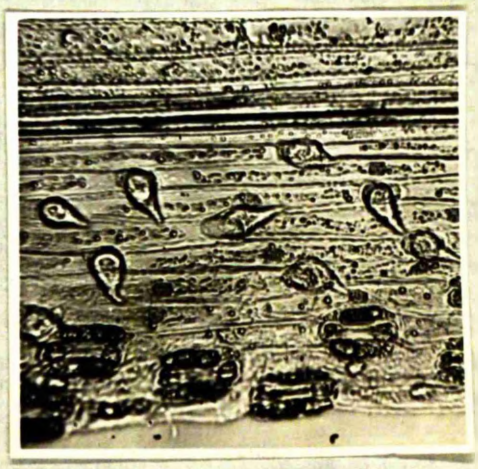

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Key to the Identification of Fragments

This Key allows the identification to species level of most of the fragments encountered in the analysis samples. In the case of some Dicotyledon plant fragments, recourse to comparison with the photographic illustrations is necessary for complete accuracy.

1. Undifferentiated cells elongated, at least 3x breadth, or inregular rows..... 2
   Cells not elongated as above..... 46
2. Cell edges corrugated..... 3
   Cell edges smooth or nearly so..... 25
3. Undifferentiated cells papillate..... 4
   Not papillate..... 8
4. Papillae at least 20μ high..... N. stricta (AD)
   Not as above..... 5
5. Papillae in fours at each stoma..... C. panicea (AB)
   Papillae in pairs at each stoma..... 6
6. Undifferentiated cells at least 5x long as broad... 7
   Not as above..... C. nigra (AB)
7. Celledges finely corrugated..... D. caespitosa (AD)
   Cell edges coarsely corrugated..... N stricta (AD)
8. Differentiated cells, except stomata, in intercostal region..... 9
   Not as above..... 13

9. Differentiated cells single..... 10

Differentiated cells two or more in rows..... 12

10. Silica cells irregular but often H-shaped.. M. caerulea (AB)

Micro-hairs single between undifferentiated cells..

... D. caespitosa (AB)

Not as above..... 11

11. Silica cells regular, no hairs..... F. rubra (AB)

Silica cells regular, hairs 100 μ long. F. ovina (AB)

12. Silica bodies dumb-bell shaped; stomatal subsidiary cells hemispherical..... M. caerulea (AD)

Silica bodies elongated and rough; stomatal subsidiary cells triangular..... N. stricta (AB)

13. Stomata present..... 14

Stomata absent..... 22

14. Stomata scattered, not in rows, frequent hairs 20 - 30 μ long..... F. rubra (AD)

Stomata in single rows..... 15

Stomata in two adjacent rows..... 16

Stomata in more than two adjacent rows..... 18

15. Stomata with short, undifferentiated cell between each..... P. pratense (AB)

Stomata with long, or more than one, undifferentiated cell between each..... A. pratensis (AD,AB)

16. Subsidiary cells of stomata extending below other epidermal cells..... 17

Not as above..... A. odoratum (AB)

17. Walls coarsely corrugated..... P. pratense (AD)
Walls finely corrugated..... A. odoratum (AD)

18. Undifferentiated cells near stomata with cellulose ingrowths..... 19
Not as above..... 20

19. Most undifferentiated cells length 3 - 4x breadth... ... L. pilosa (AD)
Most cells 1 - 2 x breadth..... J. effusus (Stem)

20. Length of undifferentiated cells 3-4 x breadth..... 21
Length 1 - 2 x breadth, with many 1x.. E. angustifolium (AD)
Length 1 - 2 x breadth with few or none 1 x .... E. vaginatum (Stem)

21. Stomatal subsidiary cells shorter than guard cells... .... T. caespitosum (Stem)
Stomatal subsidiary cells as long, or longer than, the guard cells..... L. sylvatica (AD)
Stomatal subsidiary cells triangular.. C. echinata (AB)

22. Cells tapering at ends..... C. cristatus (AD)
Cells expanded at one end..... C. nigra (AD)
Cells not as above..... 23

23. Cells near costal areas often greater than 100 μ in length..... C. panicea (AD)
Cells near costal areas not noticeably longer than inter-costal cells..... 24

24. Cell walls evenly corrugated..... Eriophorum spp. (AB)
Cell walls rough with cellulose protrusions into cell..... J. squarrosus (AB)

25. Stomata general over inter-costal area..... 26

Stomata confined to near costal regions..... 37

Stomata absent..... 40

26. Differentiated cells, except stomata, present..... 27

Not as above..... 30

27. Stomatal subsidiary cells large, tall hemicentric....

..... D. *flexuosa* (AD)

Not as above..... 28

28. Hairs very frequent..... *Holcus* spp. (AD,AB)

Hairs absent, or not frequent..... 29

29. Cell walls pitted..... C. *cristatus* (AB)

Cell walls not pitted..... P. *trivialis* (AD)

30. Stomata with grass- or rush-like subsidiary cells.. 31

Not as above..... 35

31. Undifferentiated cell length 4-5 x breadth..... 32

Not as above..... 34

32. Undifferentiated cells tapered at ends..... 33

Cells not tapered at ends..... L. *perenne* (AD)

33. Stomatal subsidiary cells extending below adjacent

epidermal cells..... P. *pratensis* (AD)

Not as above..... A. *stolonifera* (AD,AB)

34. Stomata in frequent, single rows, evenly distributed...

..... J. *articulatus* (Stem)

Stomata in single rows, irregularly distributed.....

..... L. *cameatris* (AD)

35. Stomata with small epidermal cell adjacent.....

..... L. *montanus* (Stem)

Not as above..... 36

36. Epidermal cells thin, flexuous; stomata 70 μ long.....
..... E. nonscriptaa (AD,AB)

Epidermal cells thick, rigid; stomata 40 μ long.....
..... I. pseudacorus (AD,AB)

Epidermal cells thick, rigid; stomata 20-30 μ long.....
..... N. ossifragum (AD,AB)

37. Stomata in single row..... 38

Stomata in two adjacent rows..... P. annua (AD)

38. Subsidiary cells tall..... 39

Subsidiary cells low..... P. pratensis (AB)

39. Undifferentiated cells tapering at ends; subsidiary cells same length as guard cells..D. glomerata (AD,AB)

Cells hardly tapering at ends; subsidiary cells shorter than guard cells..... P. annua (AB)

40. Undifferentiated cell length at least 4 x breadth.. 41

Not as above..... 44

41. Cells straight, more or less parallel-sided..... 42

'Cells' curved; composed of smaller cells...Sphagnum agg.

42. Cells at least 10 x long as broad..... 43

Not as above..... Polytrichum agg.

43. Cell walls thin, flexuous.. L. perenne or P. trivialis

Cell walls thick, rigid..... D. flexuosa (AB)

44. Cells more or less elongated..... L. sylvatica (AB)

Cells more or less rounded..... 45

45. Walls thin and flexuous..... L. pilosa (AB)

Walls thick, rigid..... L. campestris (AB)

46. Stomata present..... 47
Stomata absent..... 62
47. Walls 'knobbed'..... 48
Not as above..... 51
48. Stomata about 100 μ long..... A. nemorosa (AD,AB)
Stomata not more than 50 μ long..... 49
49. Walls usually bent at knobs..... 50
Walls not bent at knobs; occasional hair bases.....
..... T. pratense (AB)
50. Walls very irregular in shape..... H. lupulina (AD,AB)
Walls irregular..... L. corniculatus (AD,AB)
51. Cells interlocking, jig-saw shaped..... 52
Not as above..... 55
52. Stomata frequent..... 53
Stomata infrequent..... E. nigrum (AD)
53. Stomata more or less elongated..... 54
Stomata more or less circular..... C. vulgaris (AB)
54. P. aquilinum; V. sepium; V. myrtillus. See Photographs.
55. Stomata with 1 small epidermal cell adjacent.....
..... T. repens (AB)
Stomata with 2 small epidermal cells adjacent..... 56
Stomata surrounded by close ring of small epidermal
cells..... S. scoparius (Stem)
Stomata without small epidermal cells adjacent..... 58
56. Stomata circular..... U. europaeus (Stem)
Stomata elongated..... 57

57. Stomata enclosed by small epidermal cells.....
..... *Galium* spp. (AD,AB)
Stomata not so enclosed..... *R. acetosella* (AD,AB)

58. Hair bases frequent..... 59
No hair bases present..... 60

59. Stomata sunken..... *S. scoparius* (AD,AB)
Stomata less than 100 per square mm.. *L. uliginosus* (AB)
Stomata more than 100 per square mm... *P. erecta* (AB)

60. Stomata partly sunken..... *L. uliginosus* (AD)
Not as above..... 61

61. Cell outline wavy..... *V. canina* (AD,AB)
Cell outline not wavy..... *P. vulgaris* (AB)

62. Cells with irregular outline, interlocking..... 63
Not as above..... 65

63. Cells with thin walls, sinuous..... *C. vulgaris* (AD)
Cells with thick walls, rigid, extremely sinuous.....
..... *P. aquilinum* (AD)

64. Cuticle thin, not striate..... *V. myrtillus* (AD)
Cuticle thick, faintly striate.... *V. oxycoccus* (AD)

65. Cuticle with striations or cuticular 'hairs'.... 66
Not as above..... 68

66. Cell outline angular..... 67
Outline not sharply angular..... *P. vulgaris* (AD)

67. Cuticle strongly striate, no 'hairs'. *E. cinerea* (AD)
Cuticle faintly striate, 'hairs' present.....
..... *E. tetralix* (AD)

68. Cell outline multiangular..... 69

Cell outline rounded..... P. erecta (AD)

69. Glandular cells and hair bases frequent.. M. gale (AD,AB)

Not as above..... T. pratense and T. repens (AD)

DESCRIPTIONS AND ILLUSTRATIONS

The descriptions which follow are intended solely as a guide to the identification of epidermal material. Cell sizes are in many cases variable within fairly wide limits. The frequency, size and pattern of distribution of differentiated cells is of greater diagnostic value in specific determination.

1. Gramineae

Agrostis stolonifera L. Plate 3

The adaxial and the abaxial surfaces of the leaves of this species are similar.

The undifferentiated cells are 200-300 μ in length, and 20 μ broad tapering to 10 μ at the ends. The walls are thin, smooth and pitted.

Stomata occur in a single row near each costal area. The stomatal cells are 40 μ by 20 μ. The stomatal subsidiary cells are parallel-sided, occasionally extending below the adjacent epidermal cells.

No differentiated cells, other than stomata, occur in the inter-costal areas.

Alopecurus pratensis L. Plate 4

The adaxial and the abaxial surfaces of the leaves of this species are similar.

The undifferentiated cells are 400-600 μ in length, and are 20 μ wide tapering to 15 μ at the ends. The walls are thin and finely corrugated.

The stomata occur in a single row near the costal areas, and are separated longitudinally by at least one undifferentiated cell. The stomatal group of cells measures 40 μ by 30 μ. The stomatal subsidiary cells are high parallel-sided and extend below the adjacent epidermal cells.

Anthoxanthum odoratum L. Plates 5,6

On the adaxial surface the undifferentiated cells are from 250-400 μ in length and are 30-40 μ wide, hardly tapering. The walls are smooth and are not pitted.

The stomata measure 40 μ by 25 μ, with low dome-shaped subsidiary cells which extend below the adjacent epidermal cells.

Macro-hairs are frequent in the costal areas and are usually 200-250 μ in length.

On the abaxial surface the undifferentiated cells are/

/are 300-400 μ in length and 25 μ wide with little or no taper.

The stomata are sparse on this surface. The stomatal cells are 55 μ by 20 μ with low parallel-sided subsidiary cells which do not extend below the adjacent epidermal cells.

Macro-hairs are common on the costal regions and are some 200-300 μ in length. Micro-hairs of 40 μ length also occur here.

Cynosurus aristatus L. Plates 7,8

On the adaxial surface of this species the undifferentiated cells vary from 125-250 μ in length. Their width is about 25 μ. The walls are not corrugated but are heavily pitted, giving a similar appearance.

No stomata or other differentiated cells were found on this surface.

The abaxial surface consists of undifferentiated cells of 125 μ average length and 25 μ average breadth. The central cells of the inter-costal regions have thin walls which are liable to become distorted.

The stomata occur in two or three rows adjacent to the costal regions. They are 40 μ by 15 μ, and have parallel-sided subsidiary cells which hardly extend/

/extend below the adjacent epidermal cells. The stomata are separated horizontally by one long cell or by a sequence of one long cell, one short cell and one long cell.

Micro-hairs are frequent in the area between the costal region and the stomatal region. They are of 40-50 μ length and have almost circular basal cells.

Dactylis glomerata L. Plate 9

The adaxial and abaxial surfaces of the leaves of this species are similar.

The undifferentiated cells are 300-500 μ in length and 40 μ broad tapering to 20 μ at the ends. The walls are thin, smooth and unpitted.

Stomata occur in a single row adjacent to the costal areas, separated longitudinally by one epidermal cell. The stomatal cells measure 35 μ by 30 μ. The stomatal subsidiary cells are high dome shaped.

Micro-hairs occur in the costal regions and are about 40 μ long.

Deschampsia caespitosa (L.) Beauv. Plates 10,11

The undifferentiated cells of the adaxial epidermis are 150-250 μ in length and 20 μ broad, with no taper. The walls are smooth and pitted. These cells are papillate with usually one, but occasionally two, papillae per cell.

Stomata are very frequent on this surface. The stomatal cells are 55 μ long and 30 μ wide. The stomatal subsidiary cells are low dome shaped or parallel-sided and do not extend below the epidermal cells.

Micro-hairs of 30-40 μ in length occur frequently on this surface, mainly in the inter-costal regions.

The cells of the abaxial surface are 150-250 μ in length and are 25 μ wide. The walls are very thick, sinuous and pitted. Each cell is separated from the next in a longitudinal direction by a short, stout micro-hair of 25-30 μ in length.

No stomata were found on this surface.

Deschampsia flexuosa (L.) Trin. Plates 12,13

The undifferentiated cells of the adaxial surface are 100-200 μ in length and 10 μ wide. The walls are smooth, thin , and tend to become distorted.

Stomata are scattered over the inter-costal regions. The stomatal cells are 30 μ by 20 μ ; the subsidiary cells are high domed.

Between the stomatal and costal areas, the undifferentiated cells are separated longitudinally by micro-hairs, about 30 μ long.

The cells of the abaxial surface are very regular./

/regular. They are 250-300 μ in length and 25 μ broad with no taper. The walls are smooth, slightly thickened, with a few pits.

No stomata are present on this surface.

Festuca rubra L. Plate 14

The undifferentiated cells of the adaxial epidermis are some 60 μ by 15 μ at the centre, tapering to a point at each end. The walls are thin, smooth and flexuous.

Stomata are scattered over the surface. The stomatal cells are 20 μ by 10 μ; the subsidiary cells are low parallel sided.

Micro-hairs are frequent, 12-15 μ long.

On the adaxial surface, the undifferentiated cells are 40-90 μ long and 10 μ wide with no taper. The walls are thin and finely corrugated. Each cell is separated longitudinally by a silica cell, vertically elongated, 5μ by 10 μ.

There were no stomata on this surface.

Festuca ovina L. Plate 15

No adaxial surface could be prepared from this species.

The cells of the abaxial surface are 200-300 μ long/

/long and 30 μ wide. There is no taper. The walls are thick and coarsely corrugated. The cells are separated longitudinally by a silica cell, vertically elongated and frequently C-shaped.

Occasional hairs occur of 100 μ length. These arise adjacent to a silica cell, and the hair base is 20 μ square.

Holcus lanatus L. Plate 16

The adaxial and abaxial surfaces of the leaves of this species are similar.

The undifferentiated cells are 300 μ long and 30 μ broad, with a slight taper at the ends. The walls are thin and pitted. Each cell is separated from the next by a micro-hair, 50-60 μ in length.

The stomata are generally distributed over the epidermis. The stomatal cells measure 45 μ by 30 μ. The subsidiary cells are low dome shaped and do not extend below the other epidermal cells.

Macro-hairs of up to 1 mm. in length occur in the costal regions and of up to 500 μ in the inter-costal regions.

Lolium perenne L. Plates 17,18

The undifferentiated cells of the adaxial epidermis occur in irregular rows. They are 100-200 μ in length near the costal regions and about 500 μ in the inter-costal. The walls are thin and unpitted.

The stomata are scattered over the epidermis. The stomatal cells are 55 μ by 35 μ, with low dome sided subsidiary cells.

No other differentiated cells were found on this surface.

On the abaxial surface the cells are 450-600 μ in length and 30-40 μ in breadth. The walls are thin, smooth and flexuous.

No stomata were found on this surface.

Molinia caerulea (L.) Moench Plates 19,20

On the adaxial surface the undifferentiated cells are 60-90 μ long and 10 μ wide with no taper. The walls are thin and finely corrugated.

The stomata occur in numerous rows, and are separated longitudinally by one undifferentiated cell. The stomatal cells are 20 μ by 15 μ; the subsidiary cells are tall hemi-centric or dome-shaped.

Silica cell and micro-hair couples are frequent; the micro-hairs have square basal cells. The silica bodies/

/bodies are of irregular shape and size.

Macro-hairs occur principally in the costal regions and are 50-60 μ in length. Also in the costal regions there occur rows of silica and suberose cells intermixed. The silica bodies of these cells are dumb-bell shaped or H-shaped.

On the abaxial surface the cells are 100 μ long and 15 μ broad with no taper. The walls are thin and finely corrugated.

There are occasional rows of silica cells and cork cells. The silica bodies are dumb-bell shaped.

The silica bodies of the cells in the inter-costal region are H-shaped or variable.

Nardus stricta L. Plates 21,22

On the adaxial surface the undifferentiated cells are 50-70 μ long and 10 μ broad. The walls are thin, coarsely corrugated and pitted. Most of the cells are papillate, the papillae small in the inter-costal areas but up to 30 μ long in the costal areas.

The stomata are generally distributed. The stomatal cells are 25 μ by 20 μ; the subsidiary cells are low dome shaped or triangular.

On the abaxial surface the cells are 150-250 μ long and 15 μ broad. The walls are thick and coarsely corrugated./

/corrugated.

The stomata are scattered. The stomatal cells are 30 μ by 25 μ; the subsidiary cells are triangular.

Macro-hairs are found in the costal areas and are 500 μ long with occasional hairs of almost 1 mm. Micro-hairs are also found, 70-90 μ in length.

Rows of silica and suberose cells are frequent. The silica bodies are up to 50 μ in length and variable in structure.

Phleum pratense L. Plates 23, 24

On the adaxial surface the undifferentiated cells are 250-350 μ in length and 30 μ in breadth, tapering to 15 μ. The walls are thin, finely corrugated and pitted.

The stomata occur in one or two rows near the costal areas. The stomatal cells measure 45 μ by 25 μ; the subsidiary cells are parallel-sided, just extending below the adjacent epidermal cells.

On the abaxial surface the cells are 250-400 μ in length; breadth is 40 μ tapering to 20 μ at the ends. The walls are thin and coarsely corrugated.

The stomata occur in single, very occasionally double, rows, separated longitudinally by one epidermal cell. The stomatal cells measure 45 μ by 25 μ; the subsidiary cells are parallel sided and extend below the adjacent epidermal cells.

Poa annua L. Plates 25,26

On the adaxial surface the undifferentiated cells are of 150 μ average length and 30 μ average breadth. The cells taper at the ends to about 15 μ. The walls are thin and smooth.

The stomata are usually in two rows near the costal region, separated longitudinally by one or more undifferentiated cells. The stomatal cells measure 30 μ by 25 μ; the subsidiary cells are straight-sided or hemicentric and extend below the adjacent epidermal cell. In many cases they appear to be shorter than the guard cells.

No other differentiated cells were found on this surface.

On the abaxial surface the cells are 150-250 μ in length and 25 μ wide. The walls are thin, smooth and unpitted.

The stomata occur in one row adjacent to the costal area. The stomatal cells measure 35 μ by 30 μ; the subsidiary cells are almost straight-sided and are shorter than the guard cells. They do not extend to any extent below the epidermal cells.

Poa pratensis L. Plates 27,28

On the adaxial surface the undifferentiated cells measure/

/measure 100-200 μ long and 25 μ broad, tapering to 10 μ at the ends. The walls are thin and smooth.

The stomata are scattered over the surface. The stomatal cells measure 40 μ by 30 μ; the subsidiary cells are straight sided and extend below the adjacent epidermal cells.

On the abaxial surface the undifferentiated cells are 250-400 μ in length and 20 μ wide, with little or no taper. The walls are thin, finely or coarsely corrugated and pitted.

The stomata occur in single rows beside the costal areas. The stomatal cells measure 50 μ by 20 μ; the subsidiary cells are parallel sided and do not extend below the adjacent epidermal cells.

Poa trivialis L. Plates 29,30

The undifferentiated cells of the adaxial surface are 100-200 μ in length and 20 μ broad tapering to 10 μ. The walls are thin, smooth and unpitted.

The stomata occur in rows or may be scattered. The stomatal cells measure 35 μ by 15 μ; the subsidiary cells are low hemicentric.

Occasional micro-hairs of 25 μ length are found in the inter-costal regions.

On the abaxial surface the cells are 350-500 μ in length and 20μ broad, tapering slightly. The walls are/

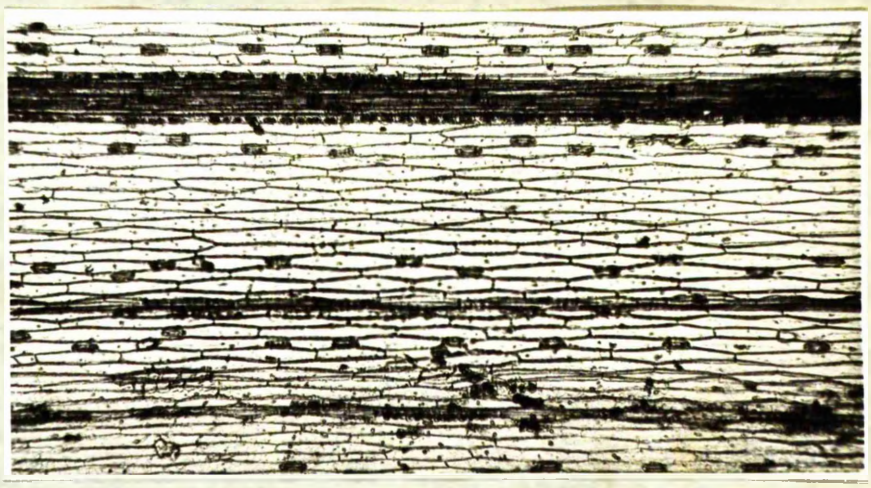
/are thin and flexuous.

No stomata or other differentiated cells were found on this surface.

PLATE 3

Agrostis stolonifera L.

Leaf - Adaxial and Abaxial epidermis



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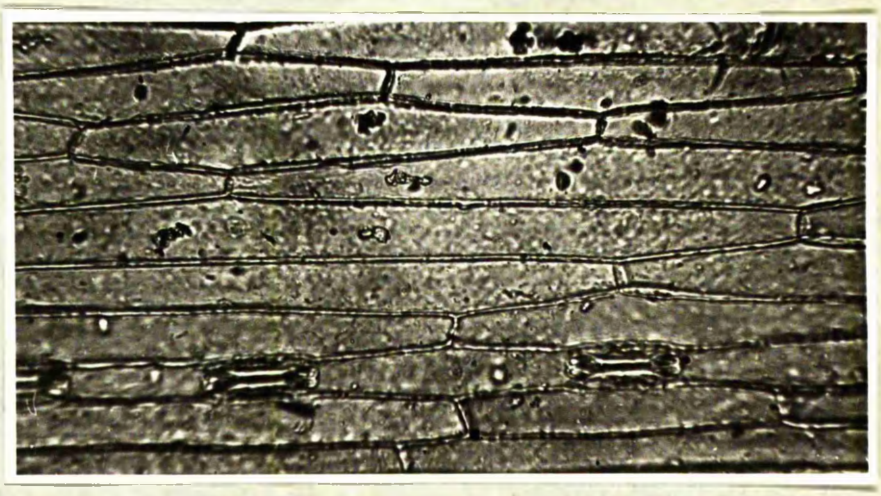

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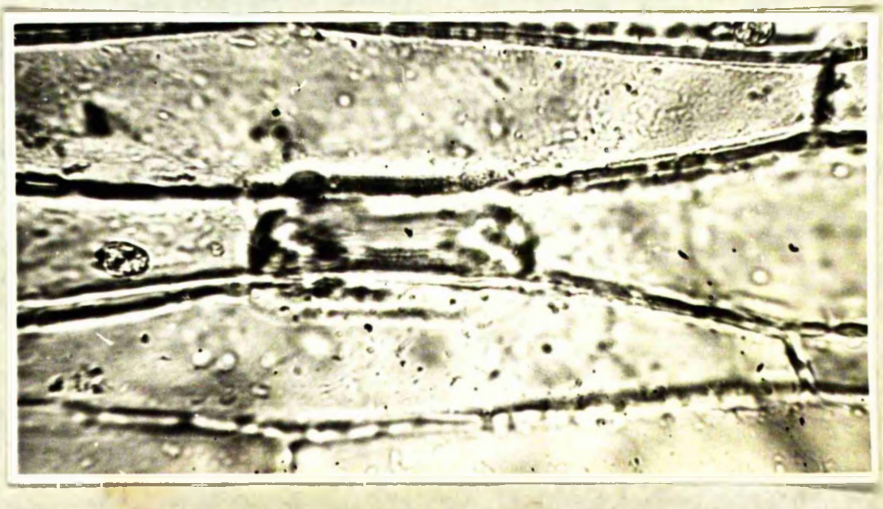
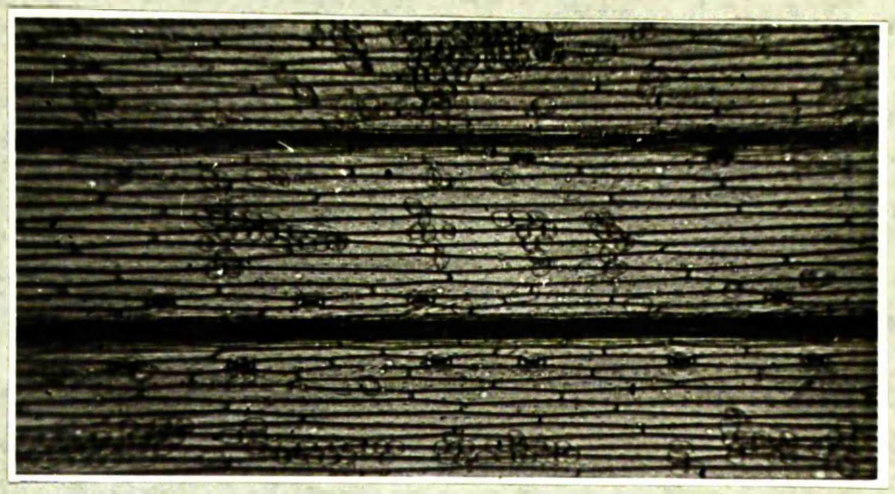


3. x 750

PLATE 4

Alopecurus pratensis L.

Leaf - Adaxial and Abaxial epidermis



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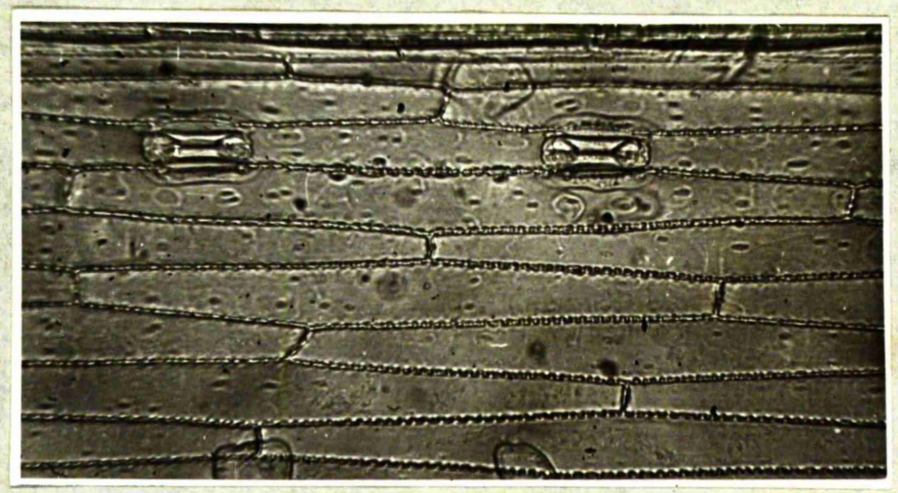
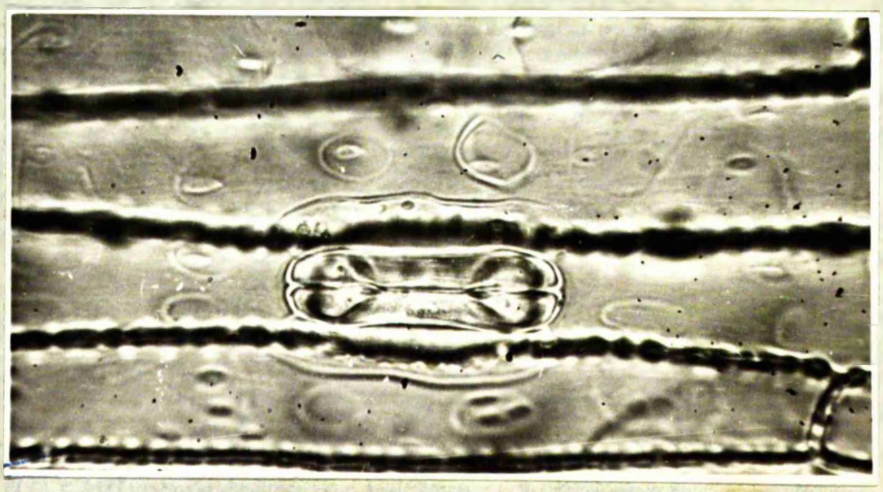


2. x 280

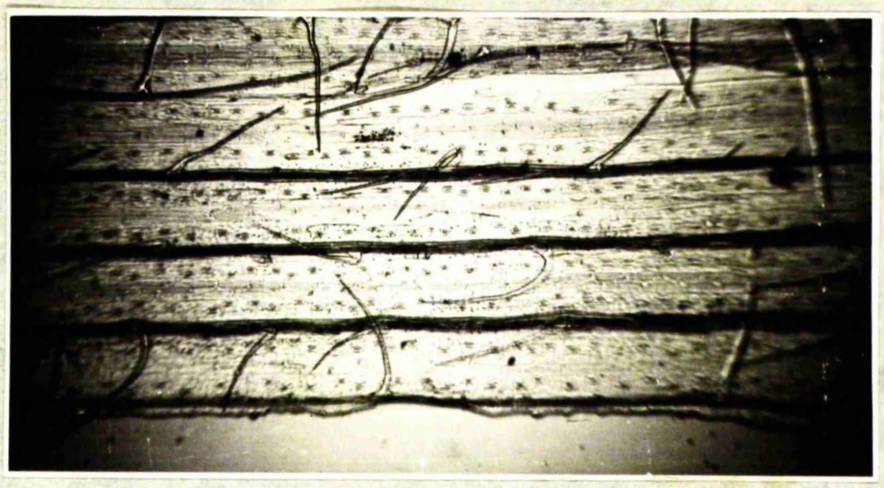


3. 3. x 750

PLATE 5

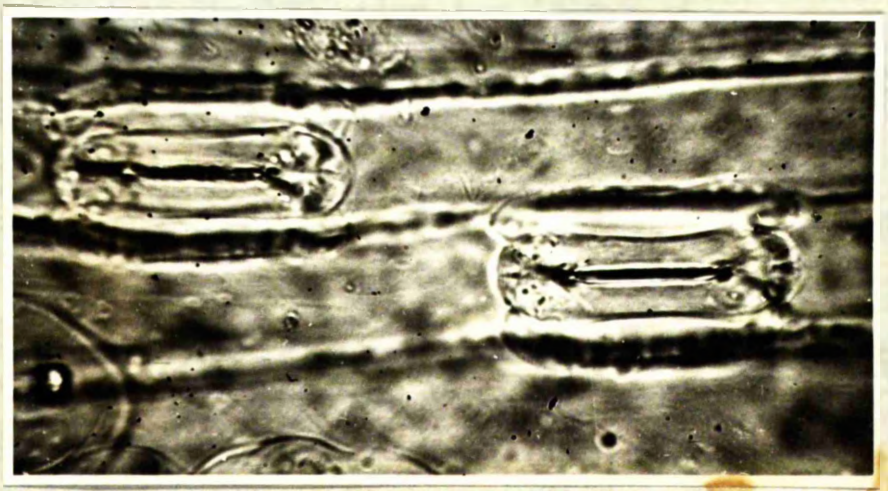
Anthoxanthum odoratum L.

Leaf - Adaxial epidermis.



1. x 40

2. x 70



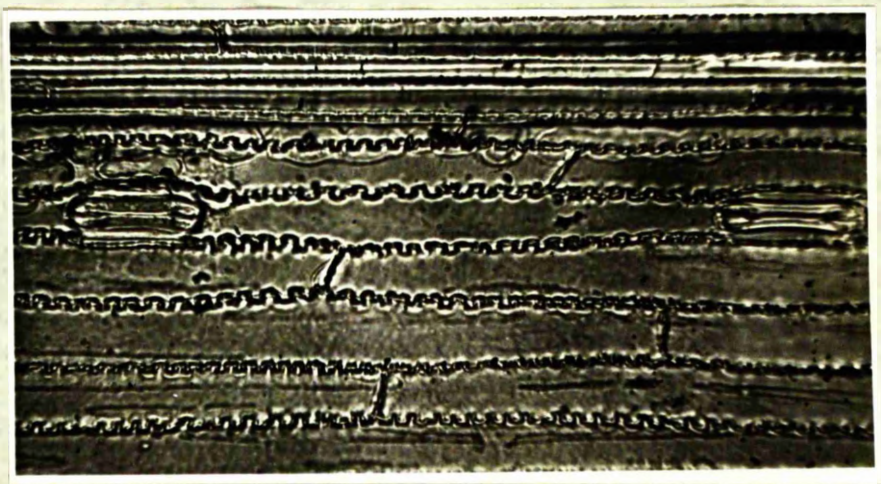
3. x 750

PLATE 6

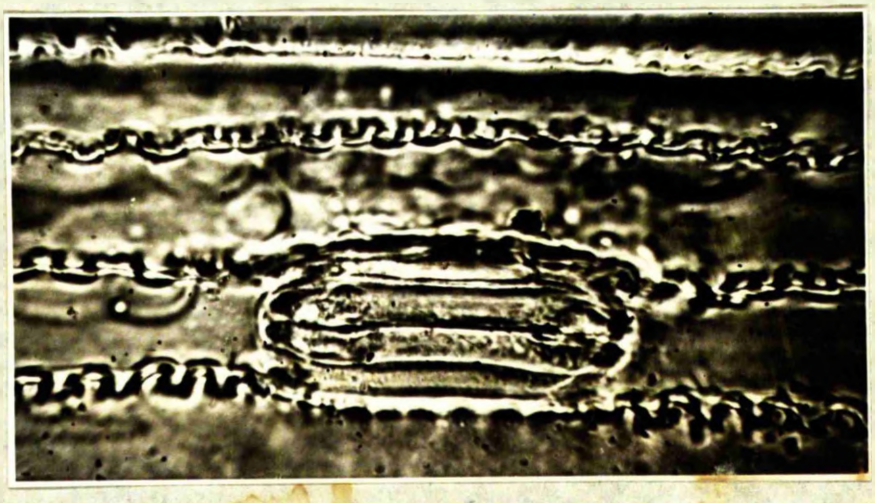
Anthoxanthum odoratum L.

Leaf - Abaxial epidermis.

1. x70



2. x 280

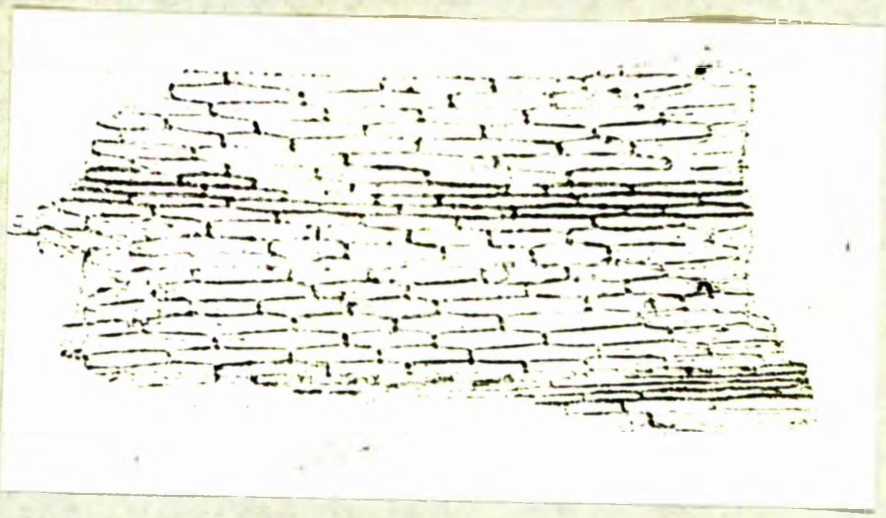


3. x 750

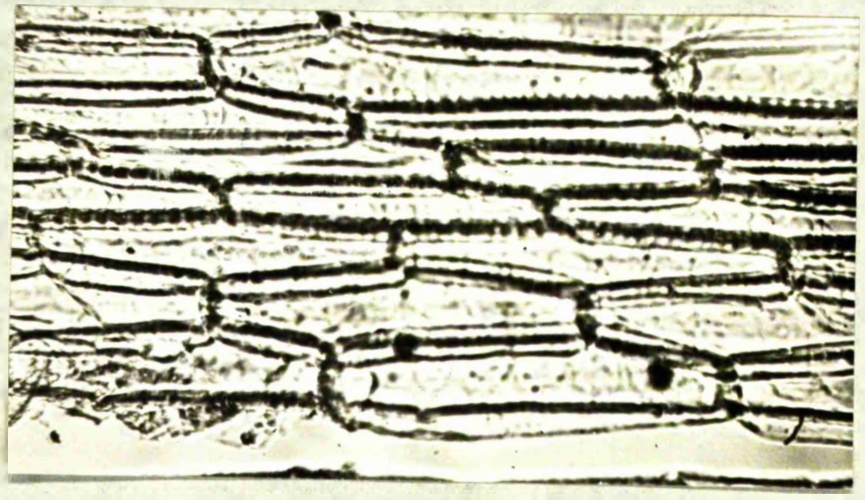
PLATE 7

Cynosurus cristatus L.

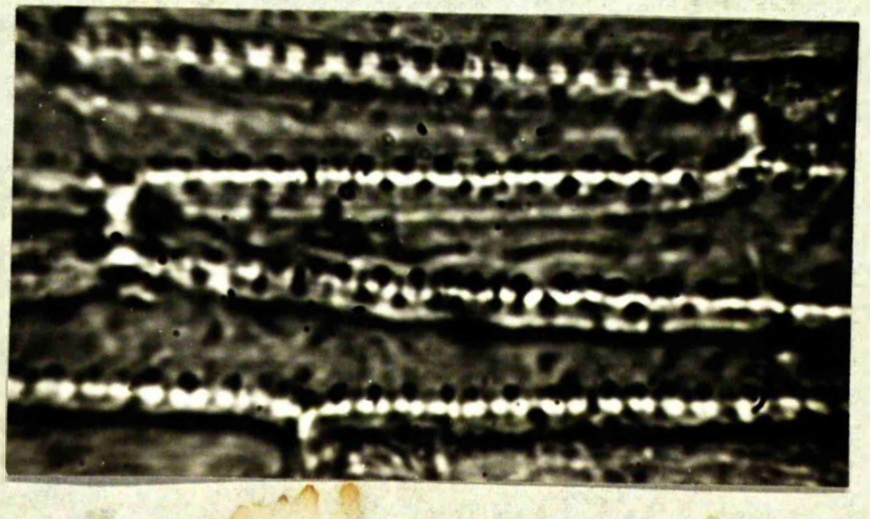
Leaf - Adaxial epidermis



1. x 70



2. x 280

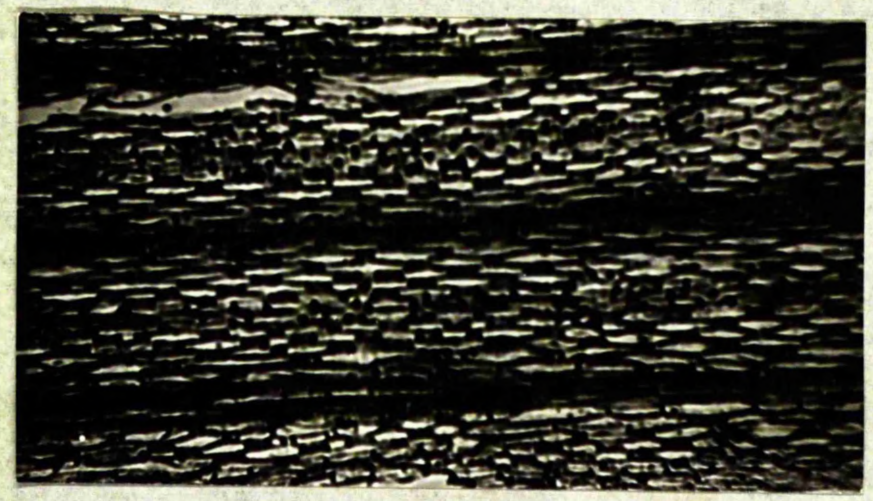


3. x 750

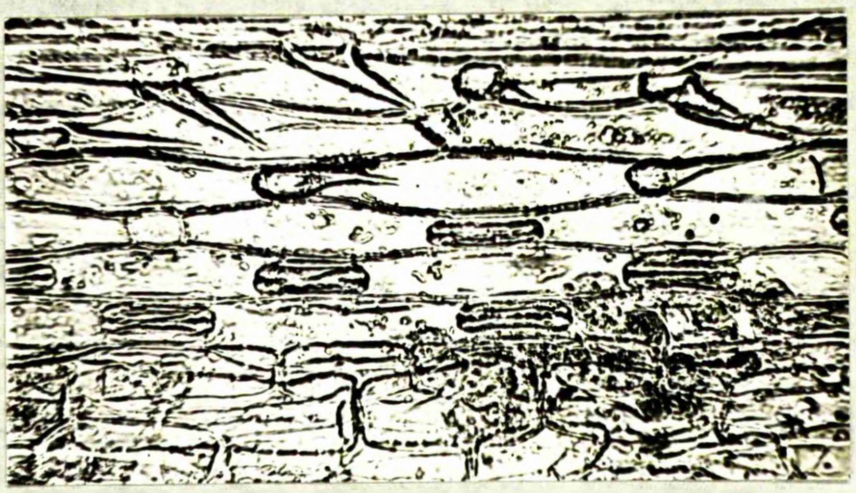
PLATE 8

Cynosurus cristatus L.

Leaf - Abaxial epidermis.



1. 1. x 70

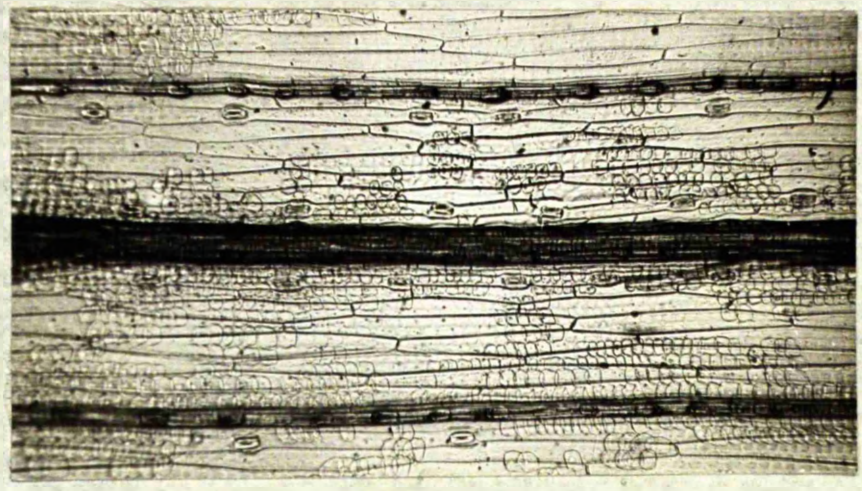


2. x 280

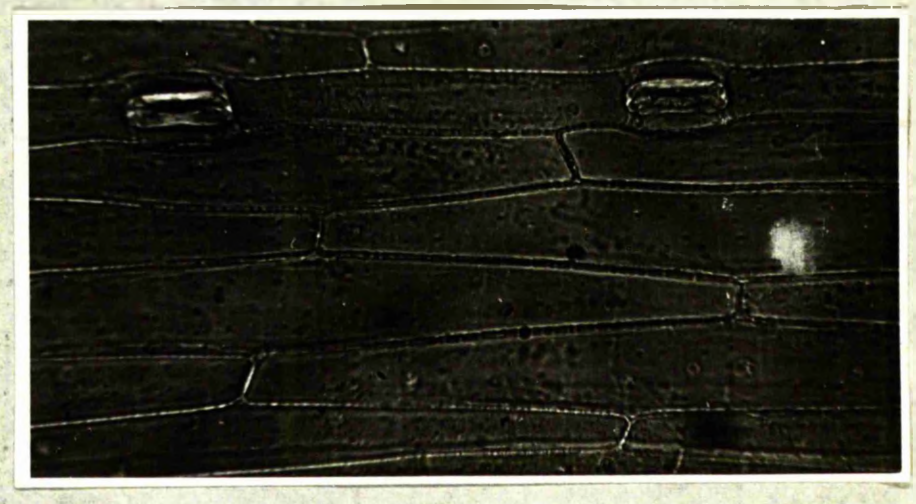
PLATE 9

Dactylis glomerata L.

Leaf - Adaxial and Abaxial epidermis.



1. x 70



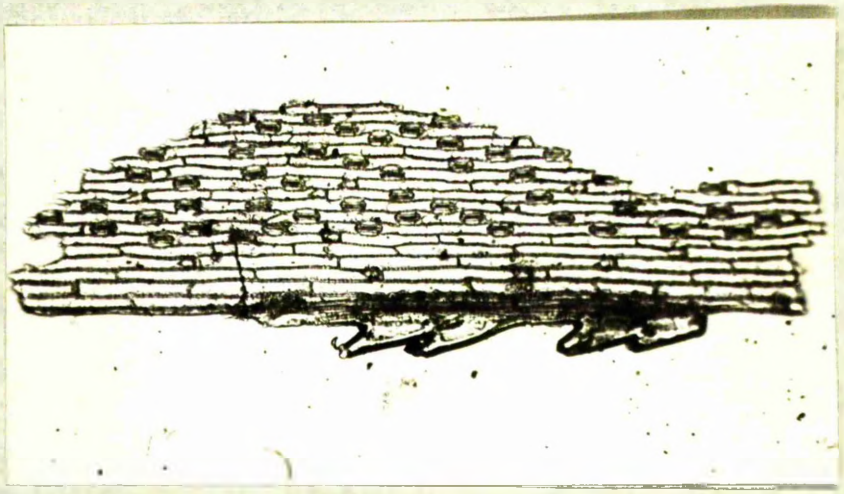
2. x 280

3. x 750

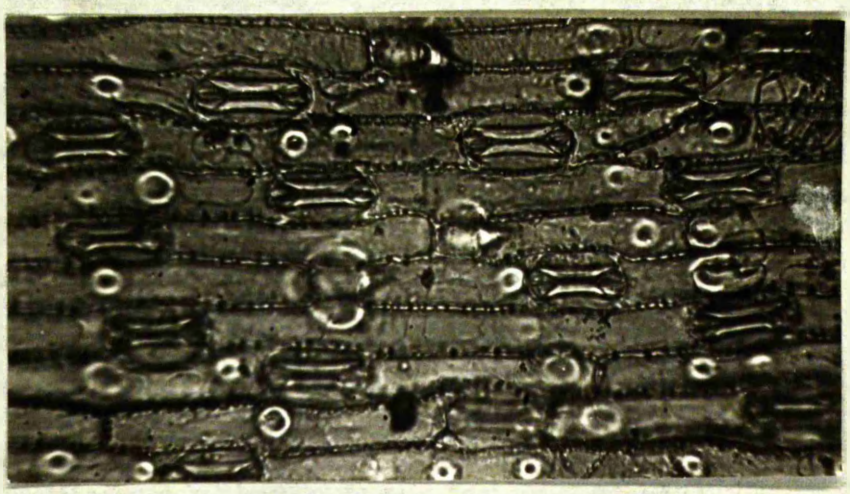
PLATE 10

Deschampsia caespitosa (L.) Beauv.

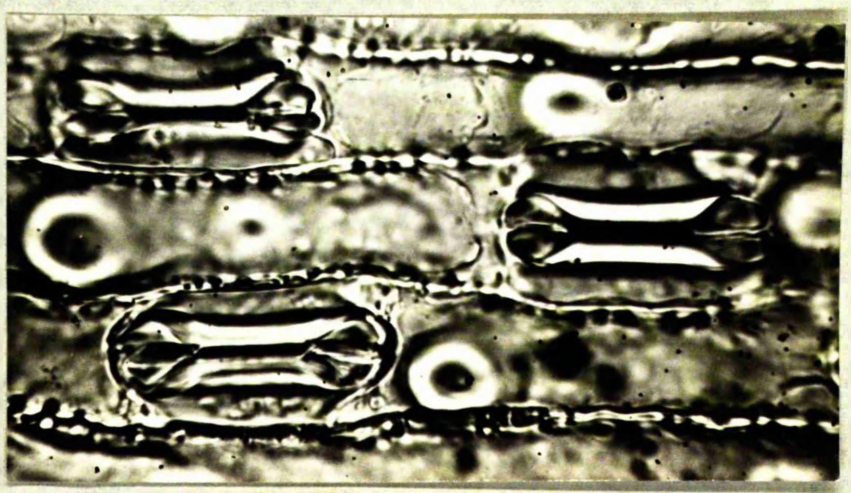
Leaf - Adaxial epidermis.



1. x 70



2. x 280

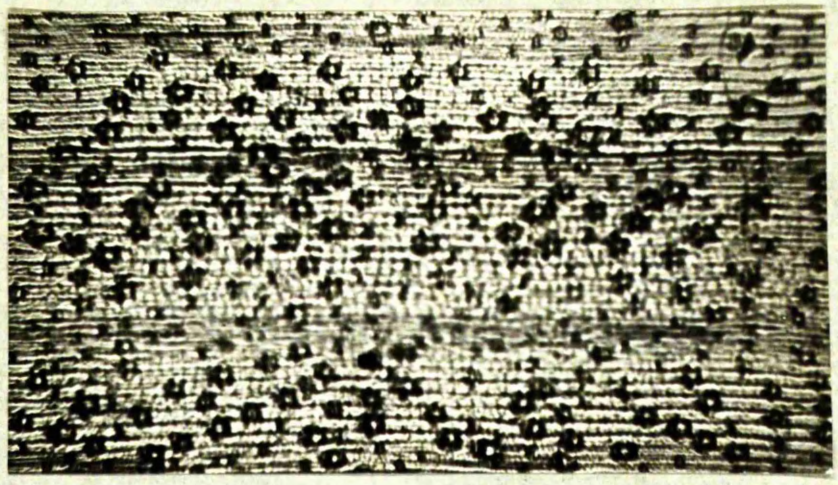


3. x 750

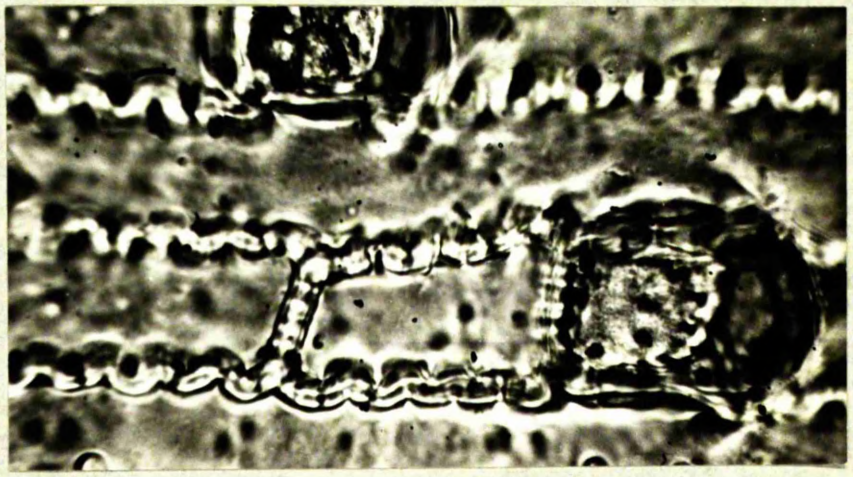
PLATE 11

Deschampsia caespitosa (L.) Beauv.

Leaf - Abaxial epidermis.



1. x 70

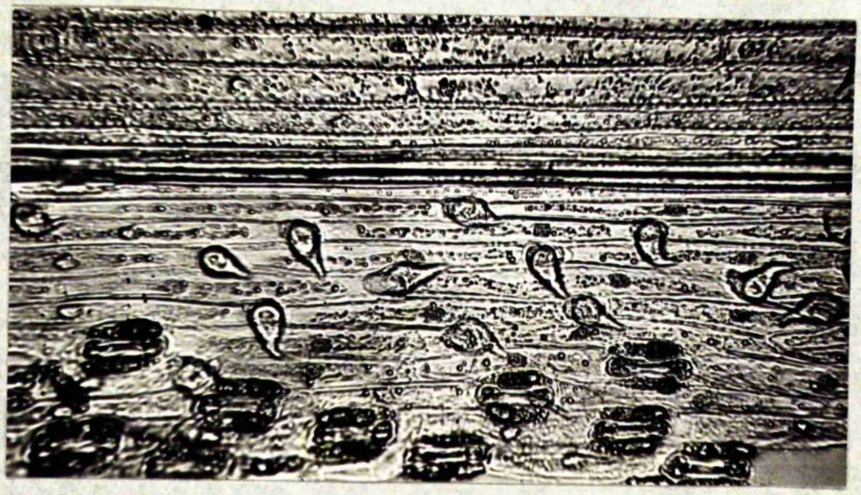


2. x 750

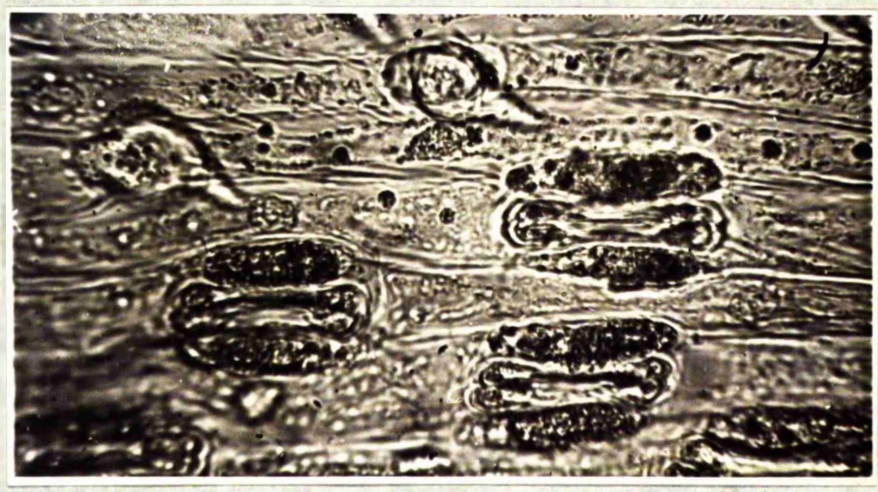
PLATE 12

Deschampsia flexuosa (L.) Trin.

Leaf - Adaxial epidermis.



1. x 280

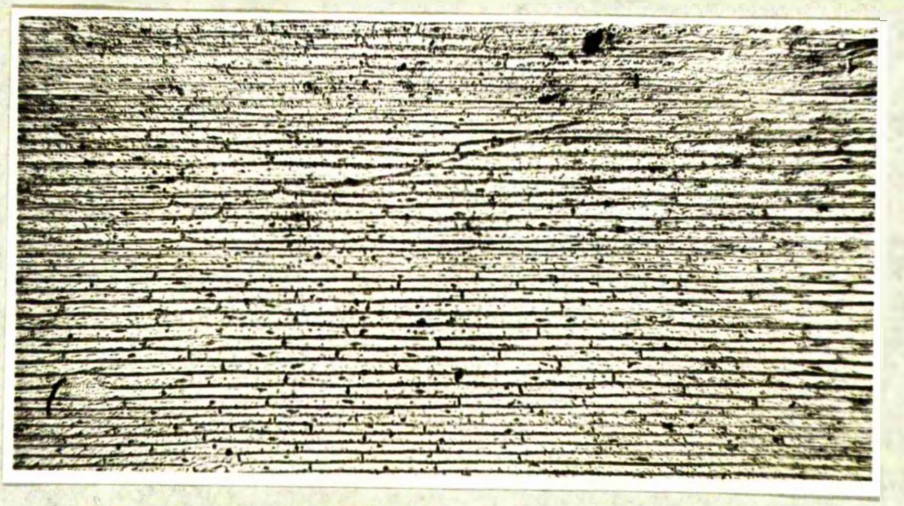


2. x 750

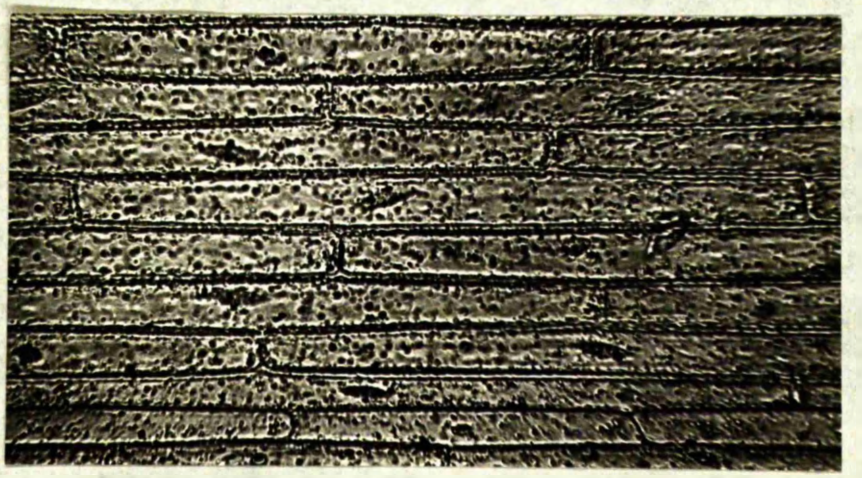
PLATE 13

Deschampsia flexuosa (L.) Trin.

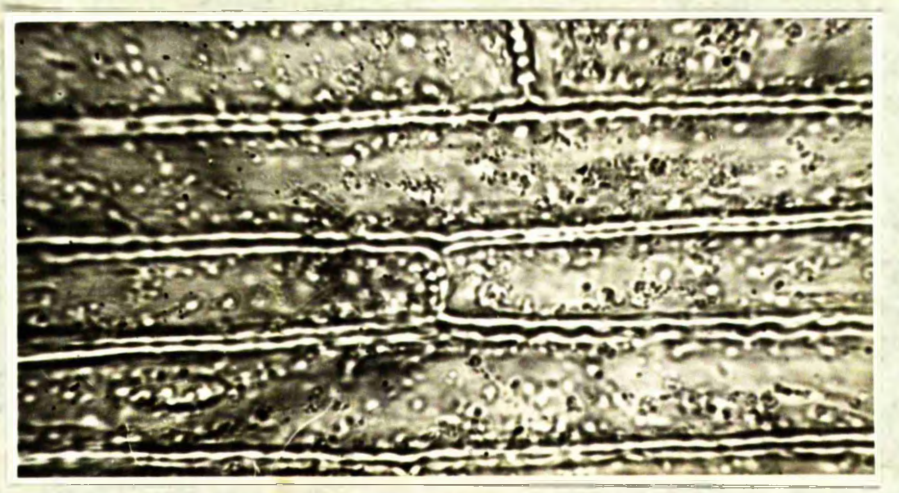
Leaf - Abaxial surface



1. x 70



2. x 280



3. x 750

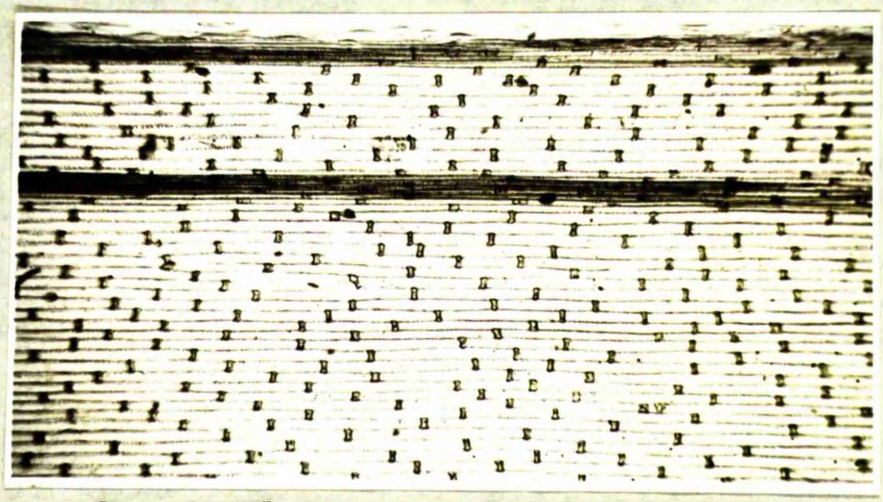
PLATE 14

Festuca rubra L.

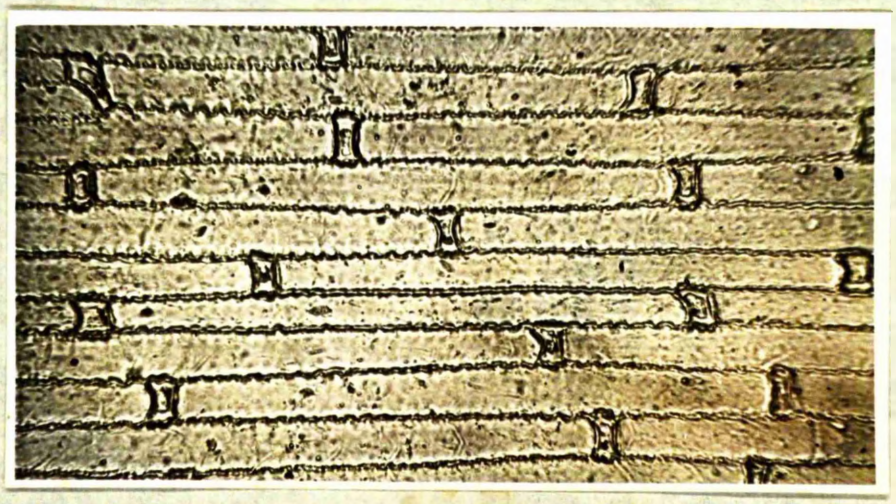
Leaf - Adaxial epidermis.

1. x 280

Leaf - Abaxial epidermis.



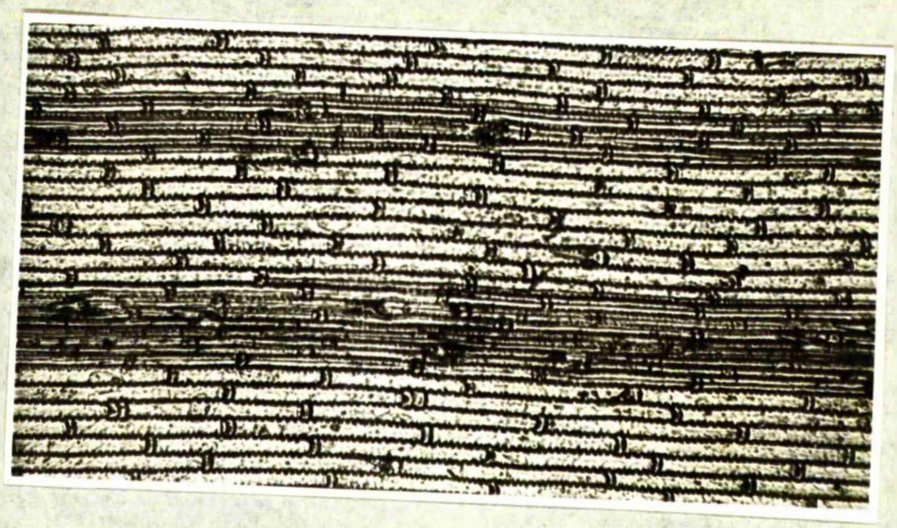
1. x 70



2. x 280

PLATE 15

Festuca ovina L.
Leaf - Adaxial epidermis.



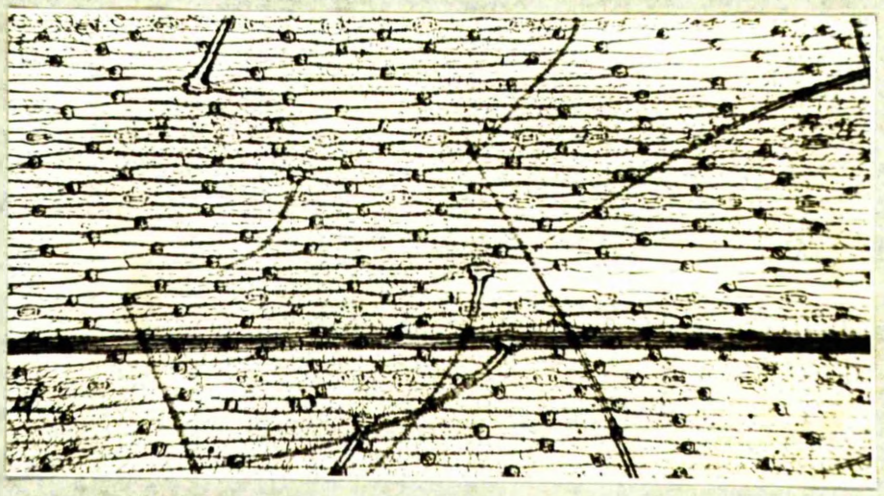
1. x 70

2. x 280

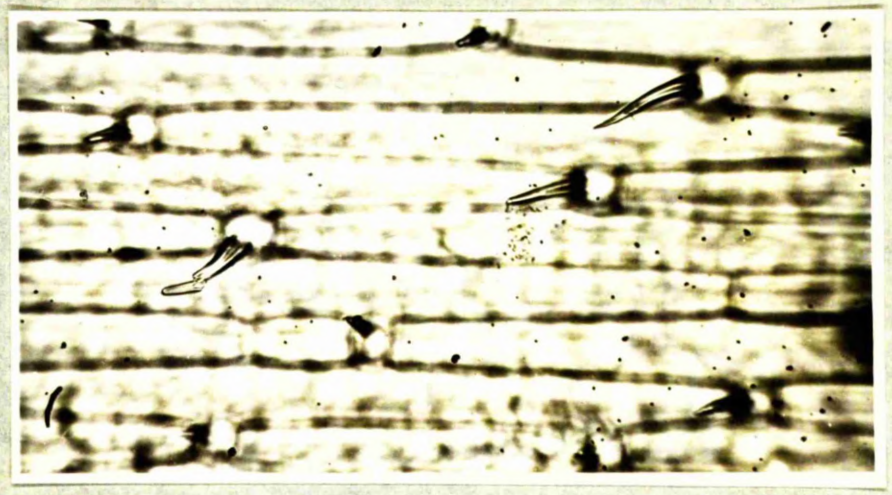
PLATE 16

Holcus lanatus L.

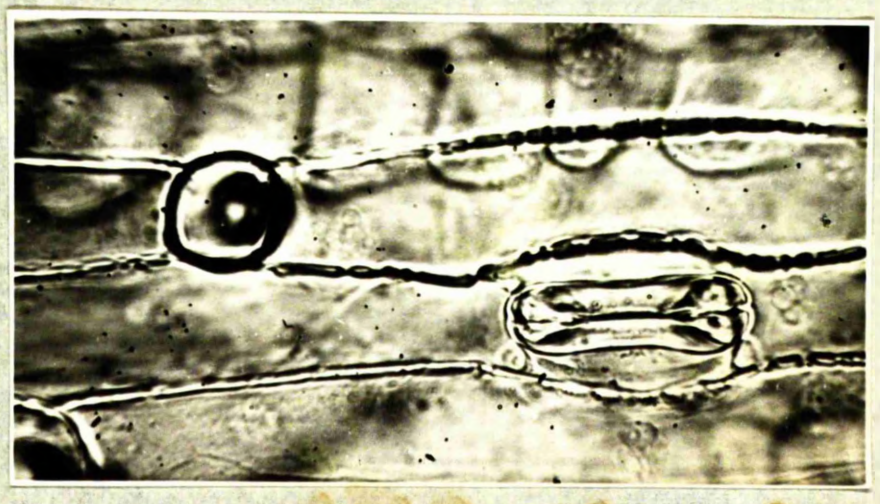
Leaf - Adaxial and Abaxial epidermis.



1. x 70



2. x 280

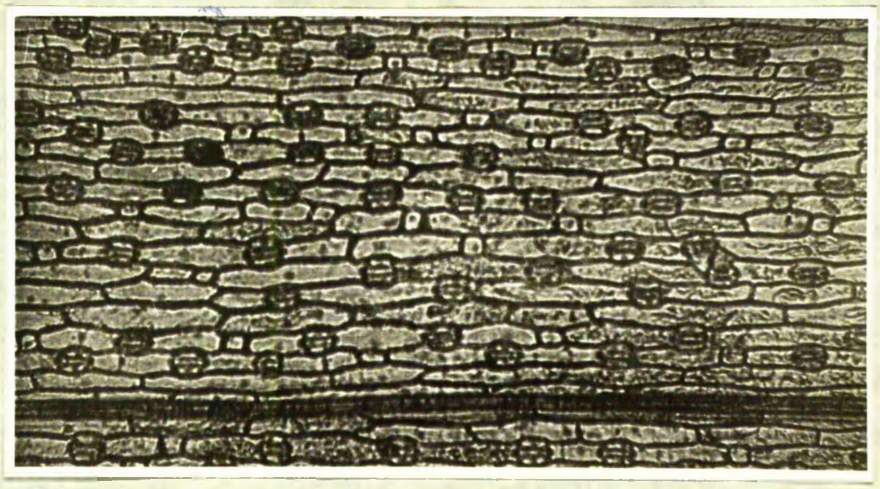


3. x 750

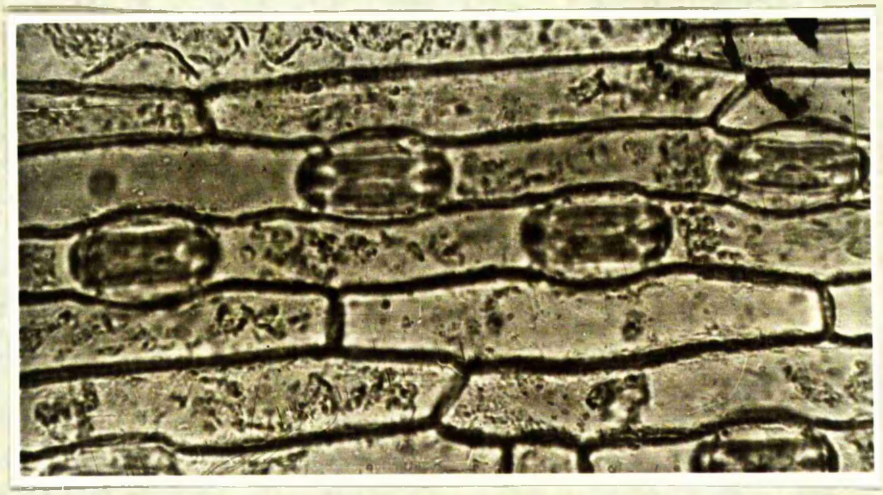
PLATE 17

Lolium perenne L.

Leaf - Adaxial epidermis.



1. x 70



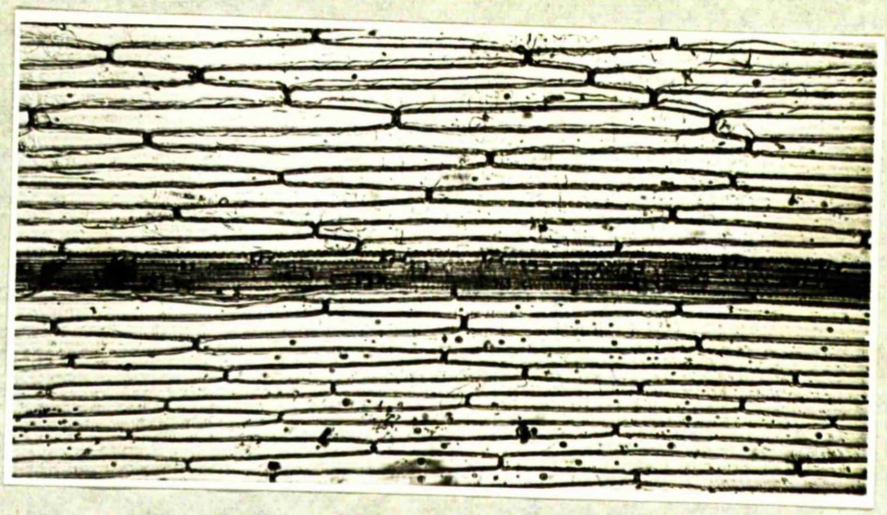
2. x 280

3. x 750

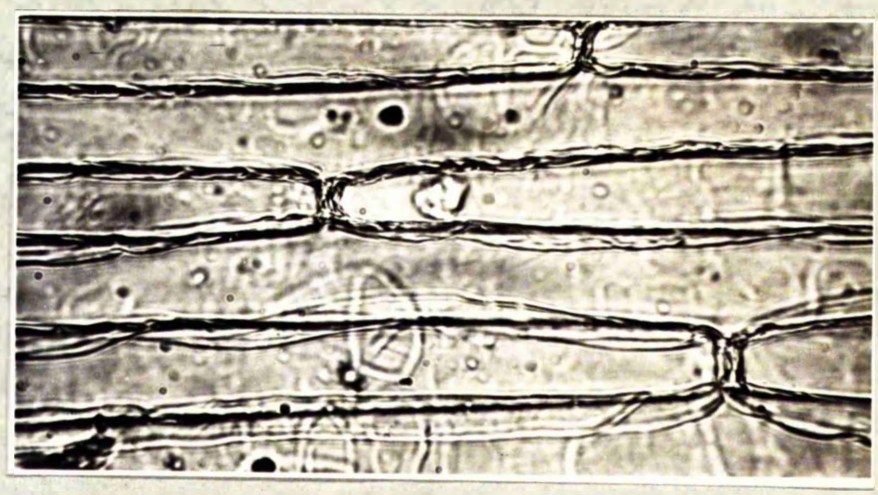
PLATE 18

Lolium perenne L.

Leaf - Abaxial epidermis.



1. x 70

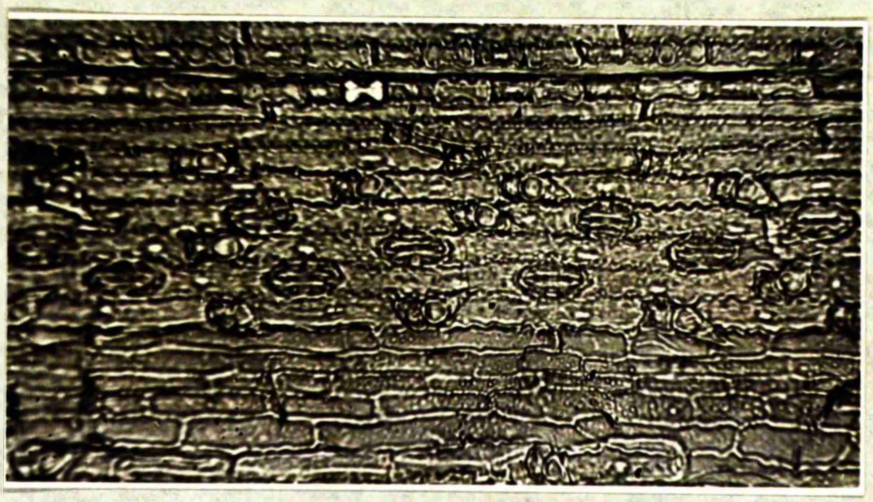


2. x 280

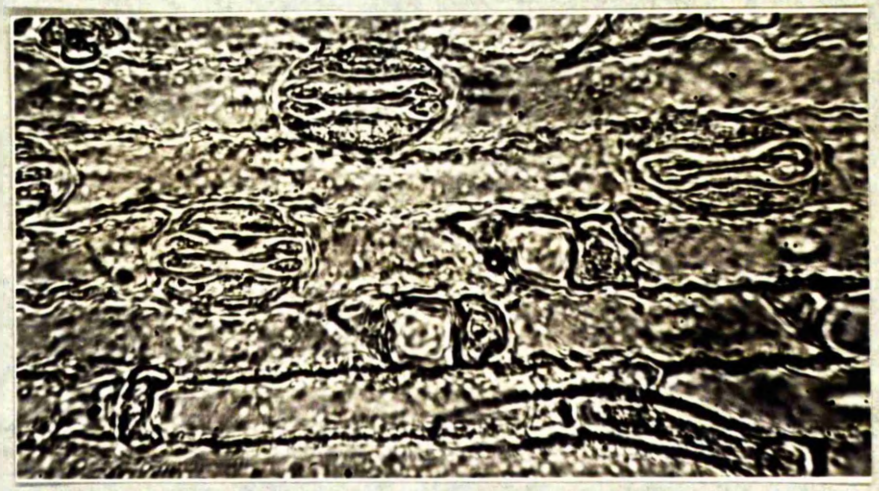
PLATE 19

Molinia caerulea (L.) Moench

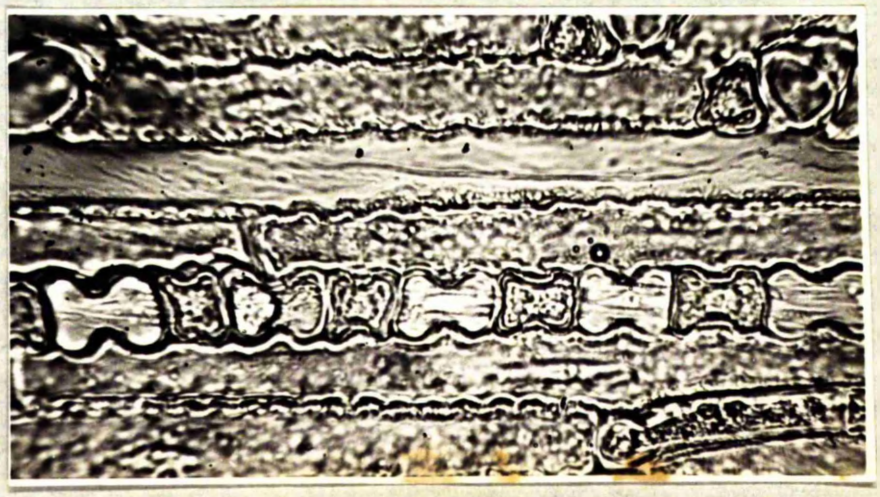
Leaf - Adaxial epidermis.



1. x 280



2. x 750



3. x 750

PLATE 20

Molinia caerulea (L.) Moench

Leaf - Abaxial epidermis.

1. x 280

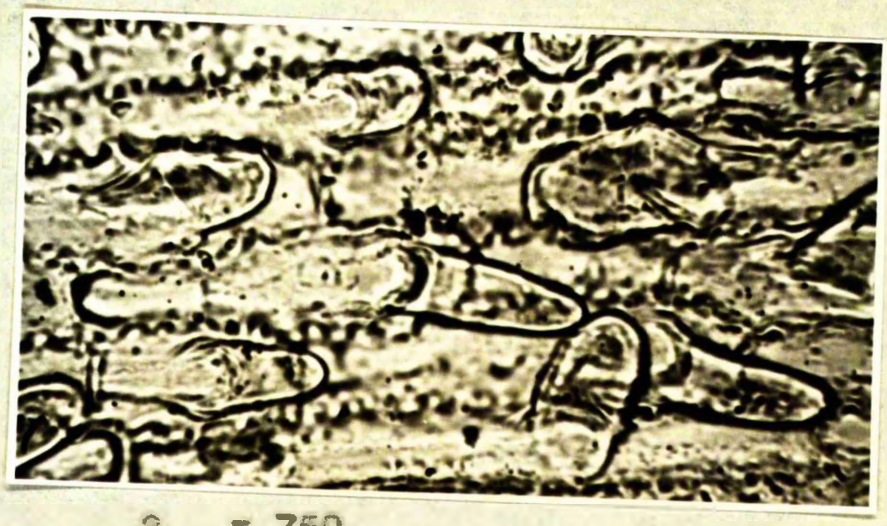
2. x 750

PLATE 21

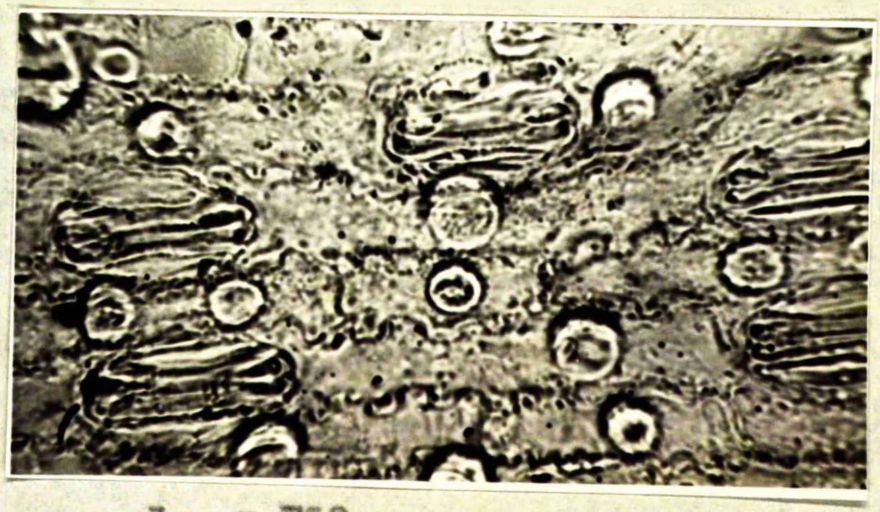
Nardus stricta L.

Leaf - Adaxial epidermis.

1. x 280



2. x 750

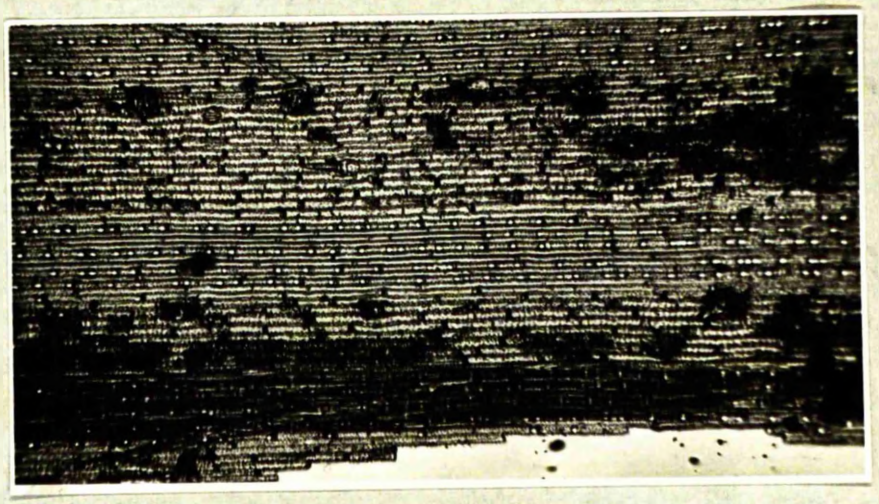


3. x 750

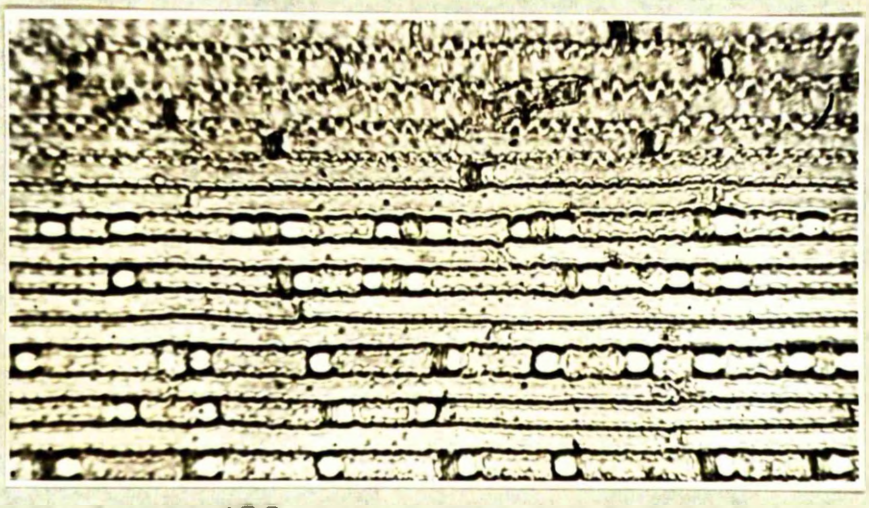
PLATE 22

Nardus stricta L.

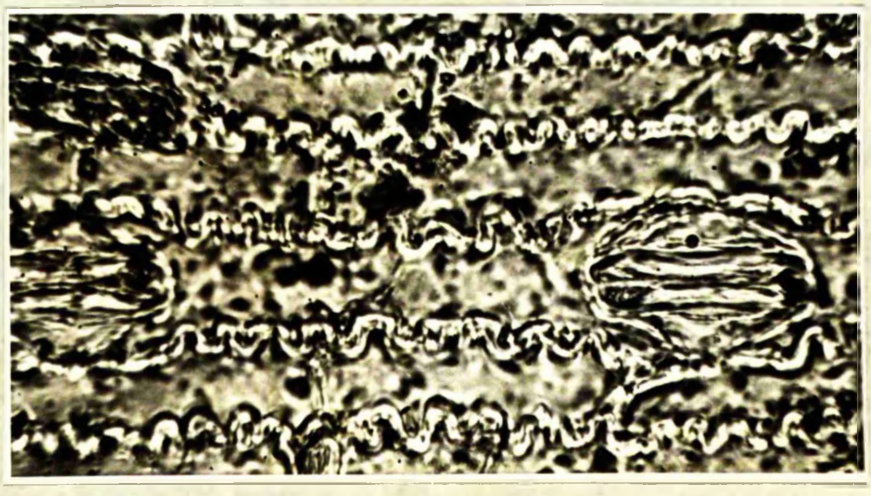
Leaf - Abaxial epidermis.



1. x 70



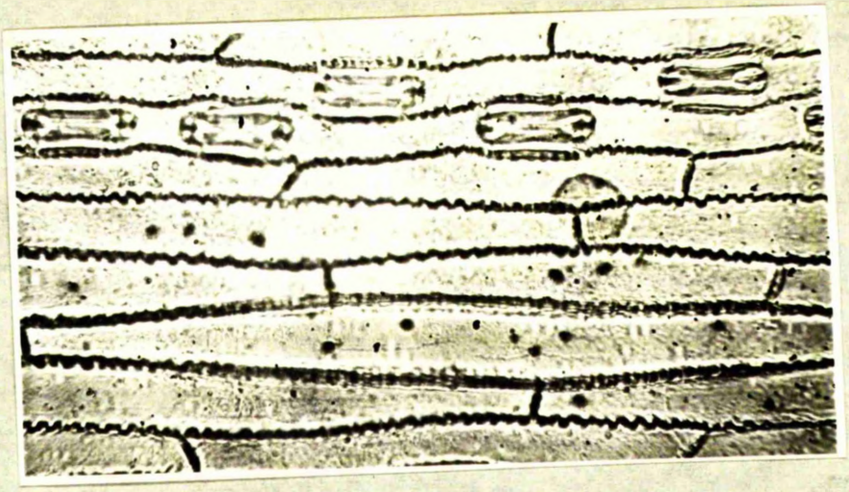
2. x 280



3. x 750

PLATE 23

Phleum pratense L.
Leaf - Adaxial epidermis.

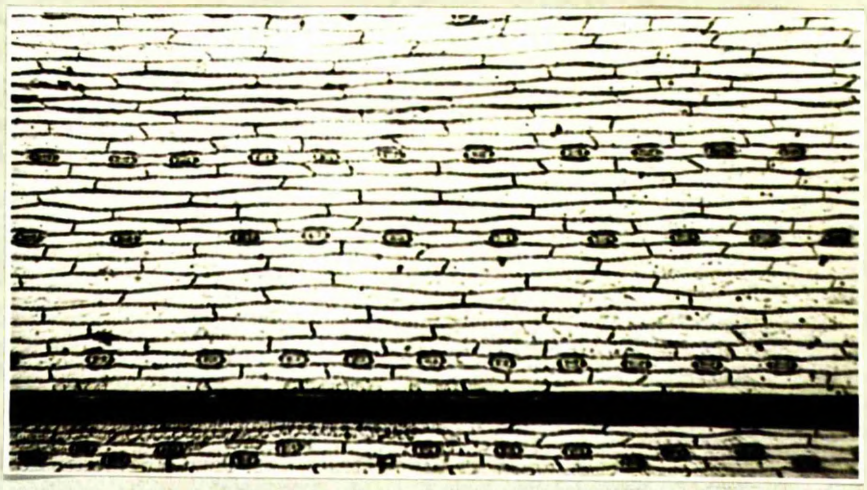


1. x 280

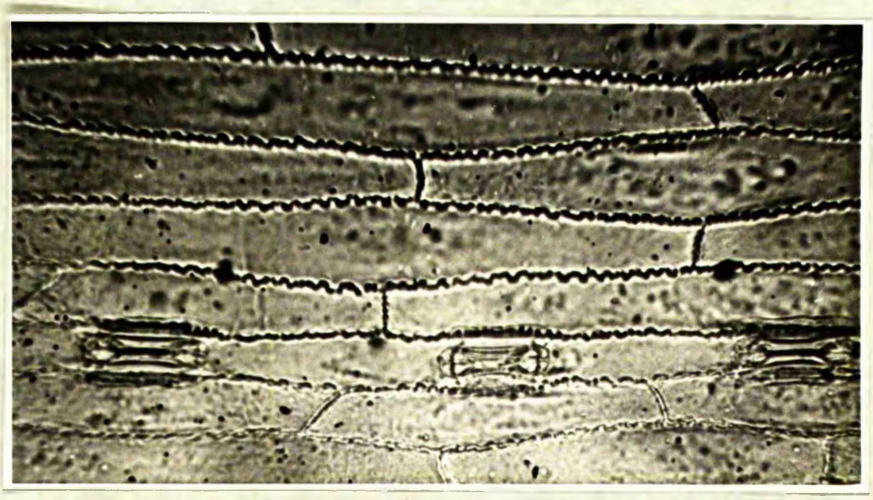
PLATE 24

Phleum pratense L.

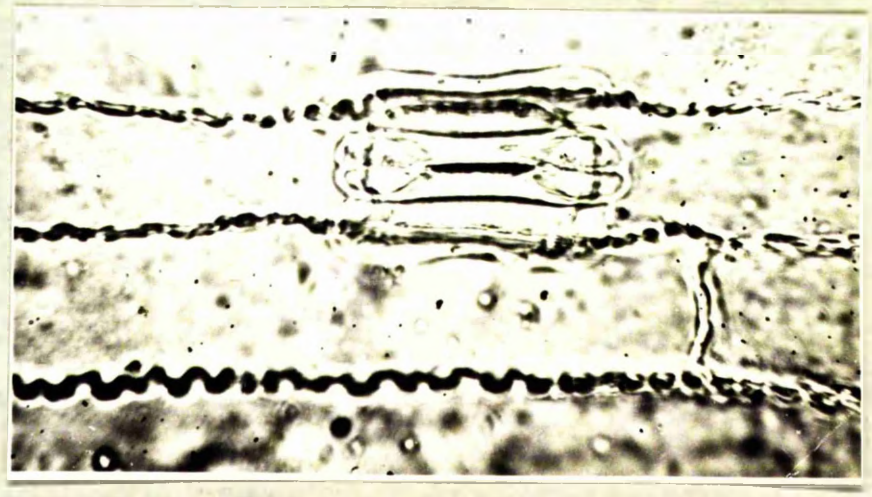
Leaf - Abaxial epidermis.



1. x 70



2. x 280

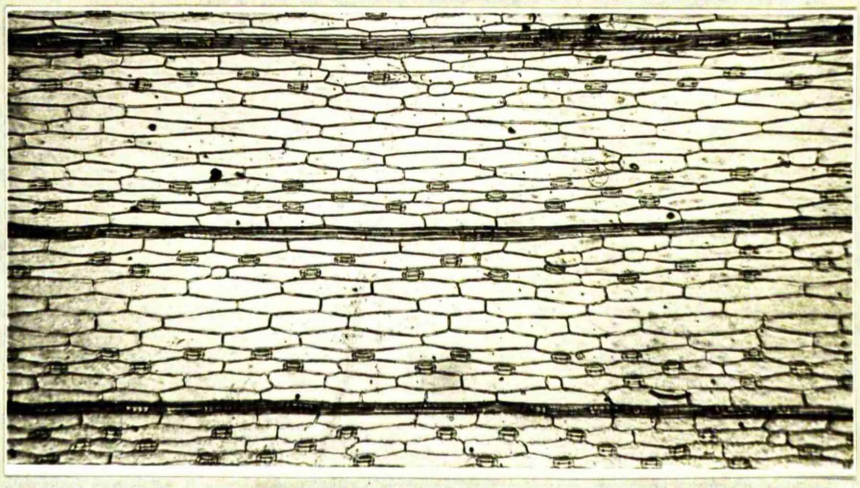


3. x 750

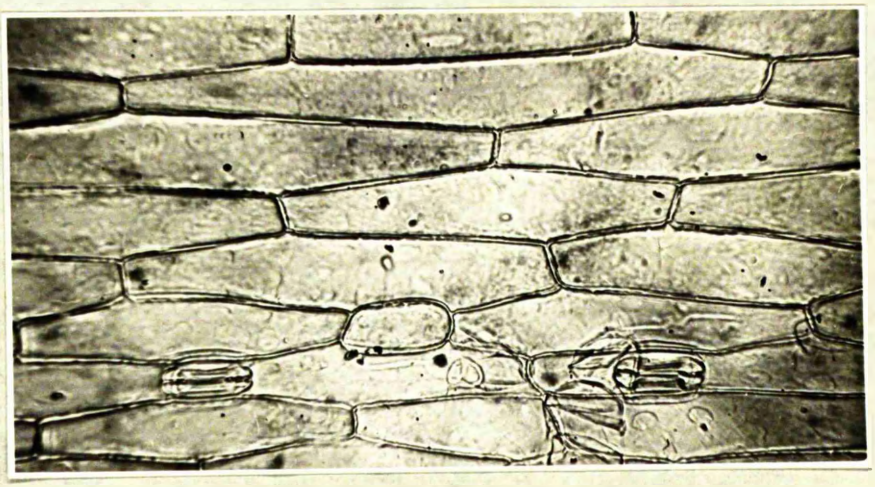
PLATE 25

Poa annua L.

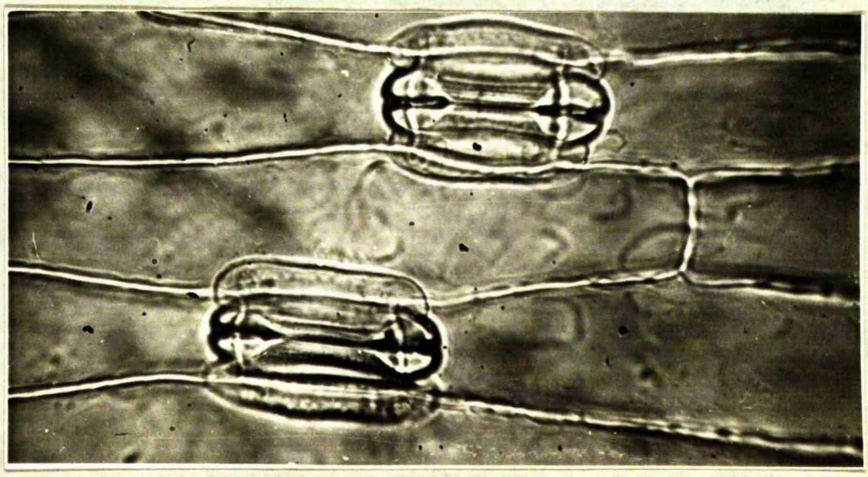
Leaf - Adaxial epidermis.



1. x 70



2. x 280

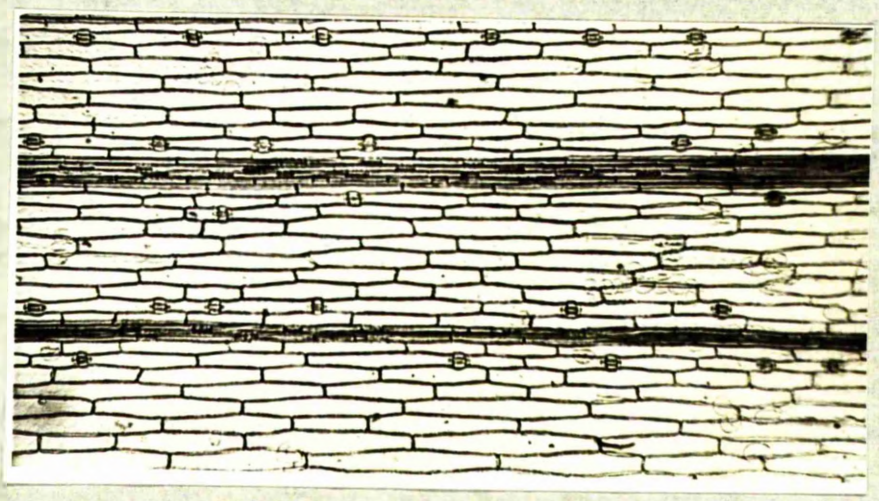


3. x 750

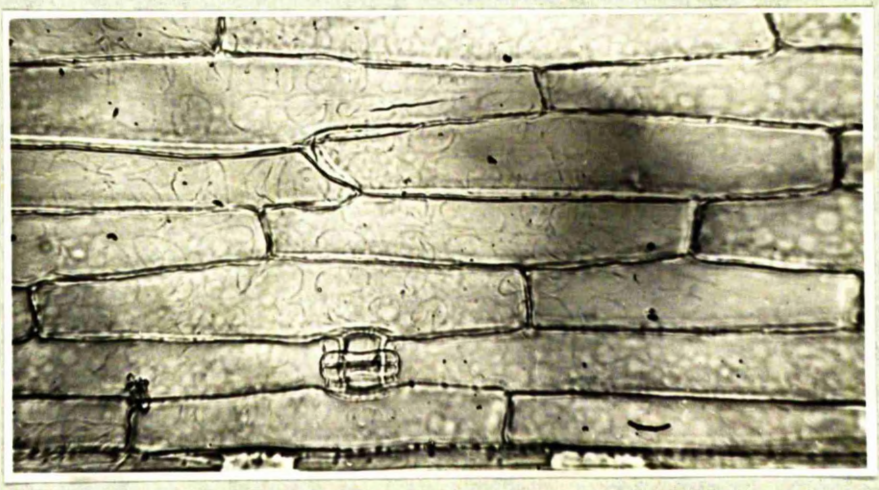
PLATE 26

Poa annua L.

Leaf - Abaxial epidermis.



1. x 70



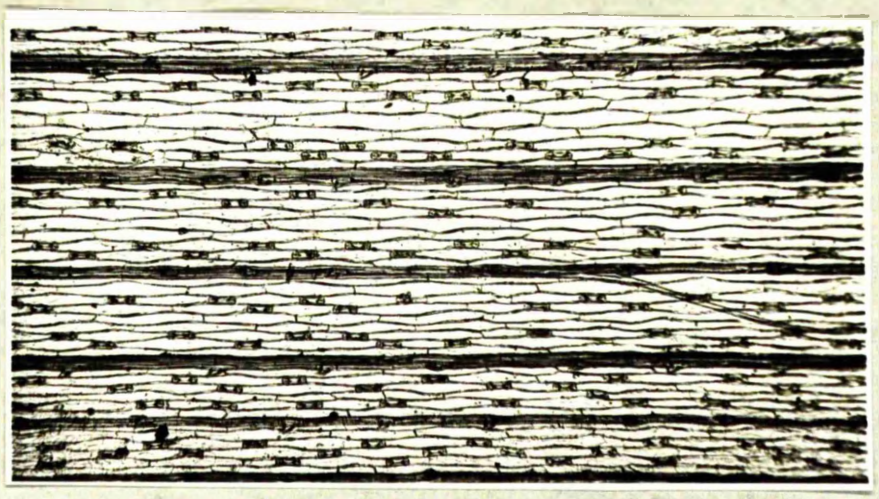
2. x 280

3. x 750

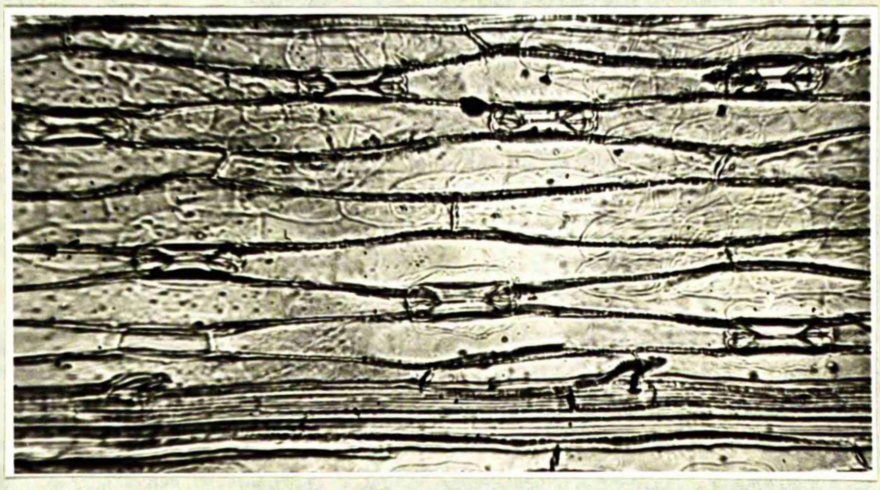
PLATE 27

Poa pratensis L.

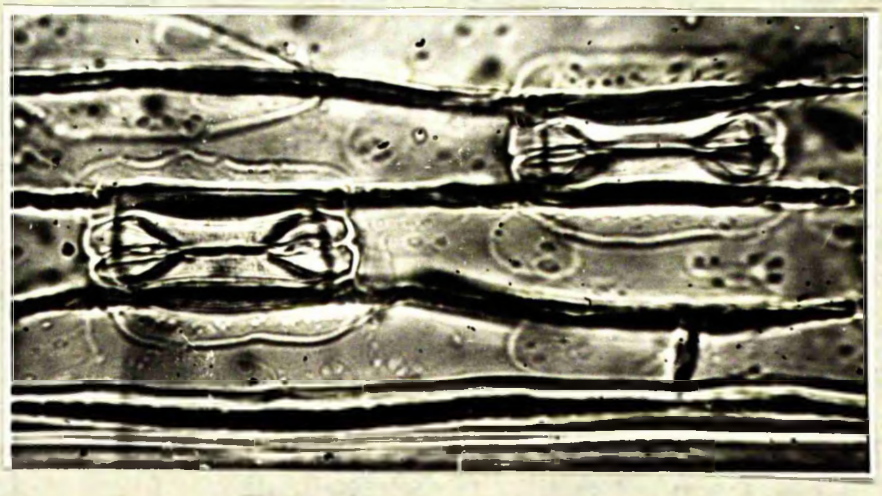
Leaf - Adaxial epidermis.



1. x 70



2. x 280

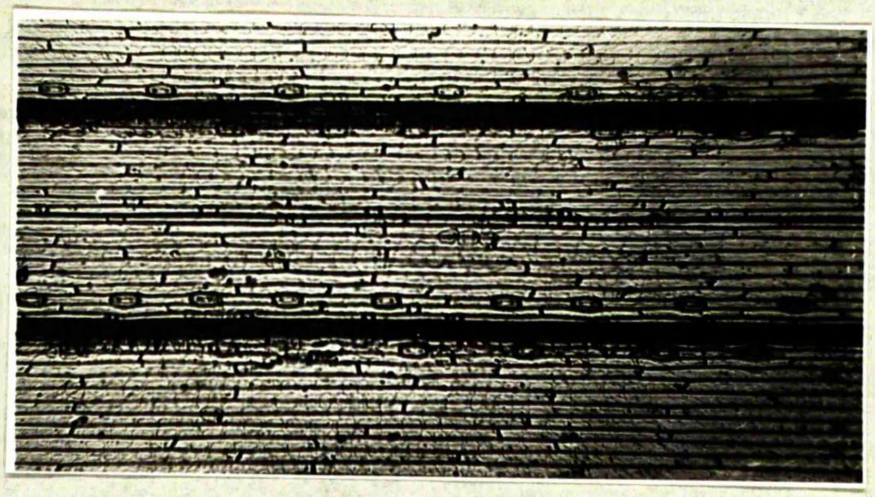


3. x 750

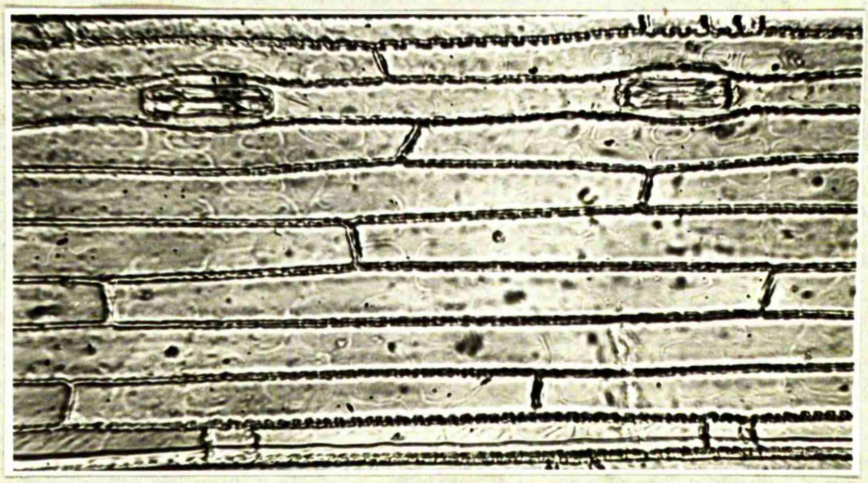
PLATE 28

Poa pratensis L.

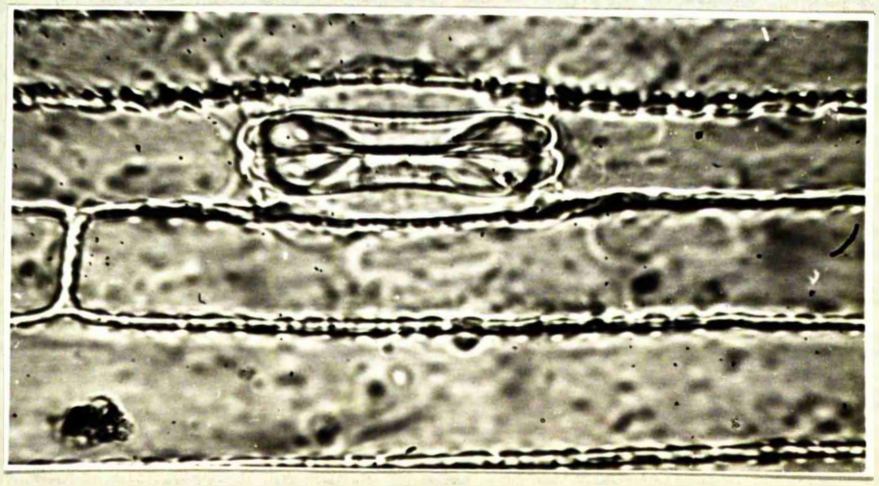
Leaf - Abaxial epidermis.



1. x 70



2. x 280

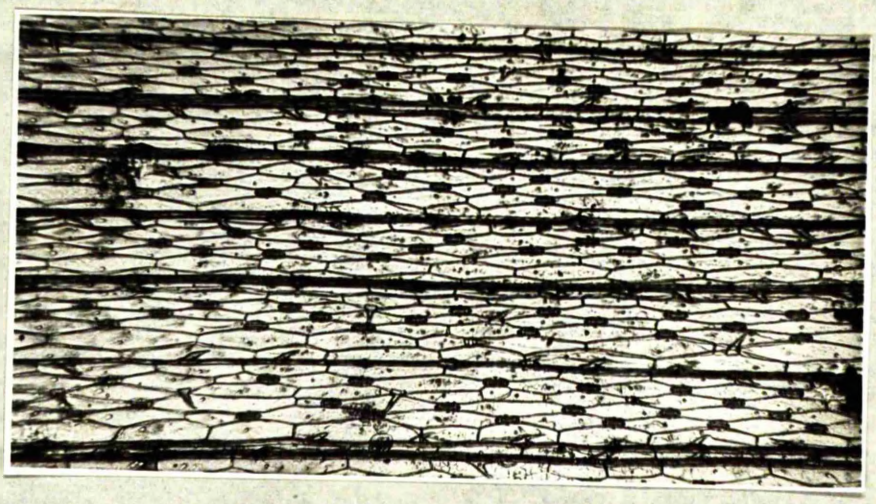


3. x 750

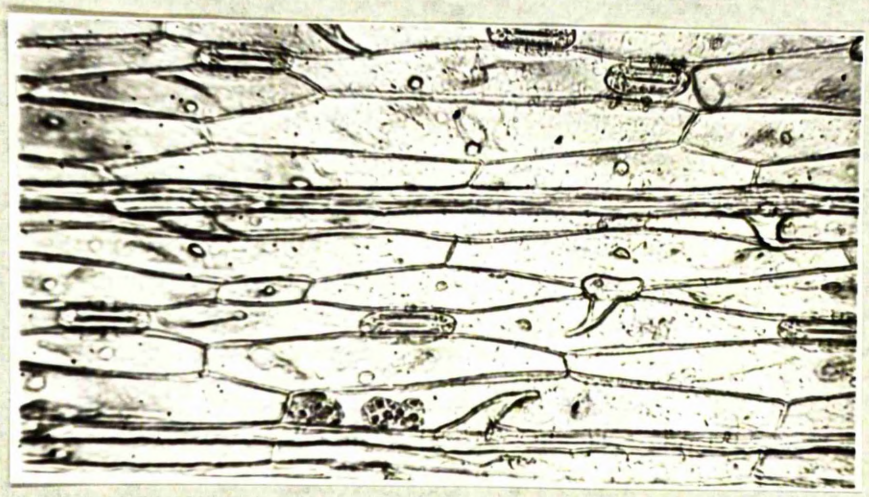
PLATE 29

Poa trivialis L.

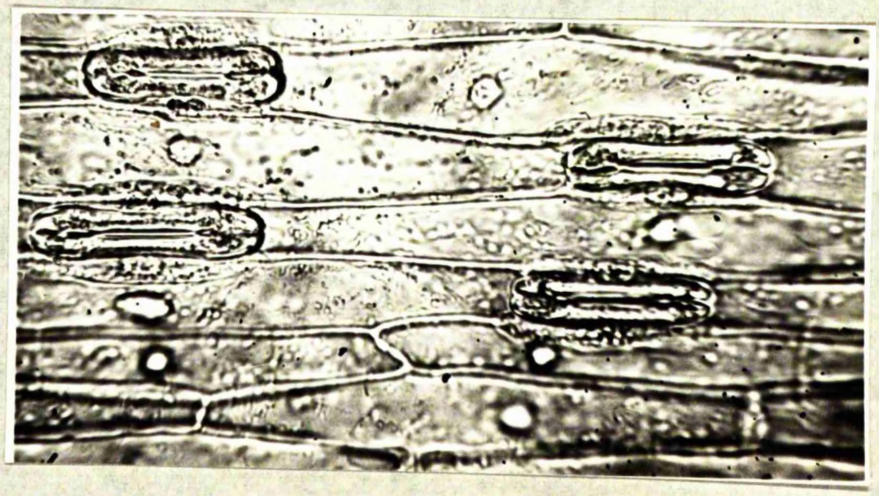
Leaf - Adaxial epidermis.



1. x 70



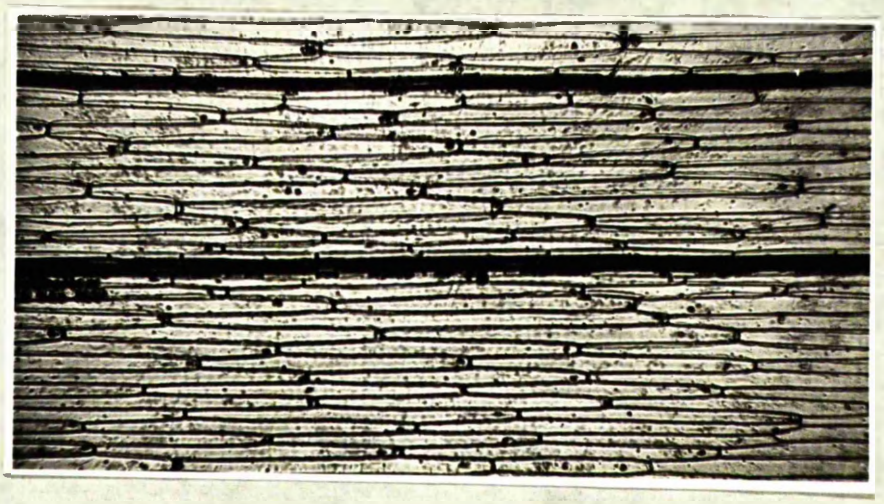
2. x 280



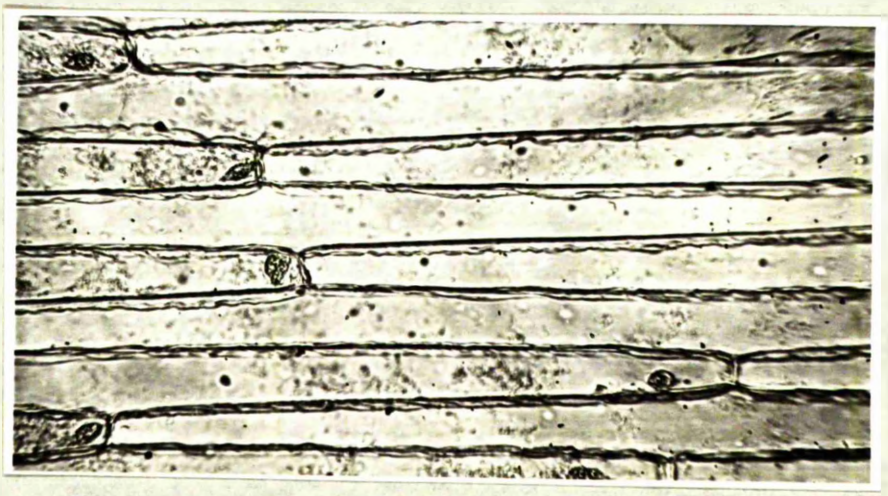
3. x 750

PLATE 30

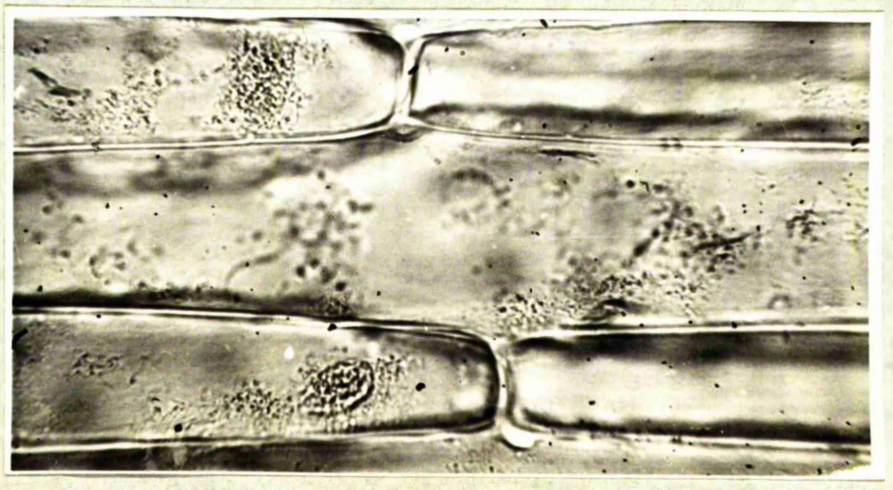
Poa trivialis L.
Leaf - Abaxial epidermis.



1. x 70



2. x 280



3. x 750

2. Cyperaceae

Carex echinata Murr. Plate 31

The undifferentiated cells on the adaxial surface are elongated and in regular rows. They measure 150 μ in length and 30 μ in breadth. They are thick-walled with coarse corrugations.

No differentiated cells were found on this surface.

The undifferentiated cells of the abaxial surface tend to be slightly smaller, with an average length of 125 μ and breadth of 25 μ. They are thick-walled with coarse corrugations.

Stomata occur in irregular rows. The stomatal group measures 50 μ by 40 μ; the subsidiary cells are triangular.

Carex nigra (L.) Reichard Plate 32

On the adaxial surface the cells measure 30-60 μ in length and are 20 μ in breadth. The walls are thick and corrugated. Occasionally the cells are expanded in width at one end.

No stomata or other differentiated cells were found on this surface.

The abaxial undifferentiated cells measure 20-40 μ in length and are some 15 μ in width. The walls are thick/

/thick and coarsely corrugated. Most of these cells are singly papillate.

The stomata are scattered. The stomatal cells measure 30 μ by 40 μ; the subsidiary cells are tall triangular.

Carex paniea L. Plates 33,34

The undifferentiated cells of the adaxial surface are in regular rows and measure 100-120 μ in length and are 30 μ in breadth. The walls are thick and coarsely corrugated.

No differentiated cells were found on this surface.

On the abaxial surface the cells are 50-90 μ in length and 20 μ wide. The walls are thick and coarsely corrugated. The cells are frequently papillate; single papillae occur in most of the undifferentiated cells but in those adjacent longitudinally to the stomata the papillae are double. These papillae overarch the stomatal pore to some extent.

The stomata are in irregular rows. The stomatal cells measure 50 μ by 40 μ; the subsidiary cells are tall hemicentric or triangular.

No other differentiated cells were found on this surface.

Eriophorum angustifolium Honck. Plates 35,36

On the adaxial surface the undifferentiated cells occur in irregular rows. They measure 50-70 μ in length and 25 μ in breadth. Shorter cells of 25 μ square occur occasionally. The walls are thick and finely corrugated.

The stomata are scattered. The stomatal cells measure 60 μ by 60 μ; the subsidiary cells are low hemispherical and are shorter than the guard cells.

On the abaxial surface the cells are in regular rows and they measure 65 μ by 35 μ. The walls are thick and finely corrugated.

No stomata or other differentiated cells were found on this surface.

Eriophorum vaginatum L. Plate 37

On this stem the costal area cells measured 40-60 μ by 25 μ in breadth. The walls are thick and coarsely corrugated. The inter-costal undifferentiated cells are less regular in length than those above.

The stomata occur in narrow bands, two or three rows wide. The stomatal cells measure 50 μ by 40 μ; the subsidiary cells are low hemispherical.

Trichophorum caespitosum (L.) Hartman Plate 38

The undifferentiated cells of the flowering stem are 120-180 μ long and 20 μ wide. The walls are thick and coarsely corrugated.

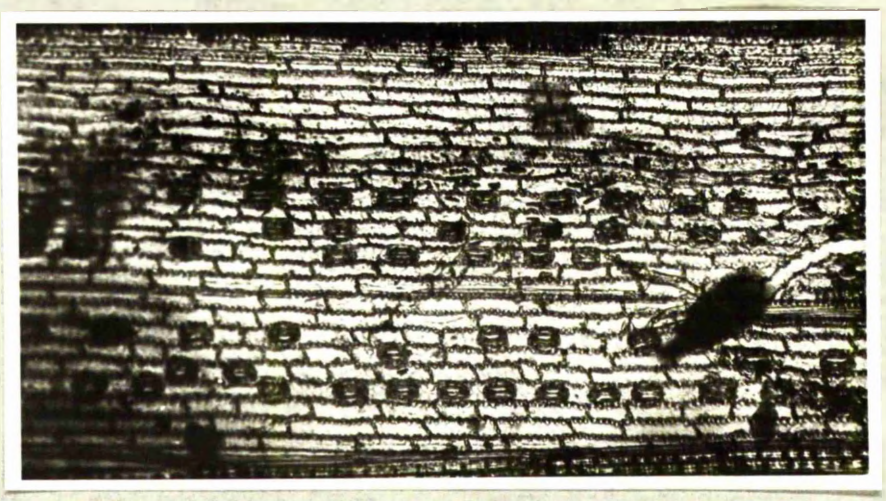
The stomata occur in irregular rows in the inter-costal areas. The stomatal cells measure 60 μ by 40 μ; the subsidiary cells are low hemispherical or straight sided.

No other differentiated cells were found on the epidermis of this stem.

PLATE 31

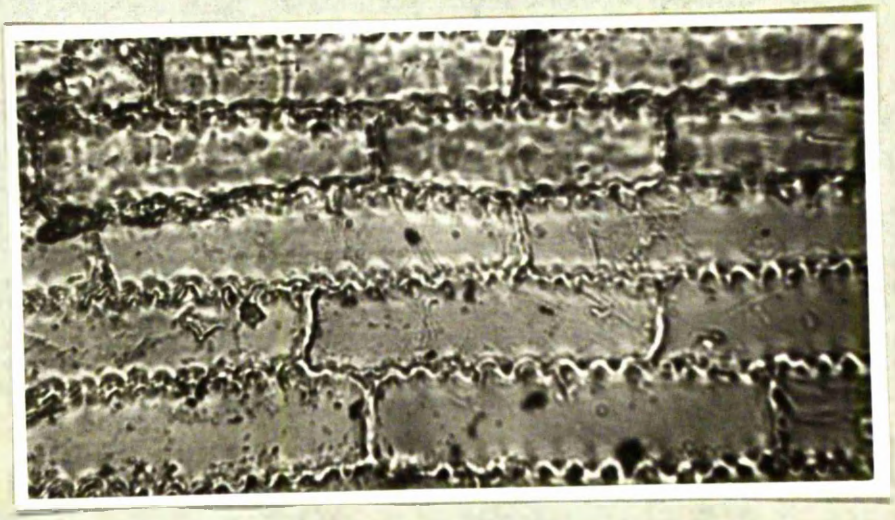
Carex schinata Murr.

Leaf - Adaxial epidermis.

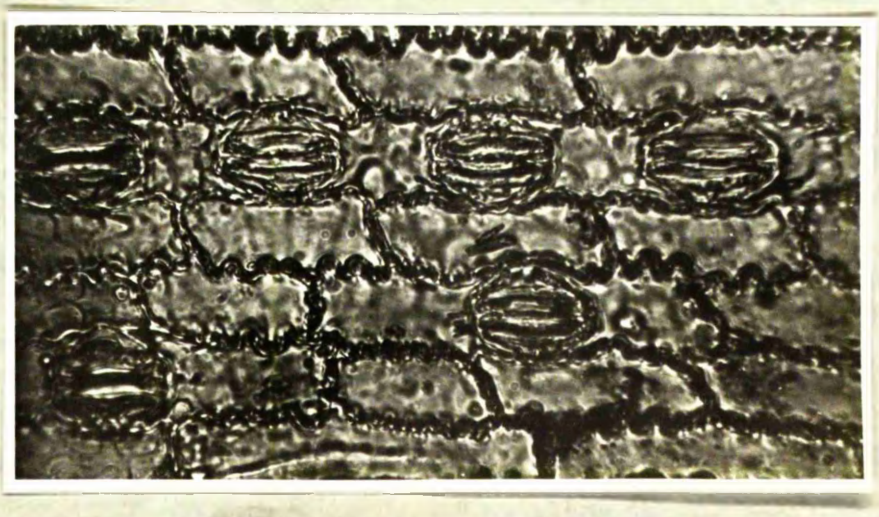


1. x 280

Leaf - Abaxial epidermis.



1. x 280

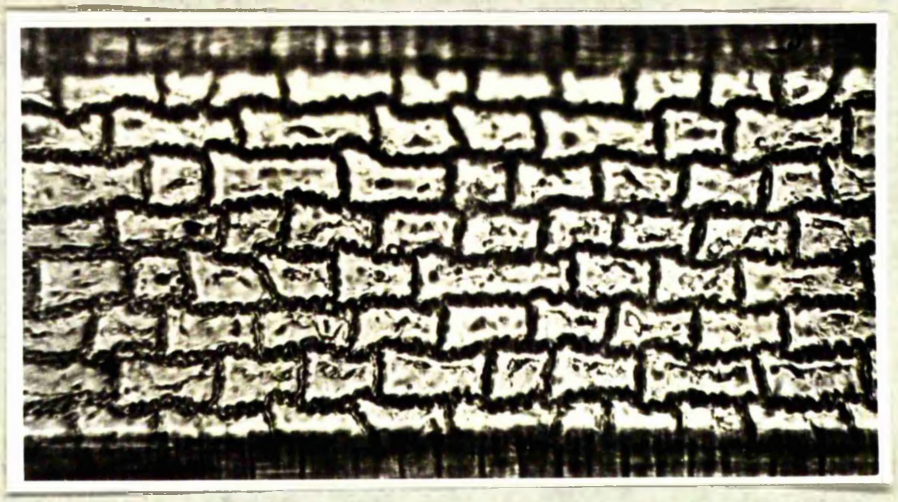


2. x 750

PLATE 32

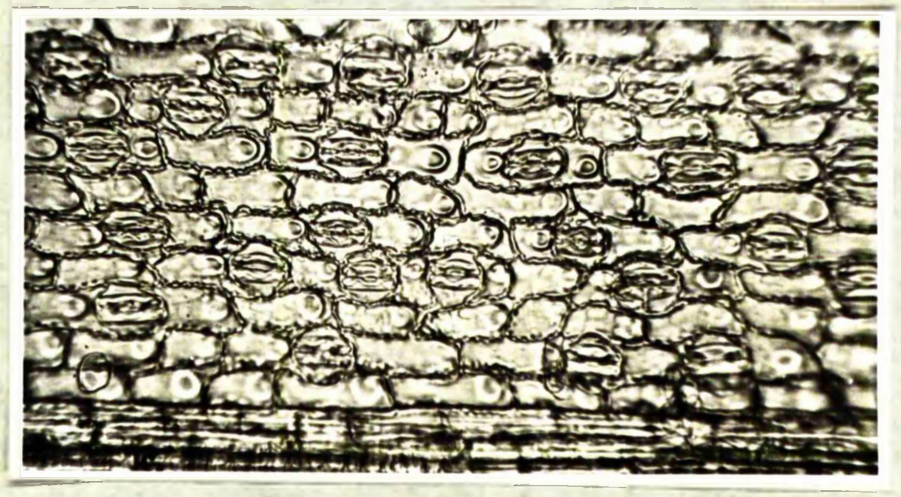
Carex nigra (L.) Reichard

Leaf - Adaxial epidermis.

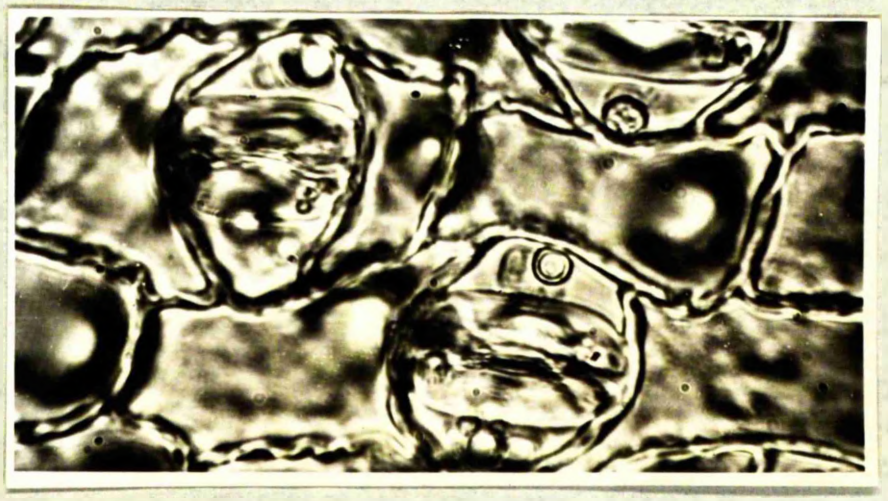


1. x 280

Leaf - Abaxial epidermis.



1. x 280

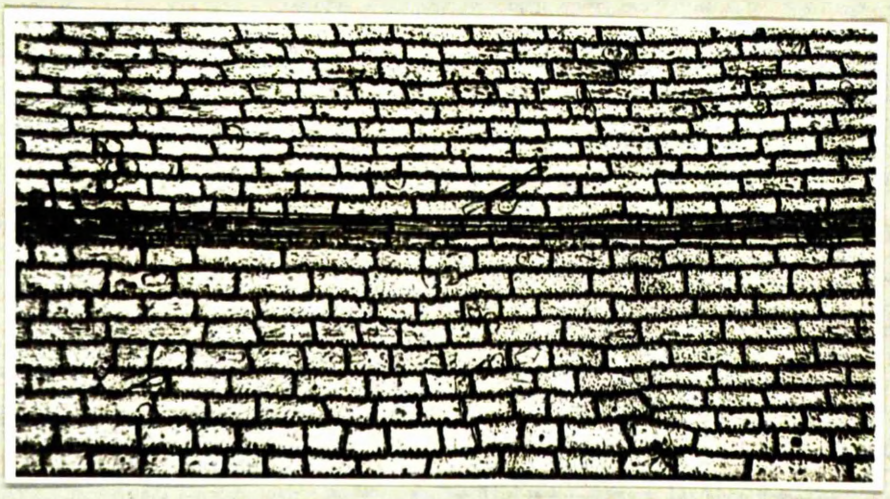


2. x 750

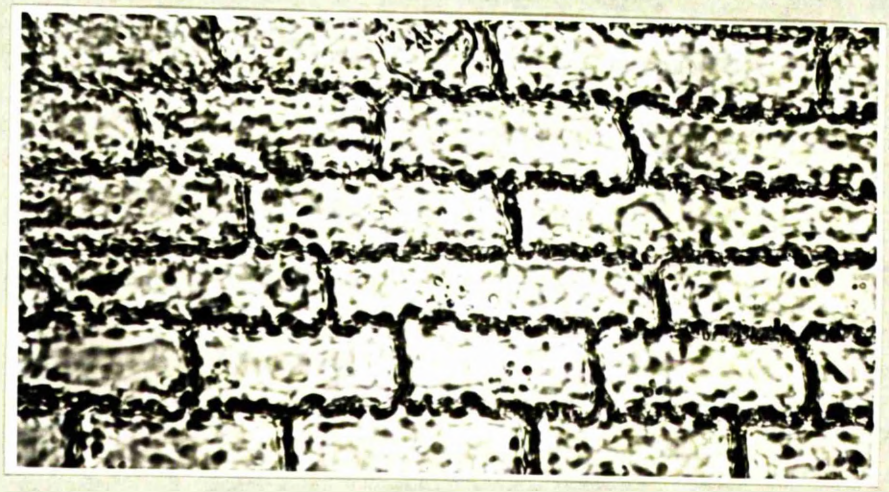
PLATE 33

Carex paniculata L.

Leaf - Adaxial epidermis.



1. x 70

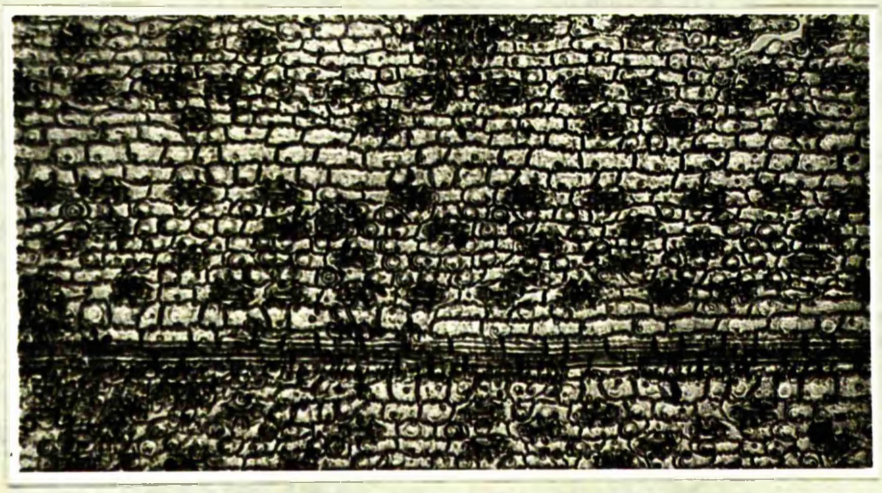


2. x 280

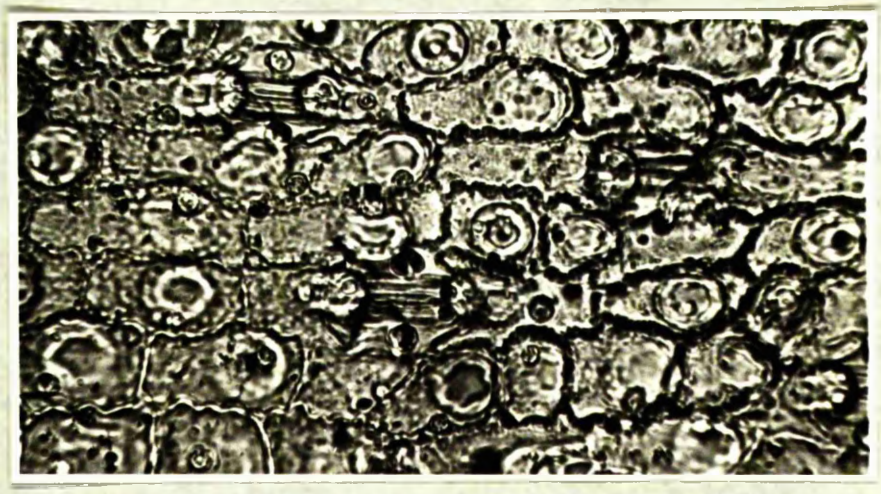
PLATE 34

Carex panicea L.

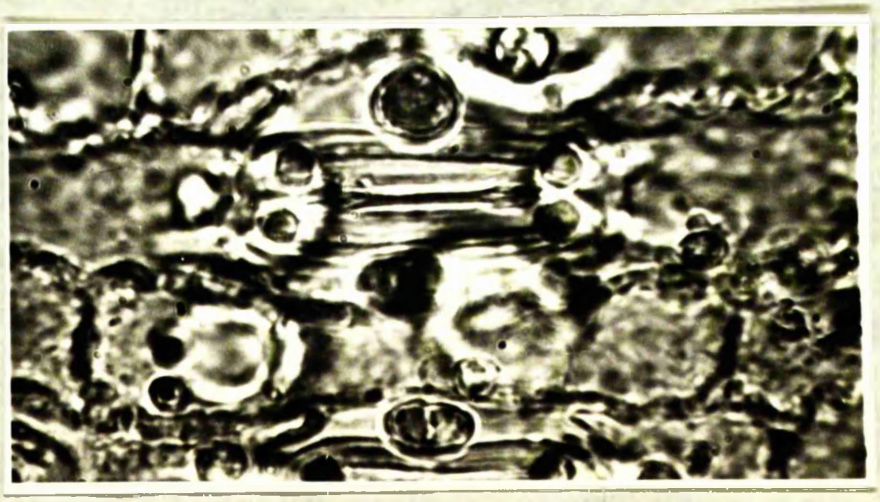
Leaf - Abaxial surface.



1. x 70



2. x 280

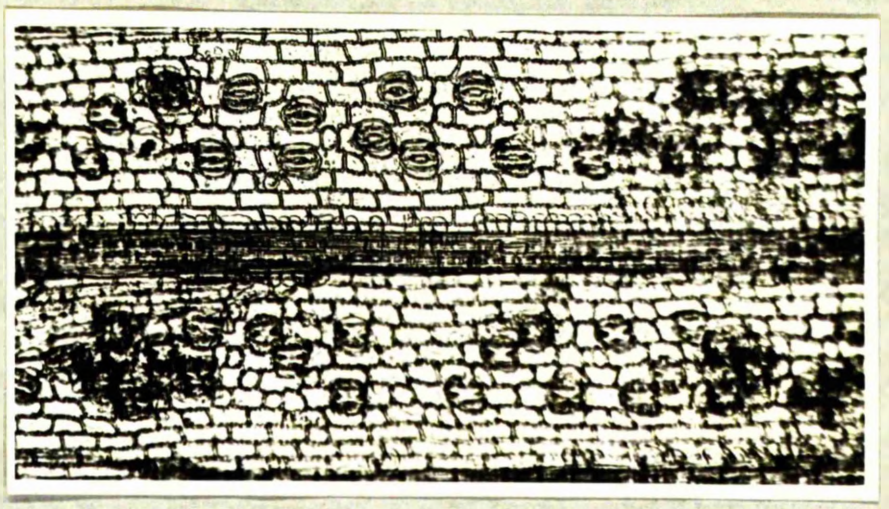


3. x 750

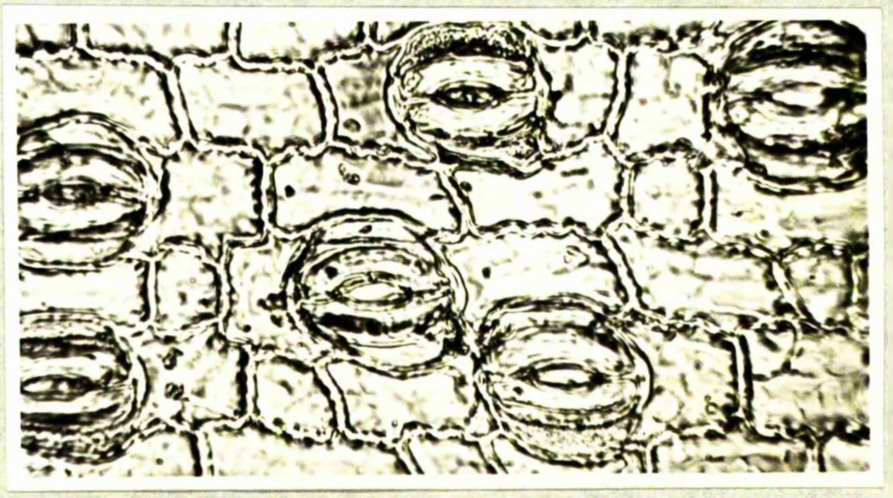
PLATE 35

Eriophorum angustifolium Honck.

Leaf - Adaxial epidermis.



1. x 70

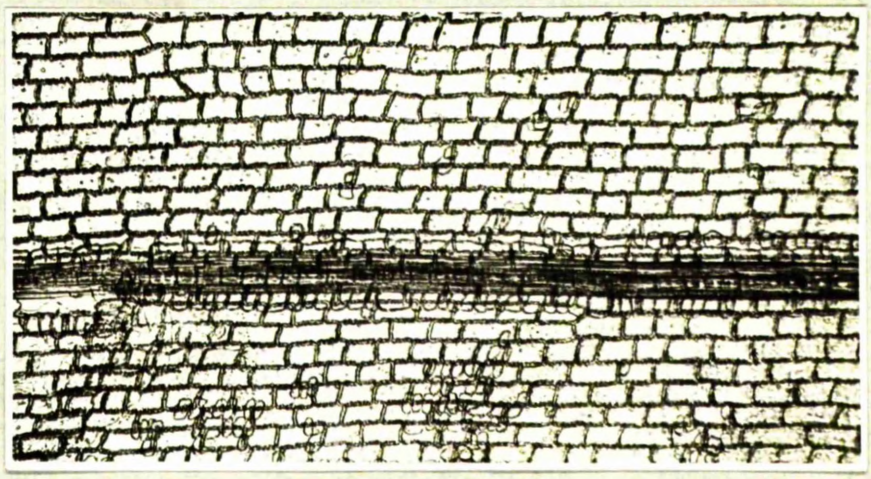


2. x 280

PLATE 36

Eriophorum angustifolium Honck.

Leaf - Abaxial epidermis.



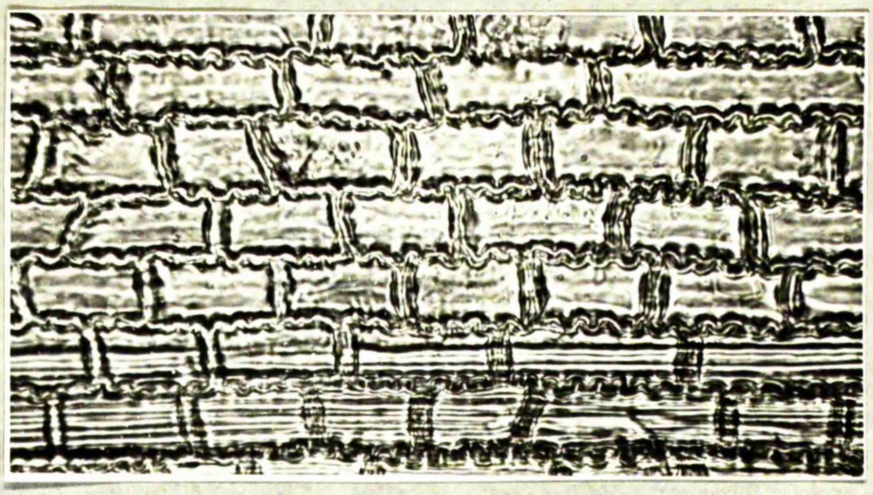
1. x 70

2. x 280

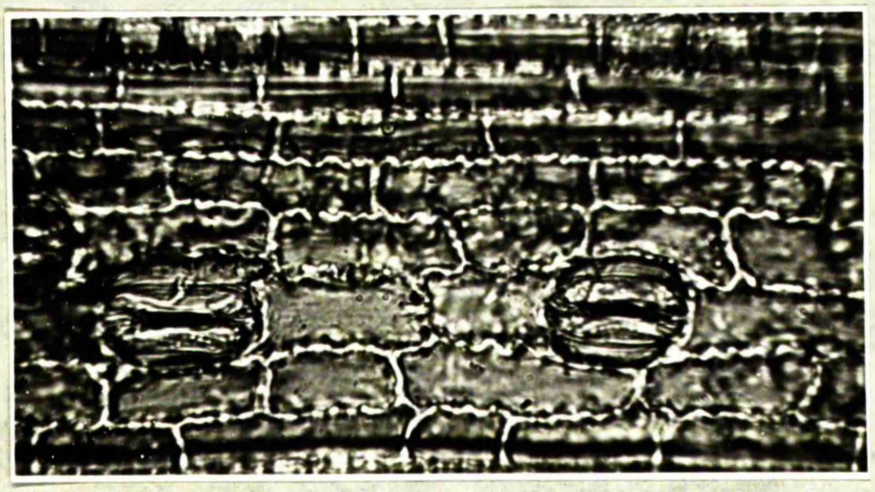
PLATE 37

Eriophorum vaginatum L.

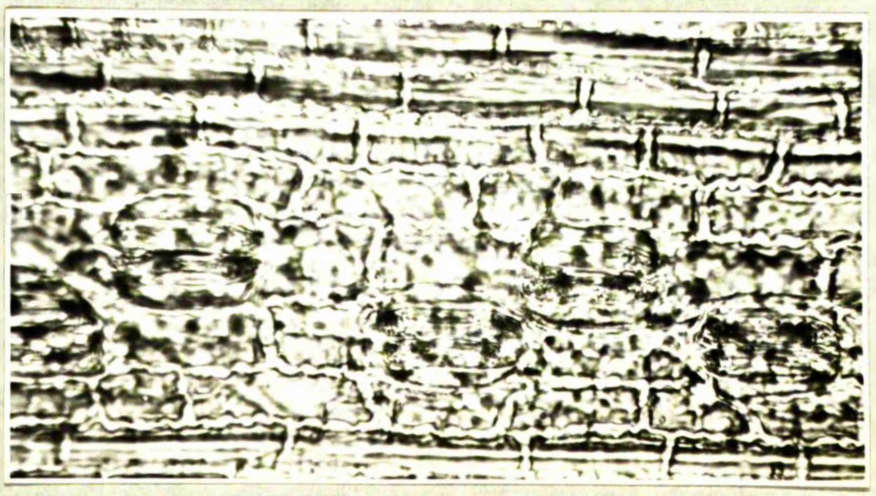
Leaf epidermis.



1. x 280



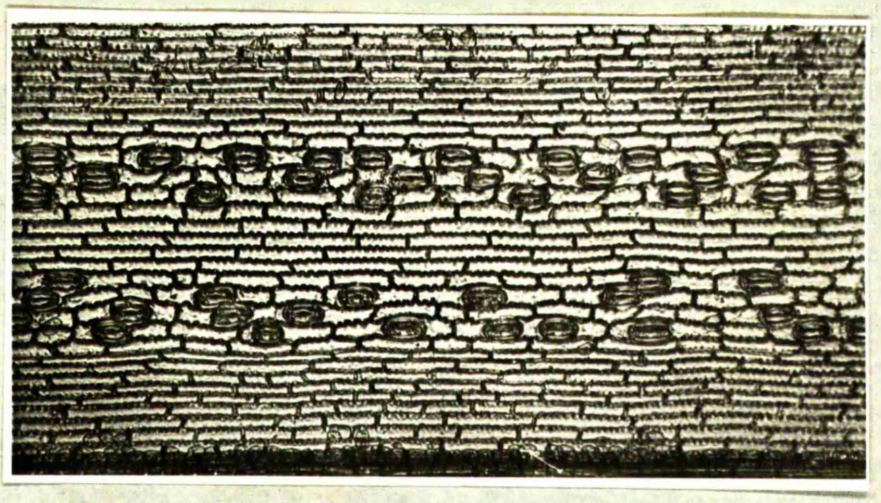
2. x 280



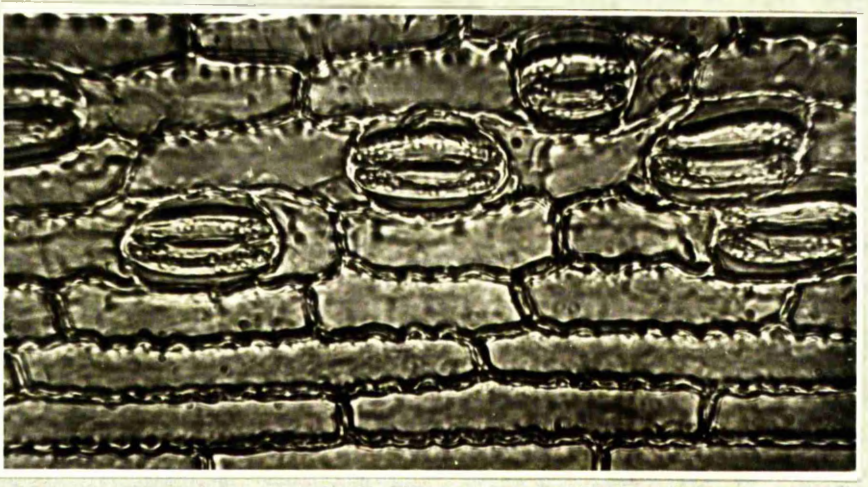
3. x 280

PLATE 38

Trichophorum caespitosum (L.) Hartman
Flowering stem epidermis.



1. x 70



2. x 280

3. Juncaceae

Juncus articulatus L. Plate 39

On the aerial parts of this plant the undifferentiated cells measure 100-125 u in length and are 25 u wide. The walls are thick and are barely corrugated.

The stomata are in rows distributed generally over the epidermis. They are separated longitudinally by usually one undifferentiated cell. The stomatal cells measure 40 u by 35 u; the subsidiary cells are low hemispherical.

No other differentiated cells were found.

Juncus effusus L. Plate 40

The undifferentiated cells vary considerably in length but are usually within the range 50-80 u long and 20 u broad. The walls are thick, with frequent cellulose outgrowths into the cell.

The stomata are scattered. The stomatal cells measure 30 u by 30 u; the subsidiary cells are tall hemispherical.

Juncus squarrosus L. Plate 41

On the adaxial surface the undifferentiated cells are 40-80 μ in length and 15 μ in width. The walls are thick and smooth, occasionally undulating.

The stomata are generally distributed. The stomatal cells measure 30 μ by 25 μ; the subsidiary cells are low hemi-spherical or straight sided.

On the abaxial surface the undifferentiated cells measure 80-100 μ in length and 25-30 μ in breadth. The walls are thick with cellulose outgrowths into the cell which give the wall a coarse appearance.

No other differentiated cells were found.

Luzula pilosa (L.) Willd. Plates 42,43

On the adaxial surface the undifferentiated cells measure 50-150 μ in length with an average of 90 μ. They are 20 μ broad. The walls are thick and coarsely corrugated.

Stomata occur in irregular rows in the inter-costal area and are usually separated longitudinally by one, or more, epidermal cells. The stomatal cells measure 30 μ by 30 μ; the subsidiary cells are straight sided.

On the abaxial surface the cells are in irregular rows. They are almost isodiametric, measuring some

40/

/40 μ across. The walls are thin and flexuous.

No other differentiated cells were found.

Luzula campestris (L.) DC. Plates 44,45

On the adaxial surface the undifferentiated cells are 60-110 μ in length and are 25 μ wide, tapering slightly. The walls are thick and are finely corrugated.

The stomata occur in rows in the inter-costal area. The stomatal cells measure 40 μ by 30 μ; the subsidiary cells are straight sided.

On the abaxial surface the cells occur in irregular rows. The cells are not truly rectangular. The walls are thin and pitted. The cells vary in diameter from 50-80 μ.

No other differentiated cells were found.

Luzula sylvatica (Huds.) Gaud. Plates 46,47

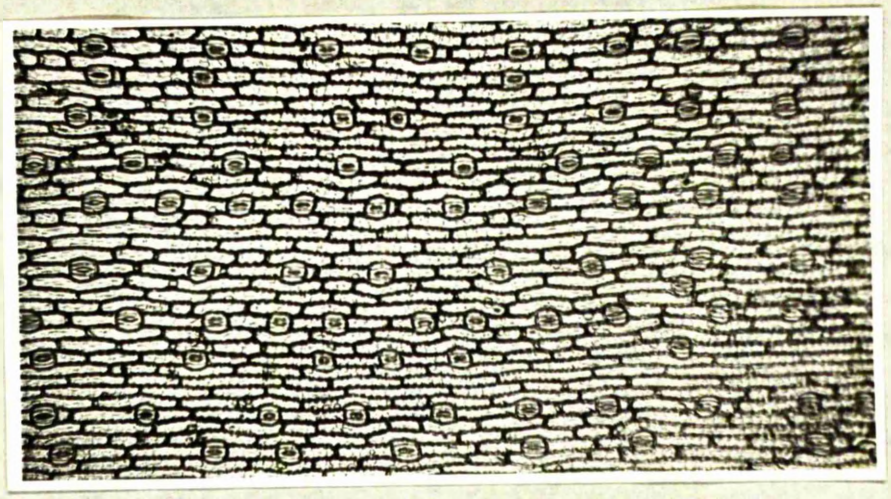
On the adaxial surface the undifferentiated cells are usually 100-130 μ in length with occasional short cells of 30-50 μ length. They are all about 20 μ wide. The walls are thick and corrugated.

The stomata are confined to the inter-costal areas in irregular rows. The stomatal cells measure 30 μ by 25 μ; the subsidiary cells are tall dome-shaped.

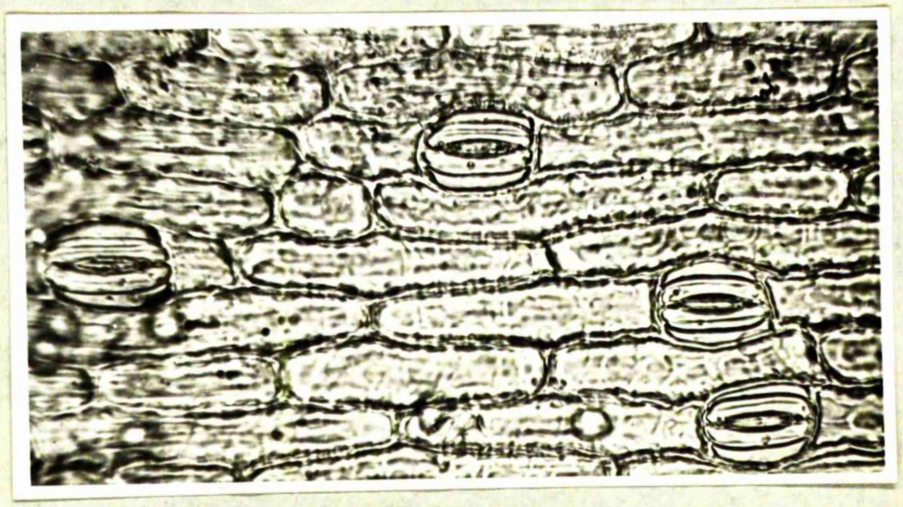
On the abaxial surface the cells are in regular rows. They measure from 60-120 μ in length and 25 μ in width.

PLATE 39

Juncus articulatus L.
Leaf epidermis.



1. x 70

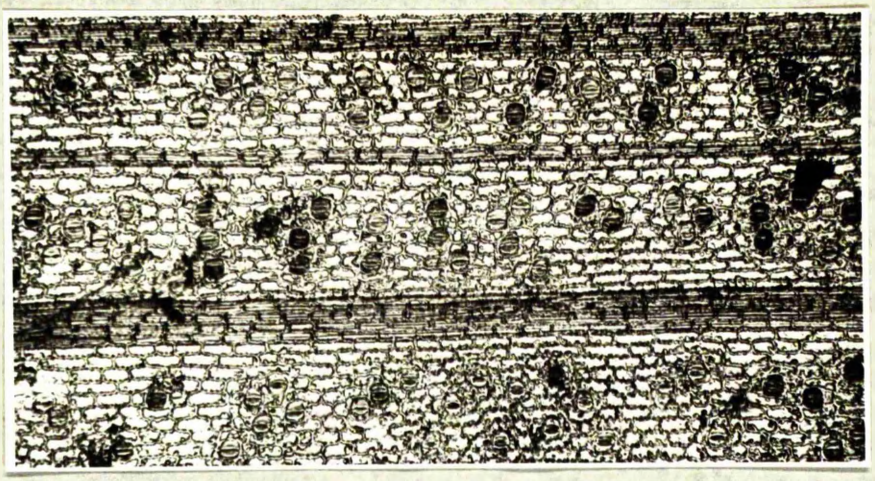


2. x 280

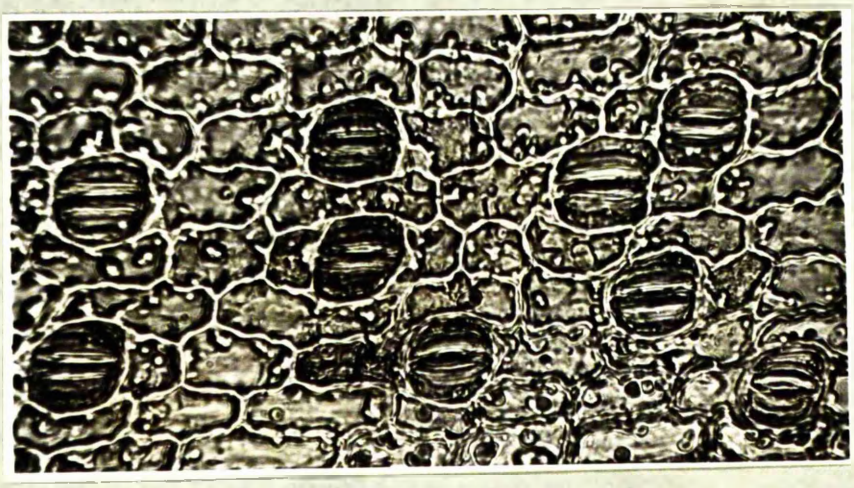
3. x 750

PLATE 40

Juncus effusus L.
Stem epidermis.



1. x 70



2. x 280

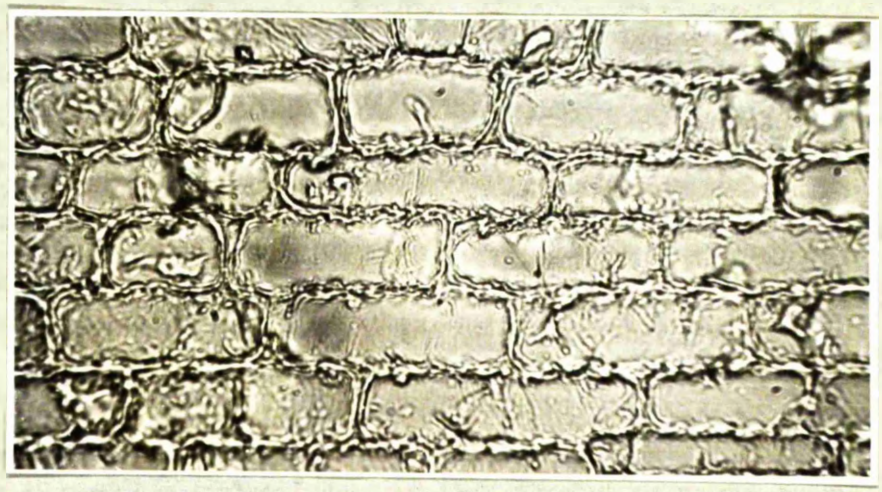
PLATE 41

Juncus squarrosus L.

Leaf - Adaxial epidermis.

1. x 280

Leaf - Abaxial epidermis.

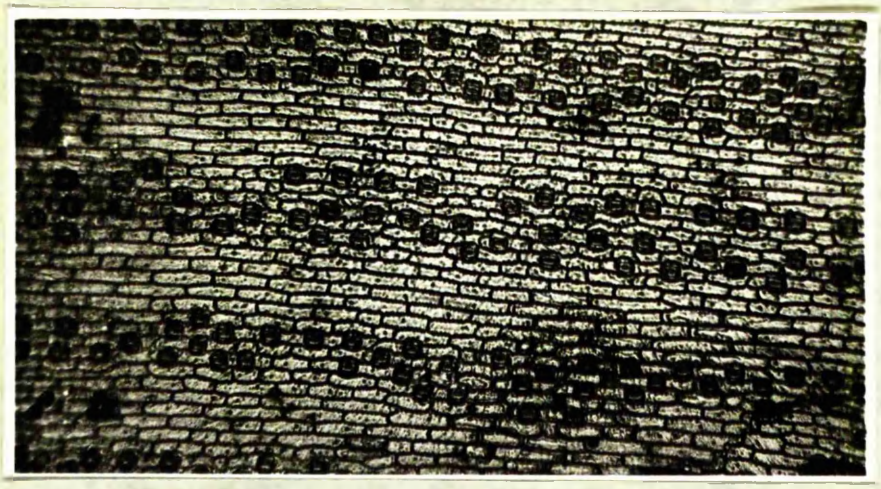


2. x 280

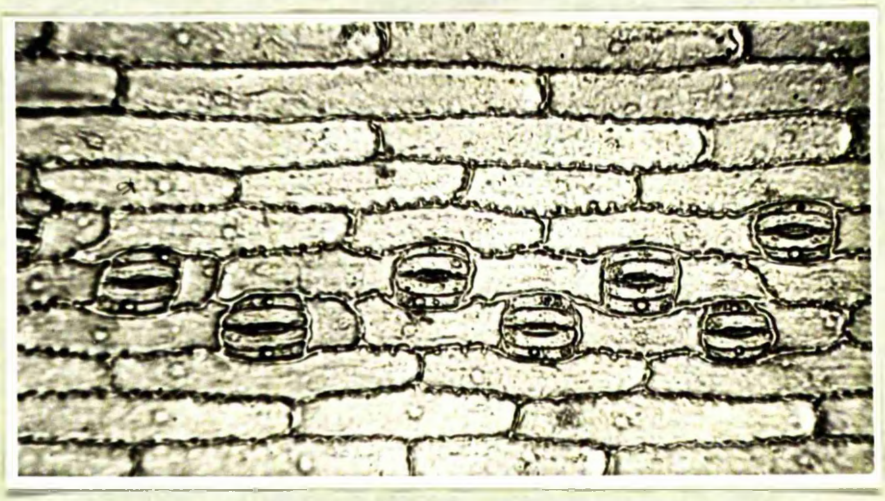
PLATE 42

Luzula pilosa (L.) Willd.

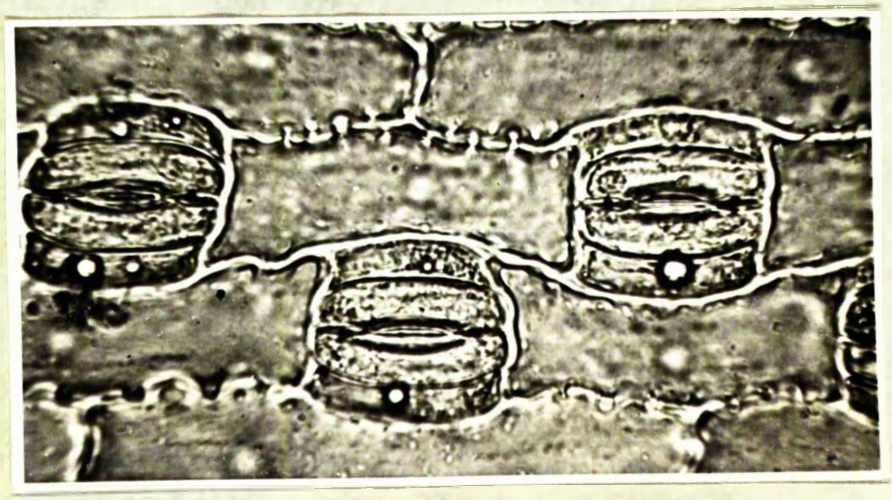
Leaf - Adaxial epidermis.



1. x 70



2. x 280

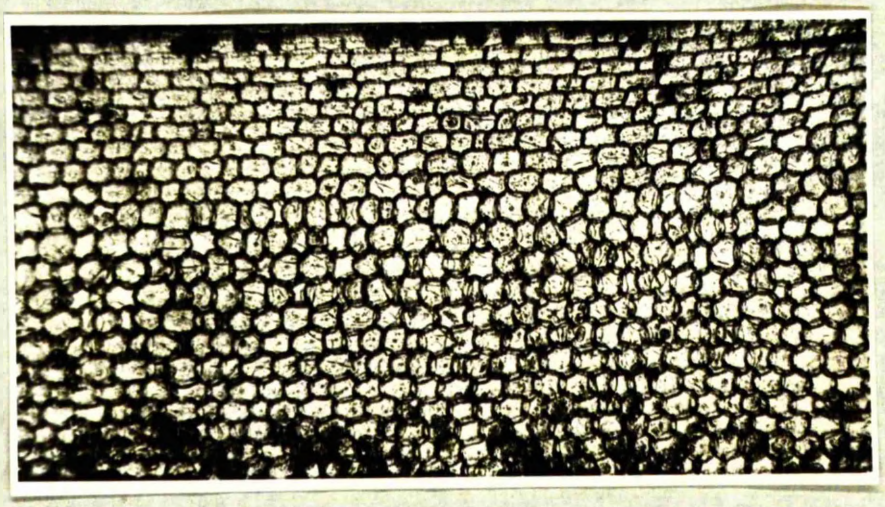


3. x 750

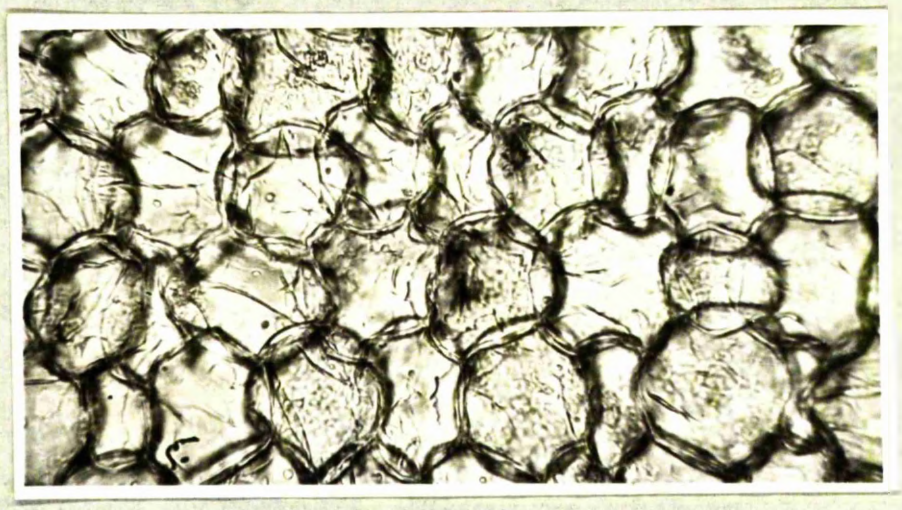
PLATE 43

Luzula pilosa (L.) Willd.

Leaf - Abaxial epidermis.



1. x 70

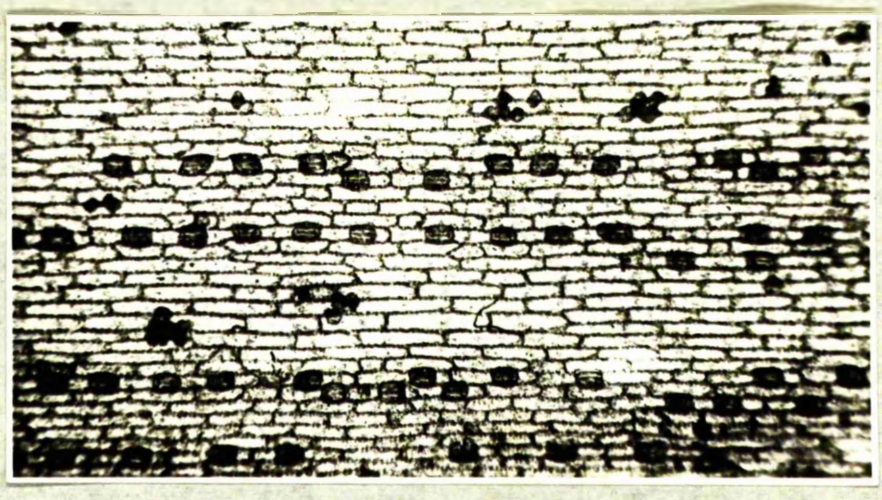


2. x 280

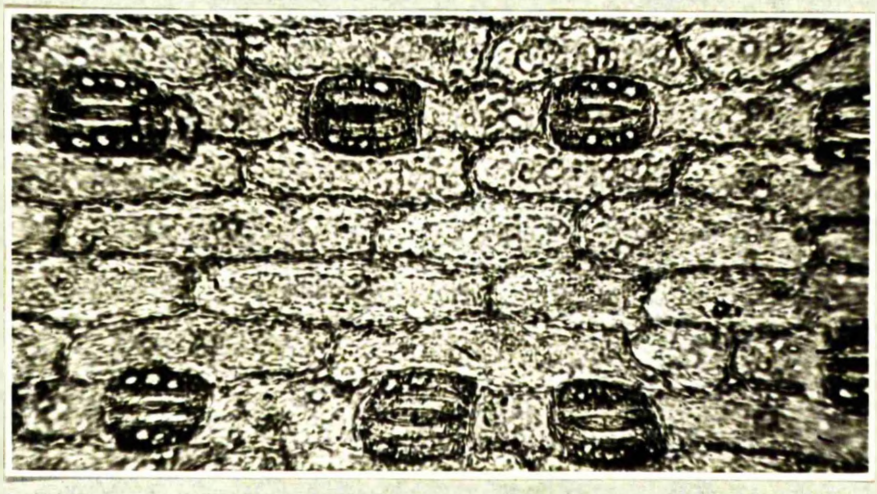
PLATE 44

Luzula campestris (L.) DC.

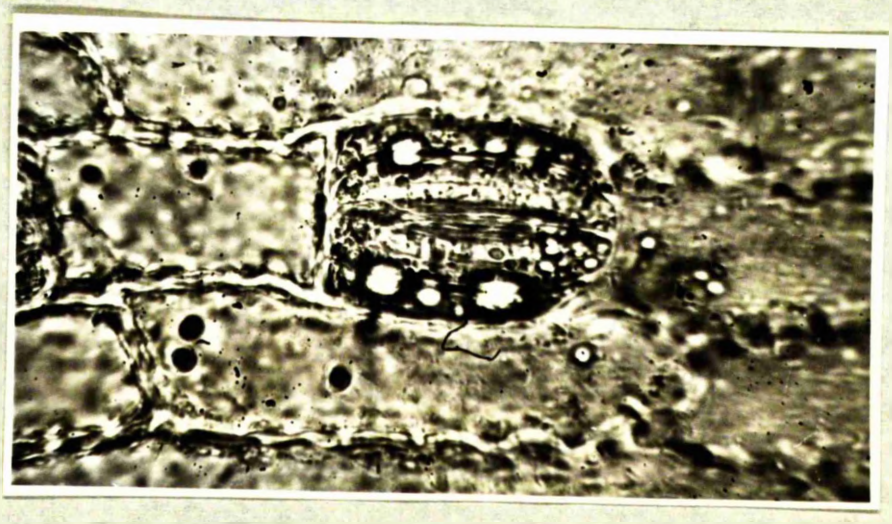
Leaf - Adaxial epidermis.



1. x 70



2. x 280

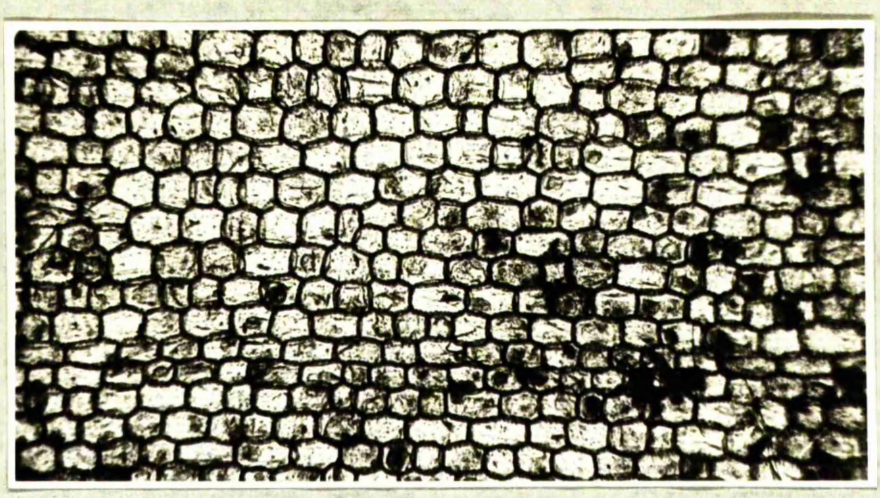


3. x 750

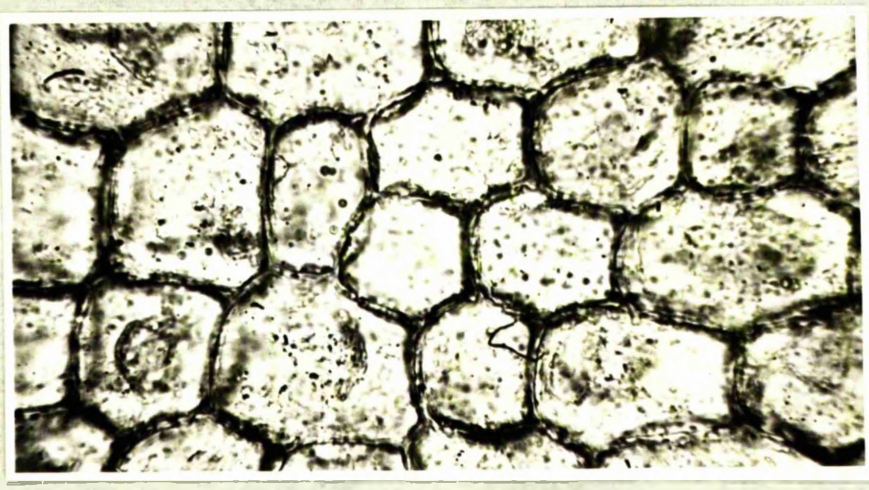
PLATE 45

Luzula campestris (L.) DC.

Leaf - Abaxial surface.



1. x 70

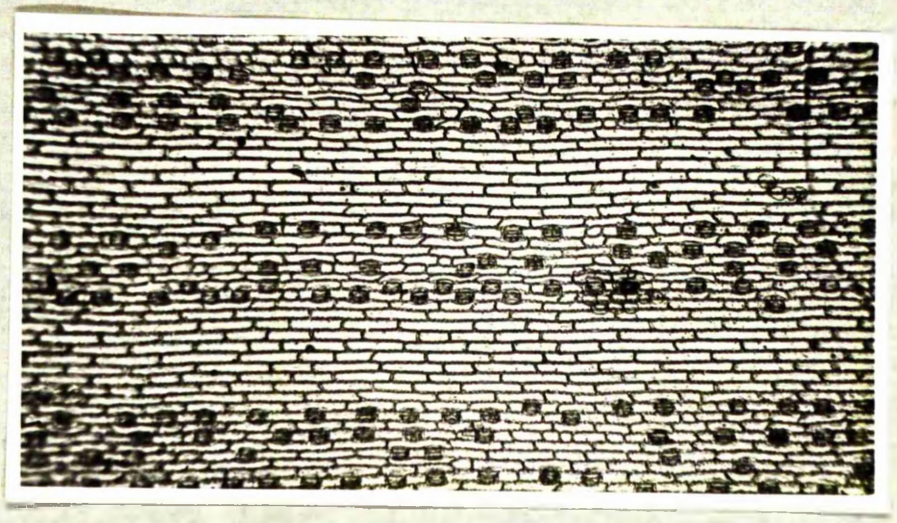


2. x 280

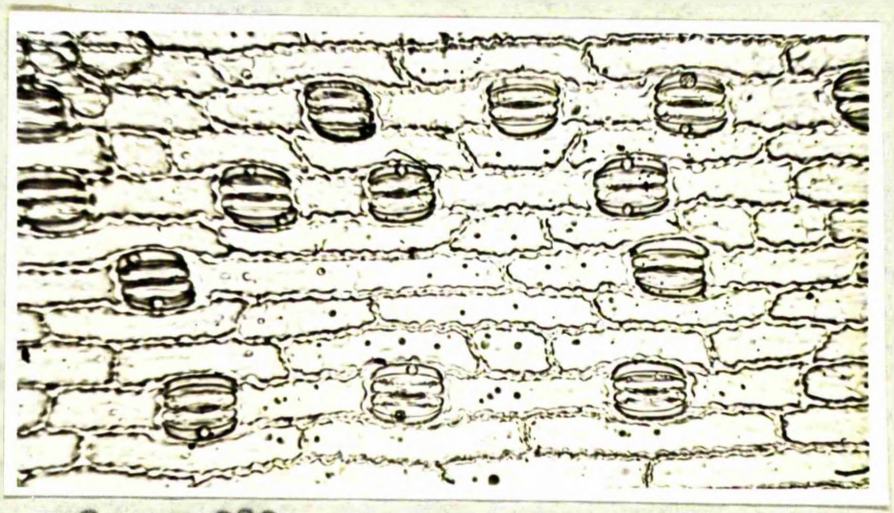
PLATE 46

Luzula sylvatica (Huds.) Gaud.

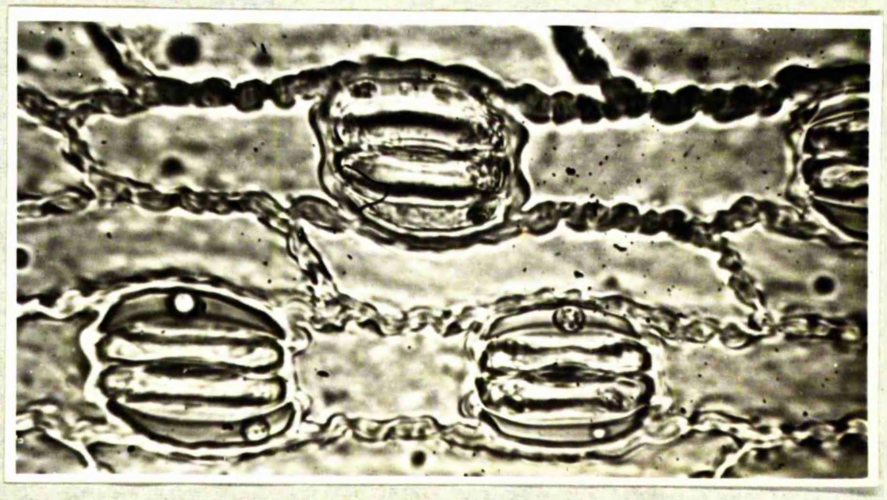
Leaf - Adaxial epidermis.



1. x 70



2. x 280

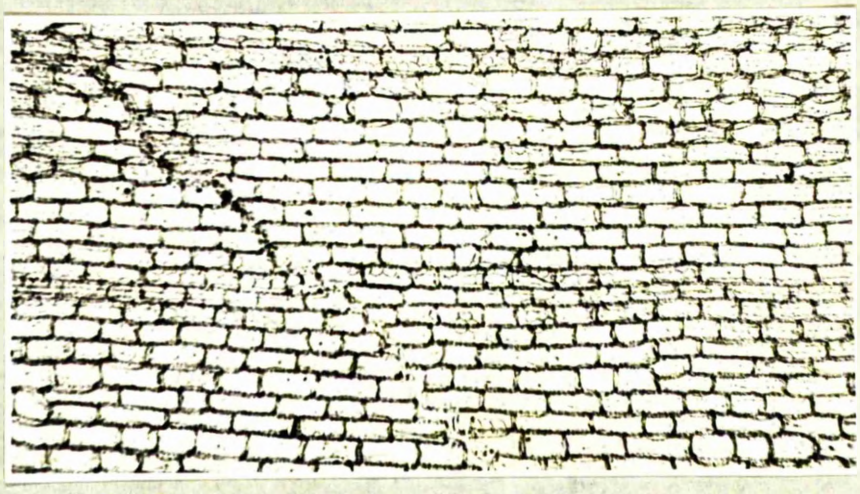


3. x 750

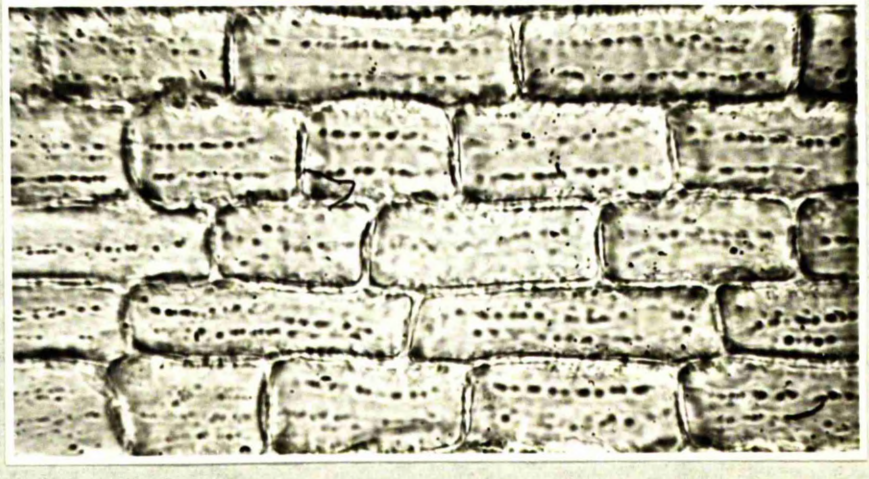
Plate 47

Luzula sylvatica (Huds.) Gaud.

Leaf - Abaxial epidermis.



1. x 70



2. x 280

4. Leguminosae

Lathyrus montanus Bernh. Plates 48,49

On the stem epidermis the cells are in irregular rows. They are of various lengths but are mostly 35 μ wide. The cells in most cases taper to a point at one end.

The stomata are scattered over the surface, and their pores are orientated lengthwise. The guard cells measure 45μ by 30 μ. Each stoma has a small epidermal cell alongside.

On the adaxial surface of the leaf the cells are irregular in size and shape and have thin walls. The stomata, which are slightly sunken, are not orientated. The guard cells measure 40 μ by 30 μ.

On the abaxial surface of the leaf the longer diameter of the cells tends to be along the same direction as the nearest vein. The stomata are similar to those on the upper surface.

Lotus corniculatus L. Plates 50,51

The?
Both surfaces of this leaf are rather similar. The cells are irregular in shape and size. The walls are thin and knobbed. The stomata measure 30 μ by 30 μ. They are not orientated.

Lotus uliginosus Schkuhr Plates 52,53

The adaxial surface of the leaf has irregularly shaped cells with thin walls which are not knobbed.

The stomata, which are partly sunken, measure 30 μ by 30 μ. They are not orientated.

The abaxial surface is similar except that it has occasional hairs, up to 2 mm. long. The hair bases are circular.

Medicago lupulina L. Plate 54

The adaxial and abaxial surfaces are similar. The cells are jig-saw in type. The walls are knobbed.

Stomata are not orientated. The guard cells measure 25 μ by 20 μ.

Sarothamnus scoparius (L.) Wimmer Plates 55,56

On the stem of this species the cells are in irregular rows. The walls are smooth and thick.

The stomata, which are scattered and orientated lengthwise, measure 40 μ by 30 μ. They are each surrounded by a ring of small epidermal cells.

The adaxial and abaxial surfaces of the leaf are similar to one another. The cells are more or less straight sided, irregular in size and shape. The walls are thick and pitted.

The stomata are scattered and are not orientated.

The stomatal cells measure 30 μ by 30 μ. They are partly sunken into the epidermis.

Hairs, of 400-500 μ length, are frequent on both surfaces.

Trifolium pratense L. Plate 57

On the adaxial surface the epidermal cells are straight sided but irregular in size and shape.

On the abaxial surface the cells are larger with thick, knobbed walls.

The stomata are scattered and are not orientated. They measure 15 μ by 15 μ.

Hairs are frequent on the abaxial surface, measuring from 500-800 μ.

Trifolium repens L. Plate 58

The adaxial surface of this species is similar to that of T. pratense.

On the abaxial surface the cells are irregular in shape and size. The cell edges are waved but are not knobbed.

The stomata are scattered and are not orientated. The stomatal cells measure 30 μ by 20 μ.

Ulex europaeus L. Plate 59

On the stem epidermis of this species, the cells are/

/are arranged irregularly in rows. The stomata are scattered over the surface and are orientated with their pores longitudinally. The stomatal guard cells measure 40 μ by 30 μ, and usually have two small epidermal cells adjacent to them.

Vicia sepium L. Plate 59a

The adaxial and abaxial leaf surfaces of this species are similar.

The cells are jigsaw in type, irregular in size and shape.

The stomata are scattered and are not orientated. The stomatal guard cells measure 35 μ by 30 μ.

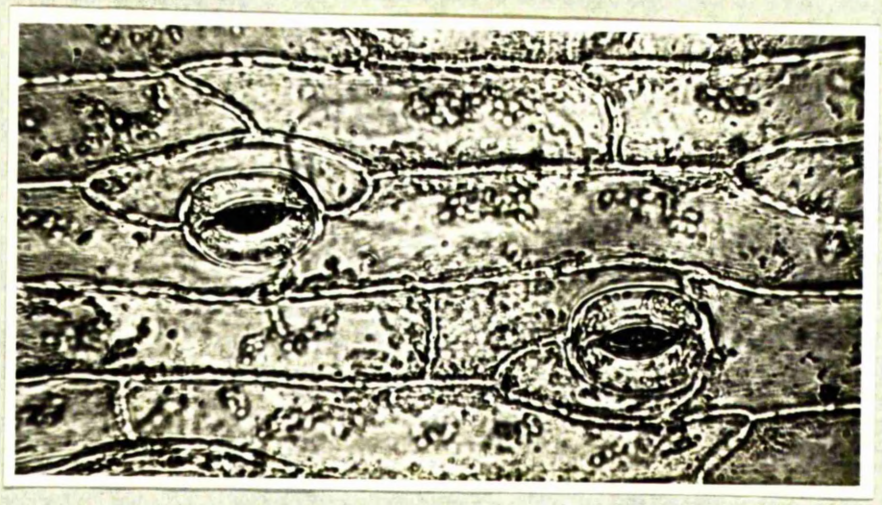
Occasional hairs of up to 1 mm. are found.

PLATE 48

Lathyrus montanus Bernh.

Stem epidermis.

1. x 70

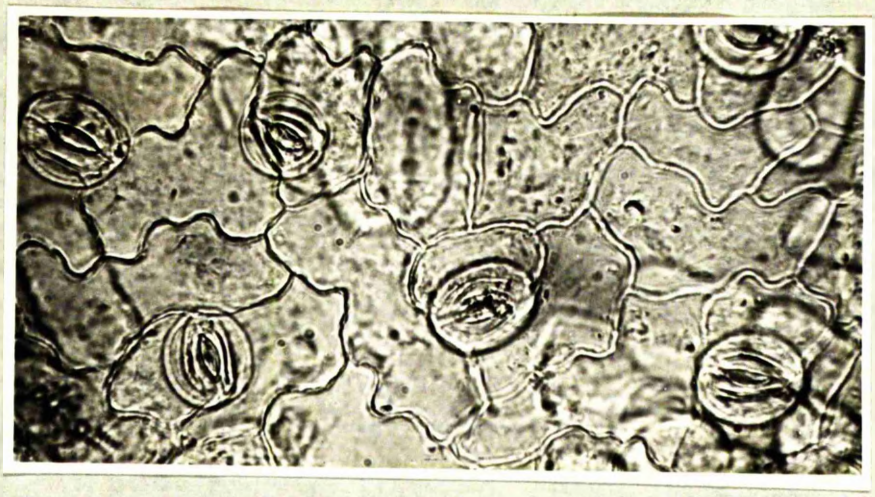


2. x 280

PLATE 49

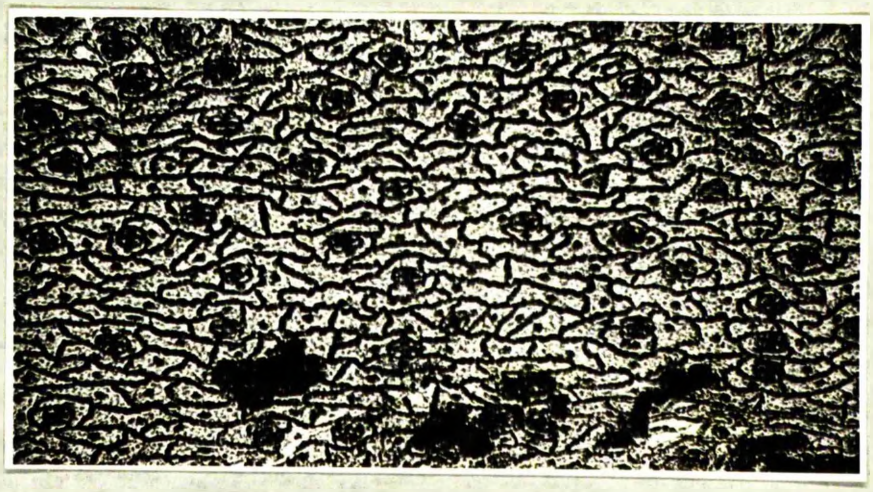
Lathyrus montanus Bernh.

Leaf - Adaxial epidermis.

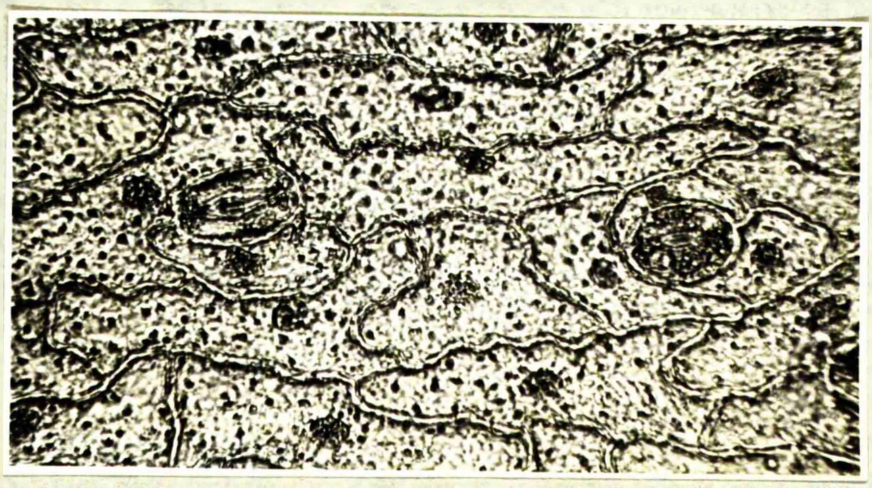


1. x 280

Leaf - Abaxial epidermis.



1. x 70

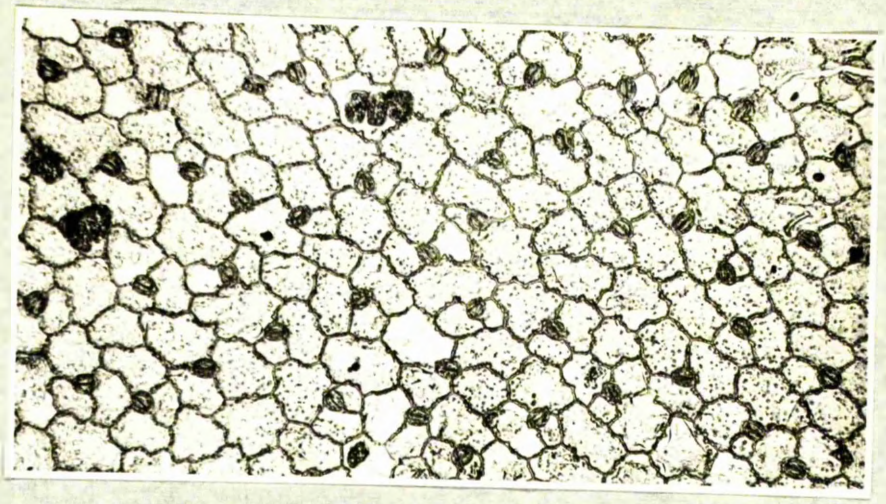


2. x 280

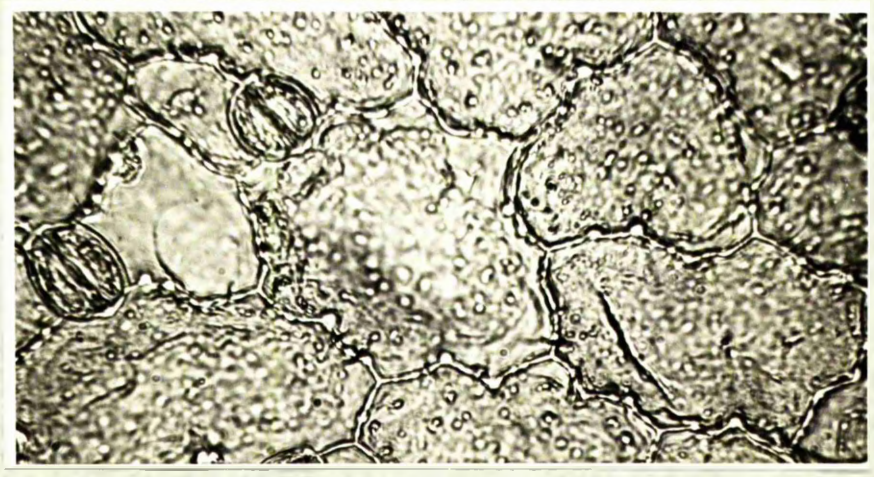
PLATE 50

Lotus corniculatus L.

Leaf - Adaxial epidermis.



1. x 70

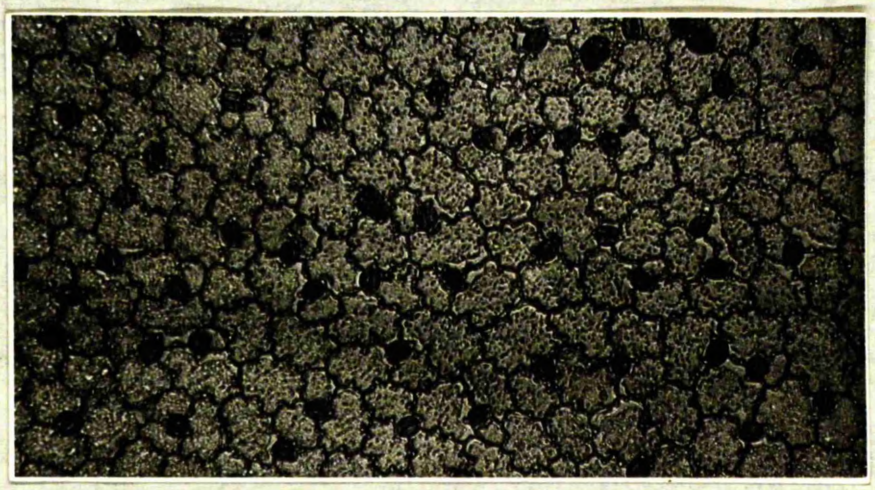


2. x 280

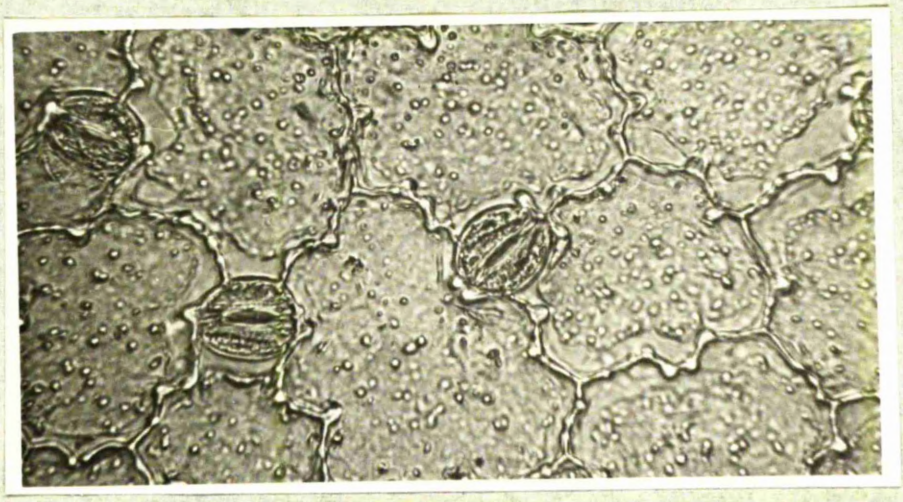
PLATE 51

Lotus corniculatus L.

Leaf- Abaxial epidermis.



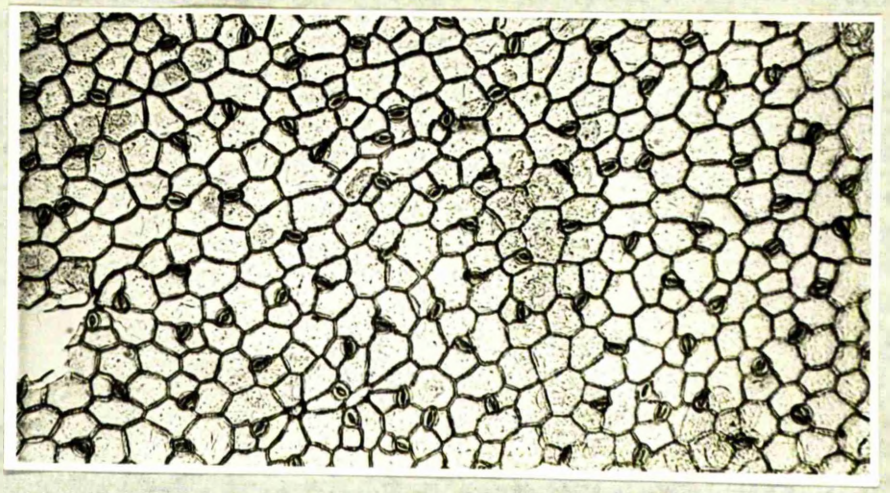
1. x 70



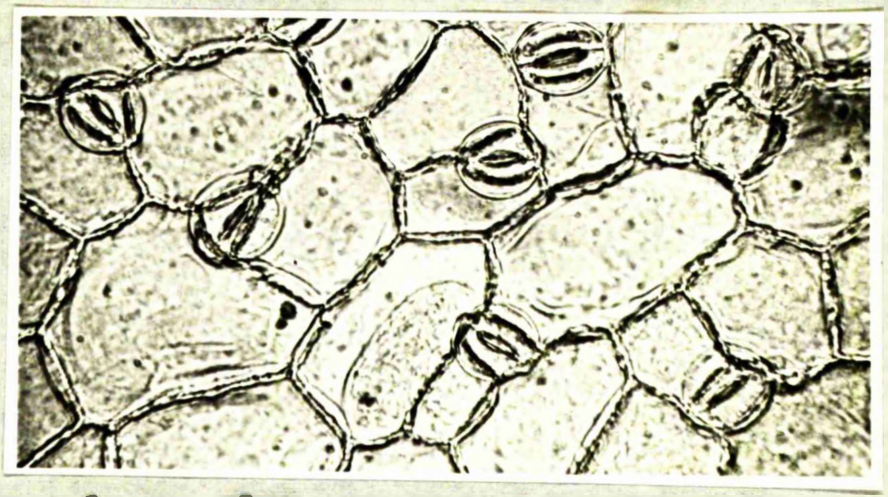
2. x 280

PLATE 52

Lotus uliginosus Schkuhr
Leaf - Adaxial epidermis.



1. x 70

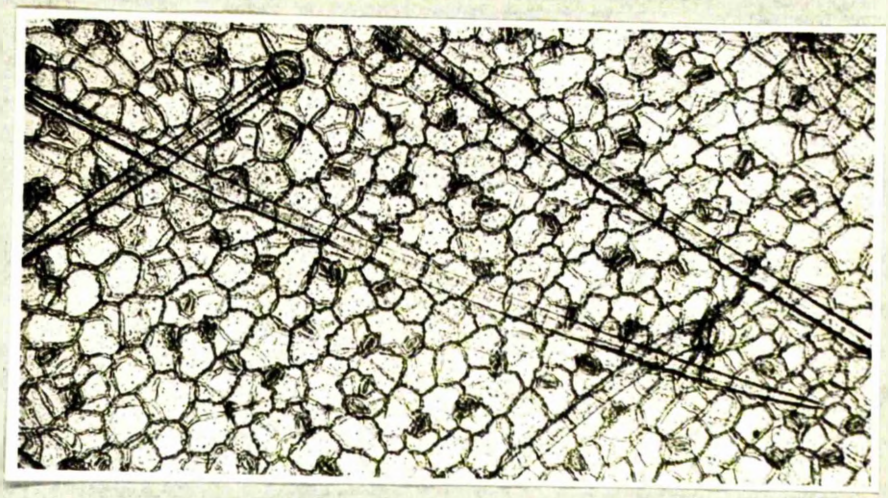


2. x 280

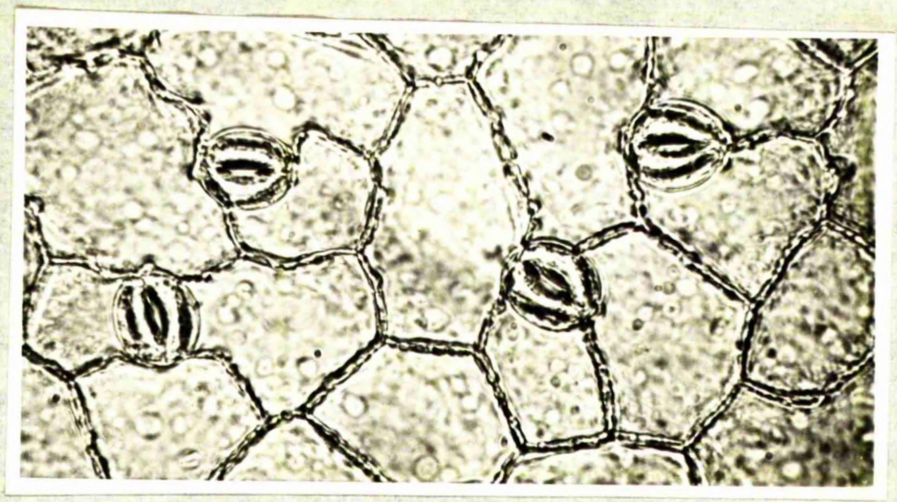
PLATE 53

Lotus uliginosus Schkuhr

Leaf - Abaxial epidermis.



1. x 70

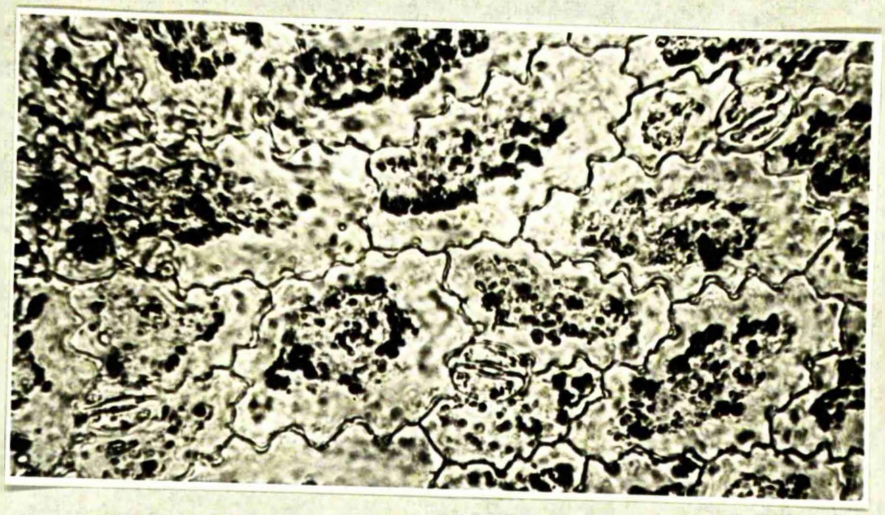


2. x 280

PLATE 54

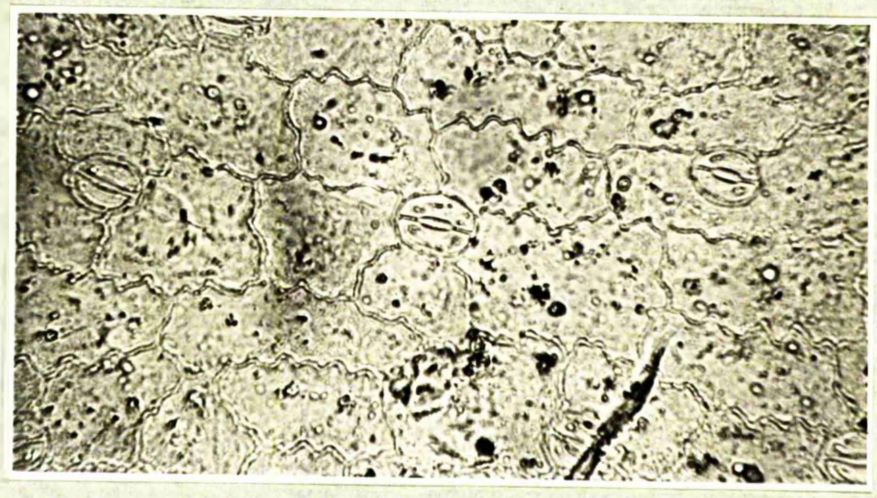
Medicago lupulina L.

Leaf - Adaxial epidermis.



1. x 280

Leaf - Abaxial epidermis.

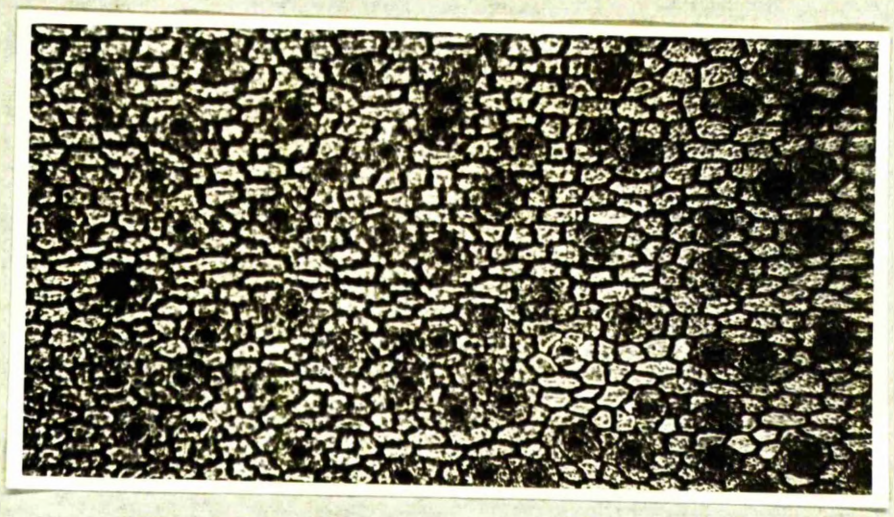


1. x 280

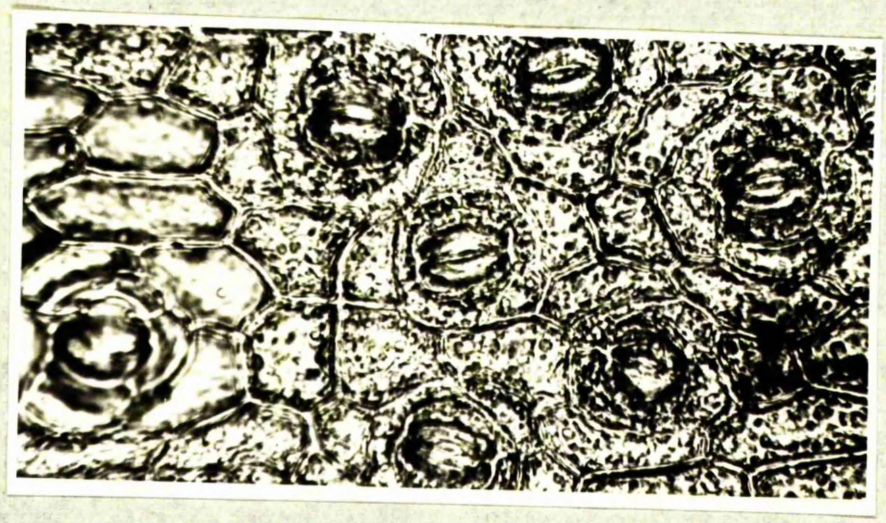
PLATE 55

Sarothamnus scoparius (L.) Wimmer

Stem epidermis.



1. x 70



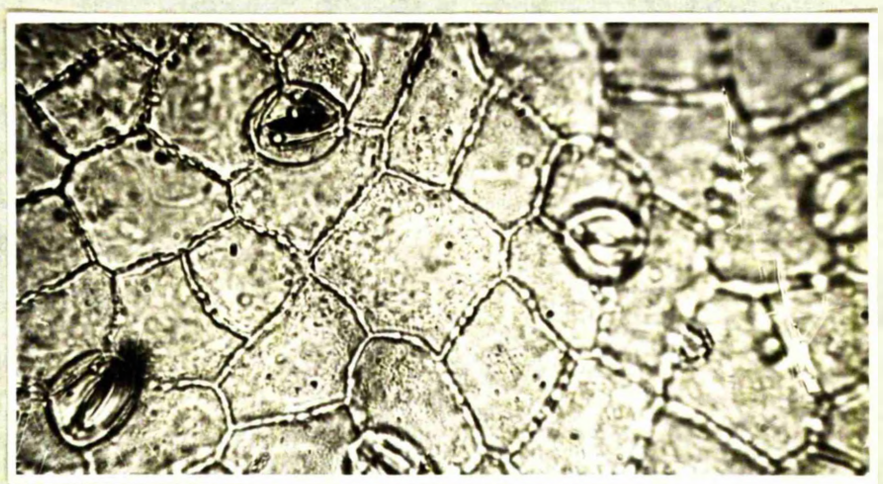
2. x 280

PLATE 56

Sarothamnus scoparius (L.) Wimmer

Leaf - Adaxial and Abaxial epidermis.

1. x 70

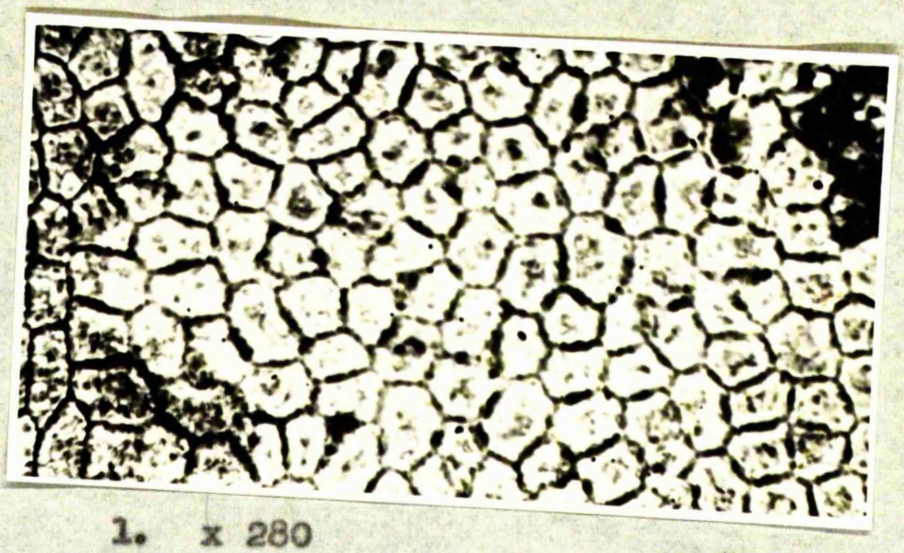


2. x 280

PLATE 57

Trifolium pratense L.

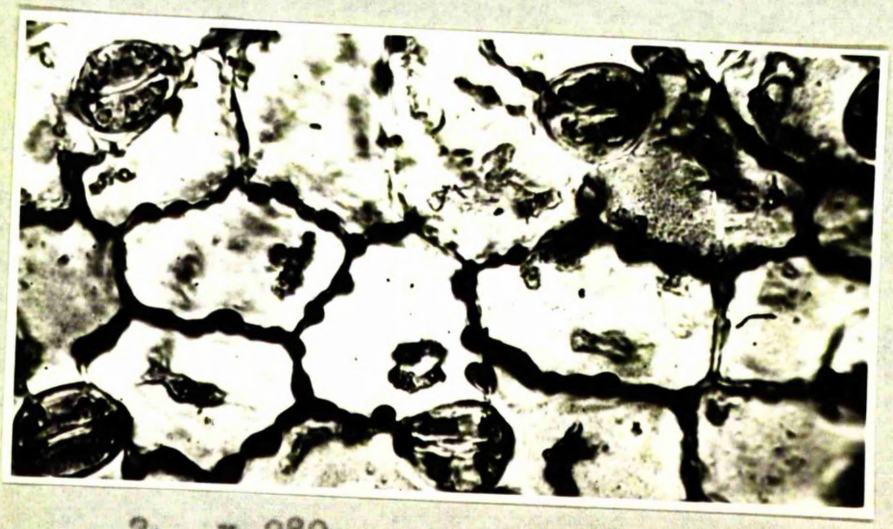
Leaf - Adaxial epidermis.



1. x 280

Leaf - Abaxial epidermis.

1. x 70

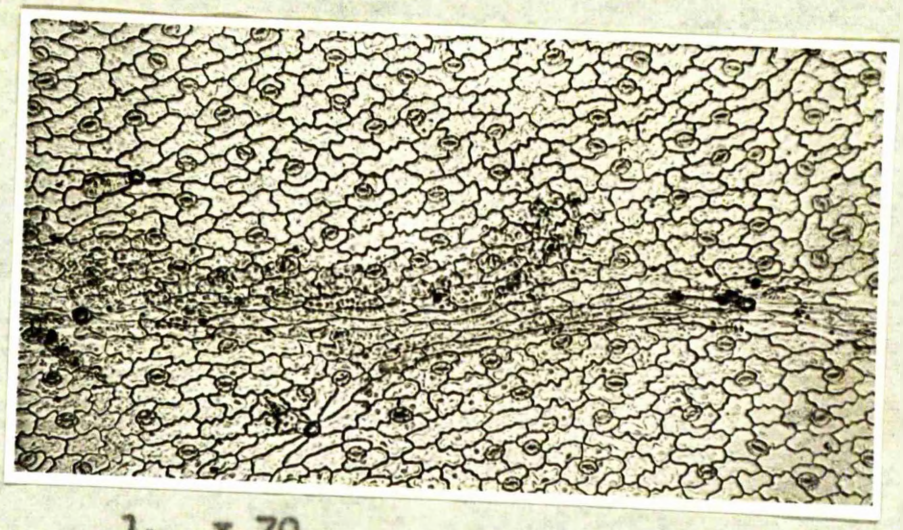


2. x 280

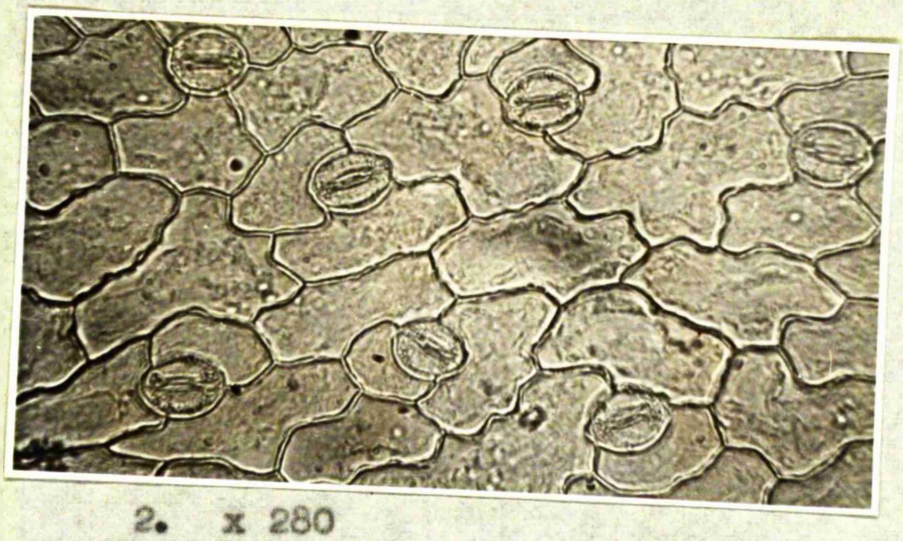
PLATE 58

Trifolium repens L.

Leaf - Abaxial epidermis



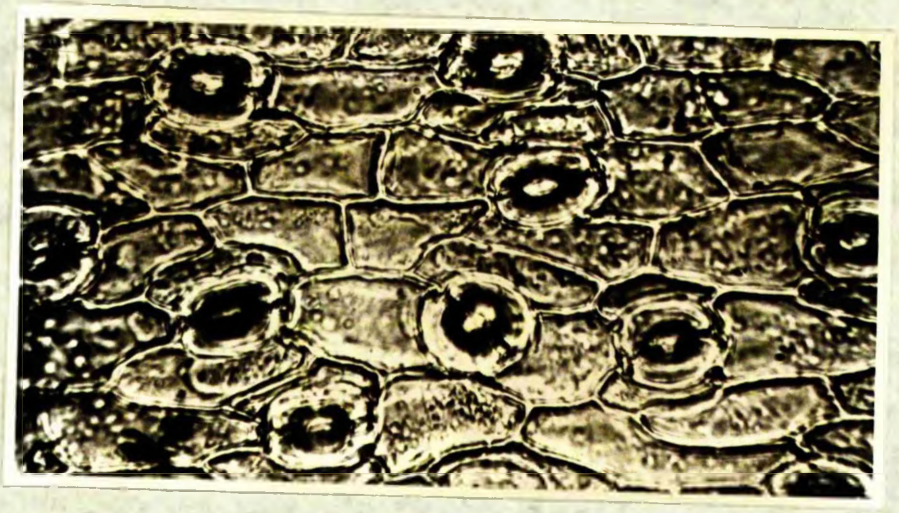
1. x 70



2. x 280

PLATE 59

Ulex europaeus L.
Stem epidermis.



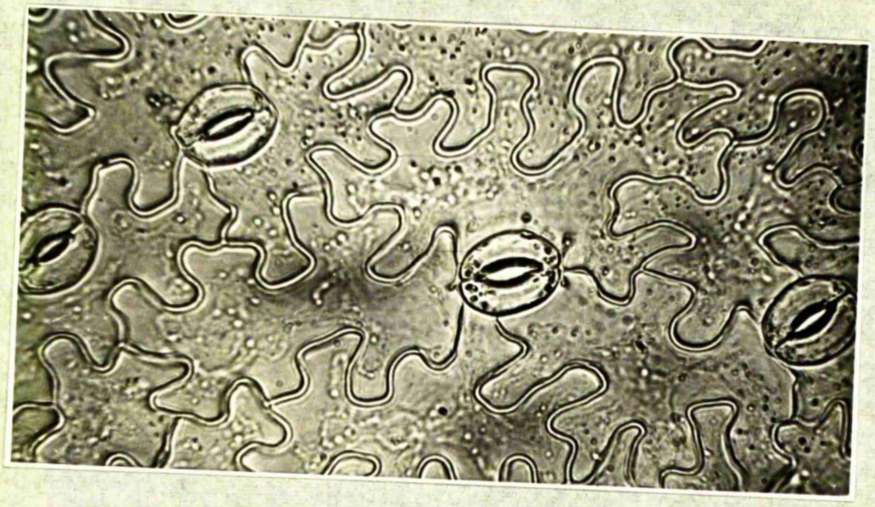
1. x 280

PLATE 59a

Vicia sepium L.

Leaf - Adaxial and Abaxial epidermis.

1. x 70



2. x 280

5. Ericaceae

Calluna vulgaris (L.) Hull Plate 60

On the adaxial surface the cells are jigsaw in type. They are thin walled and have faintly striate cutin.

On the abaxial surface the cells are slightly elongated and jigsaw in type.

On this surface the stomata are scattered. they are occasionally orientated lengthwise. They measure 30 μ by 30 μ.

Erica cinerea L. Plate 61

The epidermal cells of the adaxial surface are irregularly polygonal in shape. They have thick, pitted walls and the cuticle is strongly striate.

No abaxial surface could be prepared from this species.

Erica tetralix L. Plate 62

The cells of the adaxial epidermis are similar to those of E. cinerea with the exception that they have cuticular 'hairs' on them, measuring from 600-900 μ.

Vaccinium myrtillus L. Plate 63

On the adaxial surface the cells are irregular in/

/in shape and size. The walls are thick. No stomata were found on this surface.

On the abaxial surface the cells are irregular in shape and size, jigsaw in type. The walls are thick.

The stomata are sparse and are partly sunken. The guard cells measure 45 μ by 30 μ.

Vaccinium oxycoccus L. Plate 64

On the adaxial surface the cells are irregular but mostly polygonal. The walls are thick.

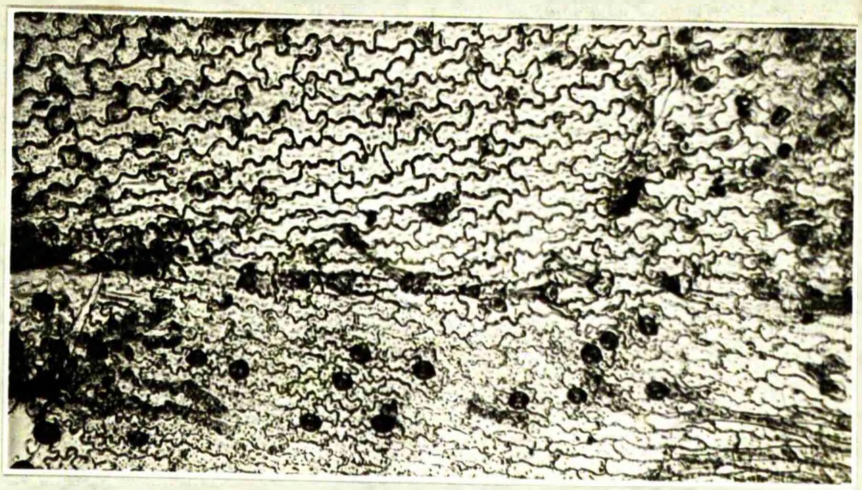
On the abaxial surface the cells are irregular in shape and size.

The stomata are frequent, usually orientated lengthwise. The guard cells measure 40 μ by 25 μ.

PLATE 60

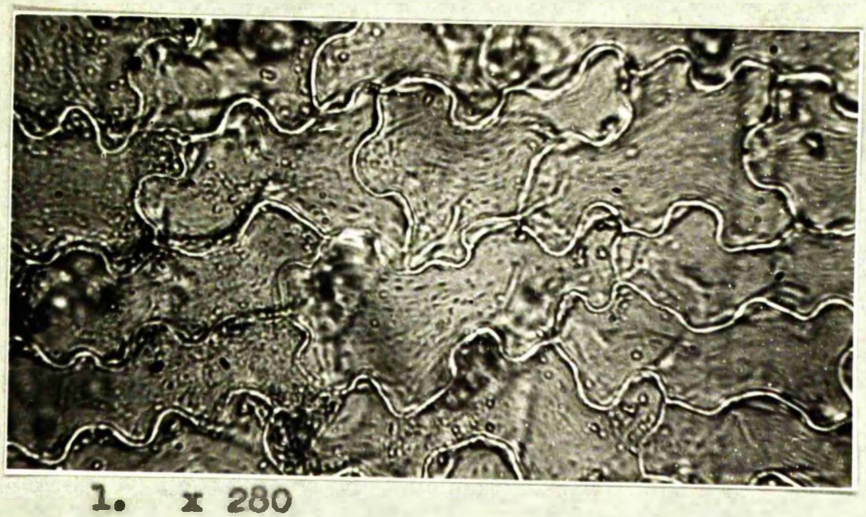
Calluna vulgaris (L.) Hull

Leaf - Adaxial and Abaxial epidermis.



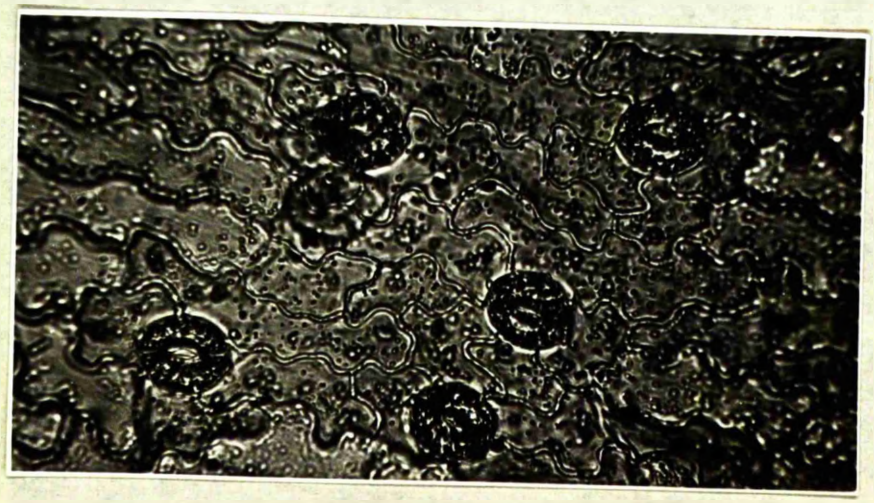
1. x 70

Leaf - Adaxial epidermis.



1. x 280

Leaf - Abaxial epidermis.

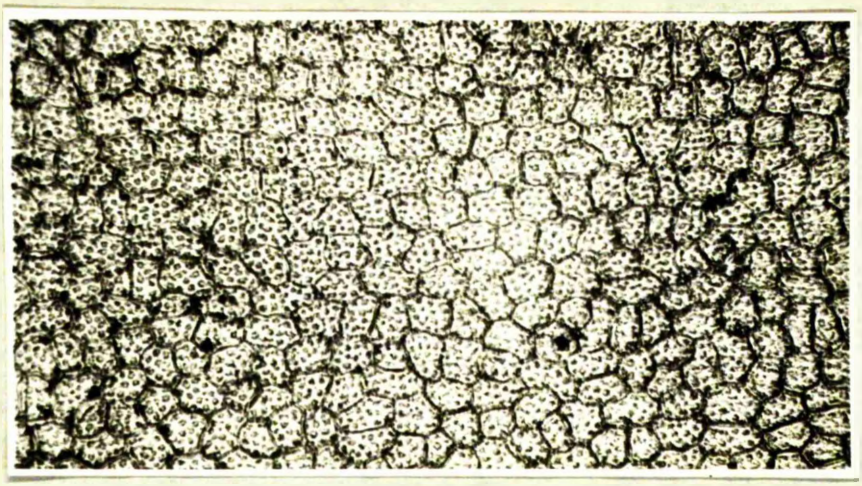


1. x 280

PLATE 61

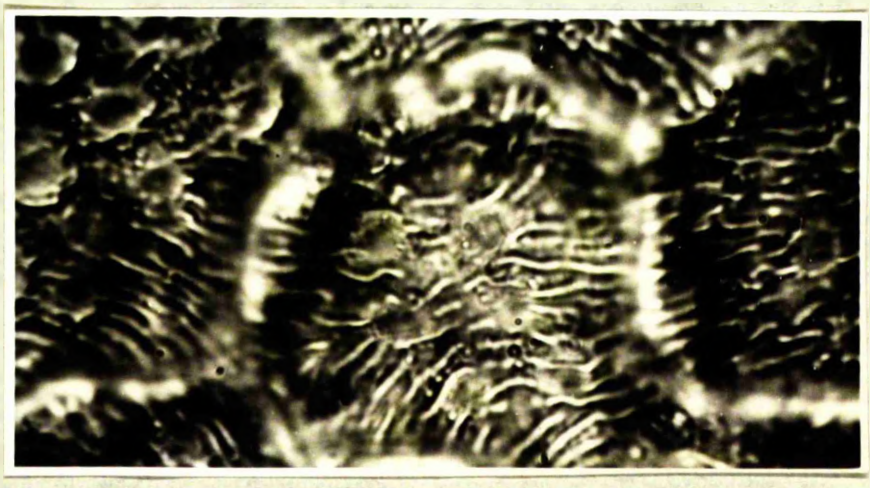
Erica cinerea L.

Leaf - Adaxial epidermis



1. x 70

2. x 280

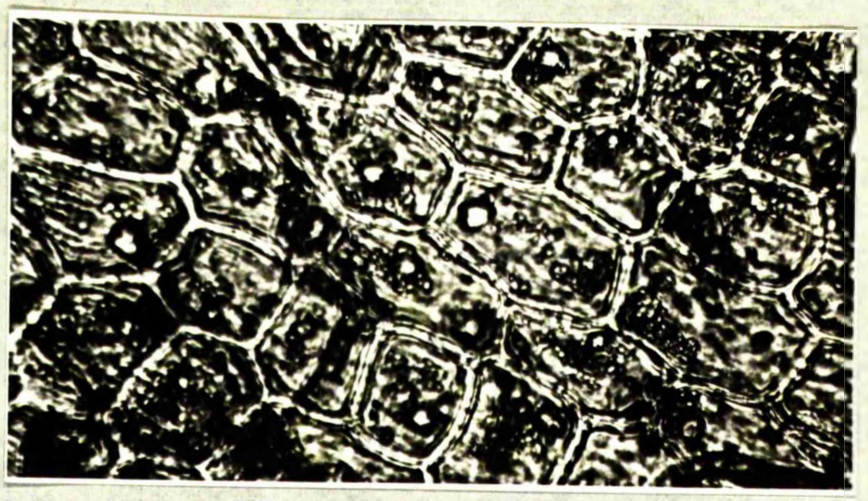


3. x 750

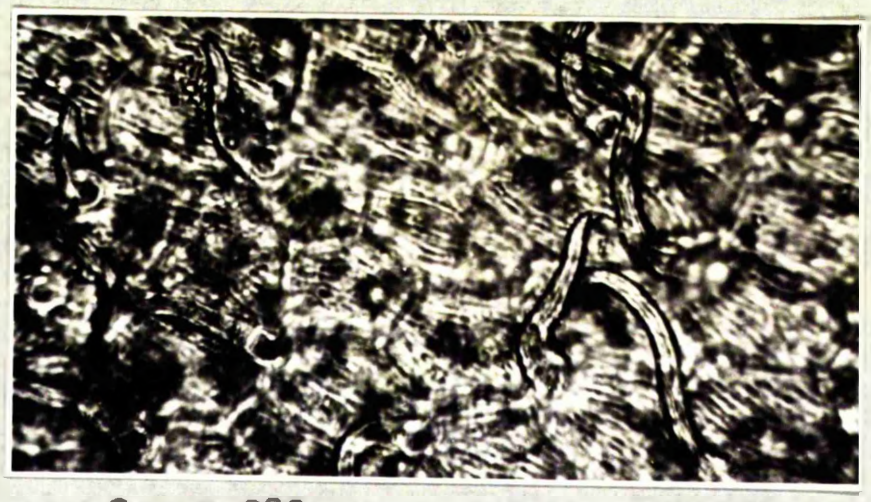
PLATE 62

Erica tetralix L.

Leaf - Adaxial epidermis.



1. x 280

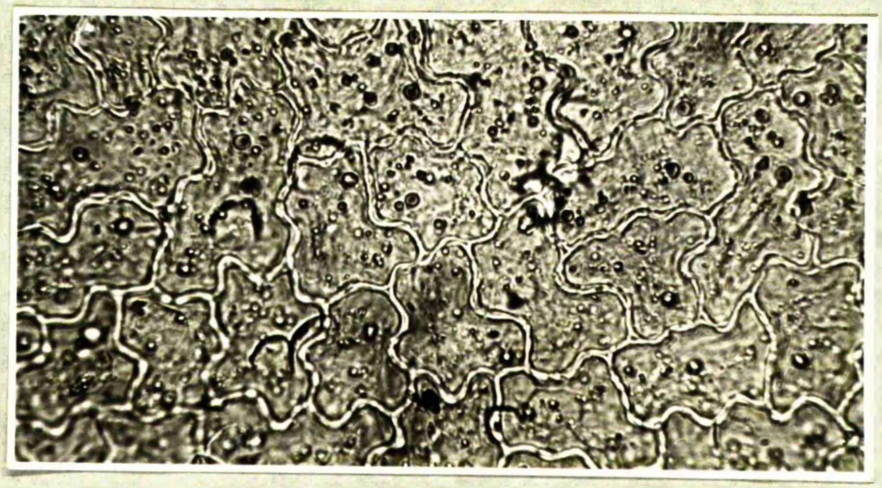


2. x 280

PLATE 63

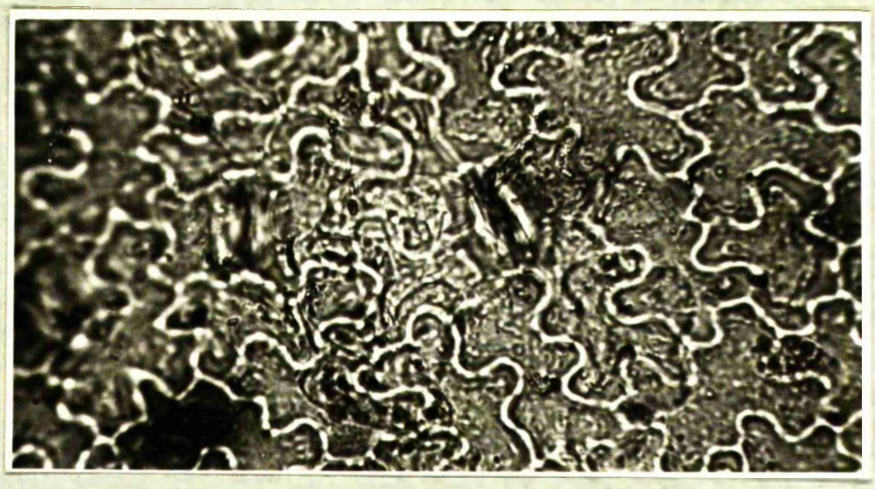
Vaccinium myrtillus L.

Leaf - Adaxial epidermis.



1. x 280

Leaf - Abaxial epidermis

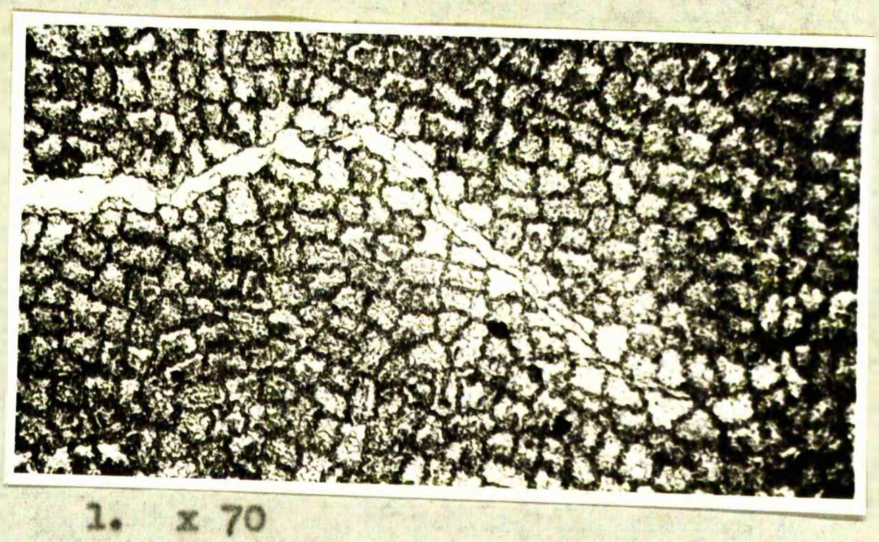


1. x 280

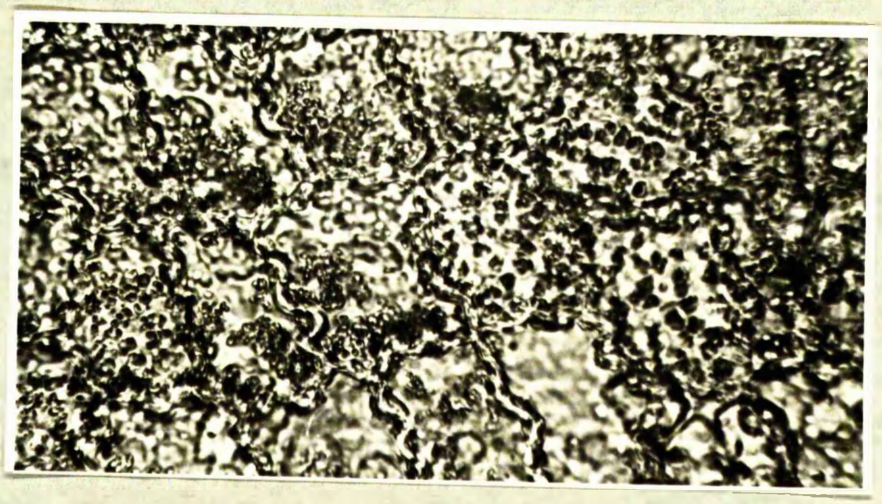
PLATE 64

Vaccinium oxycoccus L.

Leaf - Adaxial epidermis.

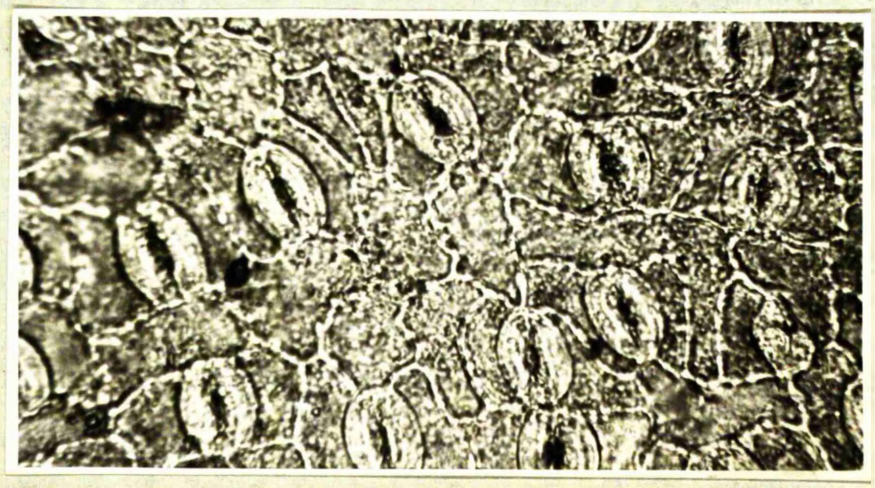


1. x 70



2. x 280

Leaf - Abaxial epidermis.



1. x 280

6. Other Forage Plants

Anemone nemorosa L. Plate 65

The adaxial and abaxial surfaces of the leaves of this species are similar.

The cells are irregularly shaped, tending towards the jigsaw type. The walls are thick and knobbed.

The stomata are frequent. The guard cells measure 90 μ by 50 μ.

Empetrum nigrum L. Plate 66

On the adaxial surface of this species the cells are irregular and jigsaw in type. The walls are thin.

The stomata are very sparse and measure 50 μ by 25 μ.

No abaxial surface could be prepared from this species.

Endymion non-scriptus (L.) Garcke Plate 67

The adaxial and abaxial surfaces of the leaves of this species are similar.

The cells are in regular rows, with the walls thin and flexuous.

The stomata are scattered. The guard cells measure 70 μ by 50 μ.

Galium saxatile L. Plate 68

The adaxial and abaxial surfaces of the leaves of this species are similar.

The cells are irregular in size and shape with thin walls.

The stomata are irregularly orientated lengthwise. The guard cells measure 40 μ by 15 μ and have two small epidermal cells alongside.

Galium verum L. Plate 69

The adaxial and abaxial surfaces of the leaves of this species are similar.

The cells are irregularly shaped, jigsaw in type. The walls are thin.

The stomata are sparse and measure 30 μ by 15 μ.

Frequent macro-hairs are present, measuring up to 200 μ in length.

Iris pseudacorus L. Plate 70

The adaxial and abaxial surfaces of the leaves of this species are similar.

The cells are arranged in regular rows. The walls are thick.

The stomata are scattered and are orientated longitudinally. The guard cells measure 40 μ by 40 μ.

Myrica gale L. Plate 71

The adaxial and abaxial surfaces of the leaves of this species are similar.

The cells are irregularly polygonal with thick walls. The stomata are very sparse; the guard cells measure 20 μ by 15 μ.

There are frequent hairs on the surface, which measure up to 400 μ in length.

Glandular structures are also frequent. The epidermal cells radiate from their base.

Narthecium ossifragum (L.) Huds. Plate 72

The adaxial and abaxial surfaces of the leaves of this species are similar.

The cells are elongated, in irregular rows. The walls are thick.

The stomata are scattered; the guard cells measure 30 μ by 25 μ and the stomatal pores are orientated lengthwise.

Polygala vulgaris L. Plates 73,74

On the adaxial surface the cells are irregular in shape with thick, pitted walls.

On the abaxial surface the cells are irregular with thick, unpitted walls.

The stomata are scattered and the guard cells measure 40 μ by 30 μ.

Potentilla erecta (L.) Rausch Plate 75

On the adaxial surface the cells are irregular in shape and size with thick walls.

On the abaxial surface the cells are irregular with thick, pitted walls.

The stomata are scattered and measure 40 μ by 25 μ.

There are frequent hairs on this surface, measuring up to 1 mm.

Rumex acetosella L. Plate 76

In this species the adaxial and abaxial surfaces of the leaves are similar.

The cells are irregular in size and shape with thin walls which are slightly flexuous.

The stomata are scattered and are occasionally orientated with the stomatal pore longitudinal.
The guard cells measure 80 μ by 40 μ. The stomata usually have two small epidermal cells beside them.

Viola canina L. Plate 77

The adaxial and abaxial surfaces of the leaves of this species are similar.

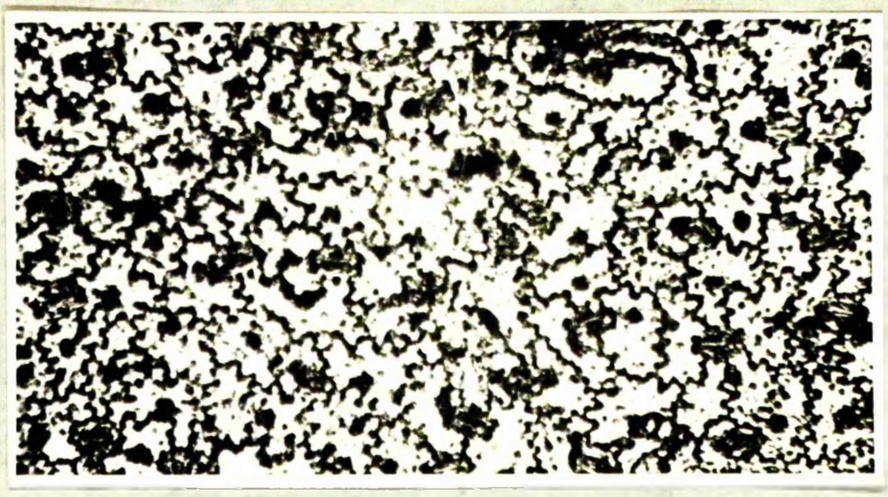
The epidermal cells are irregular in size and shape. The walls are thick.

The stomata are scattered and are not orientated. The guard cells measure 70 μ by 60 μ.

PLATE 65

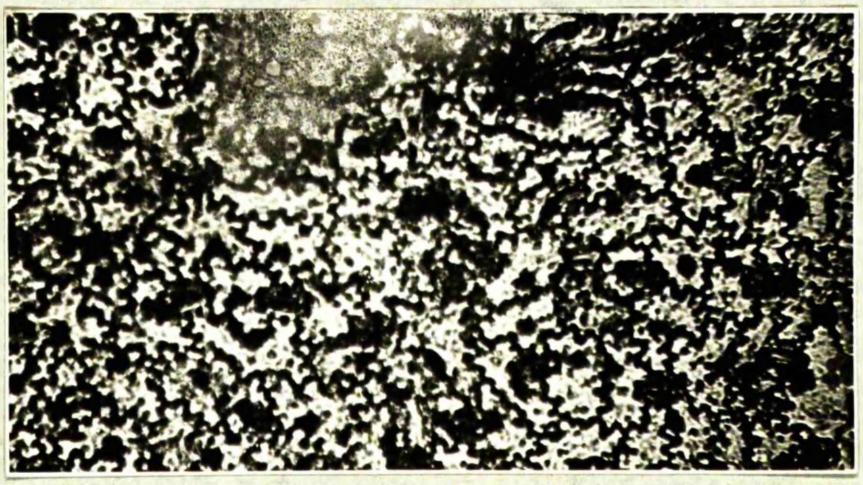
Anemone nemorosa L.

Leaf - Adaxial epidermis.

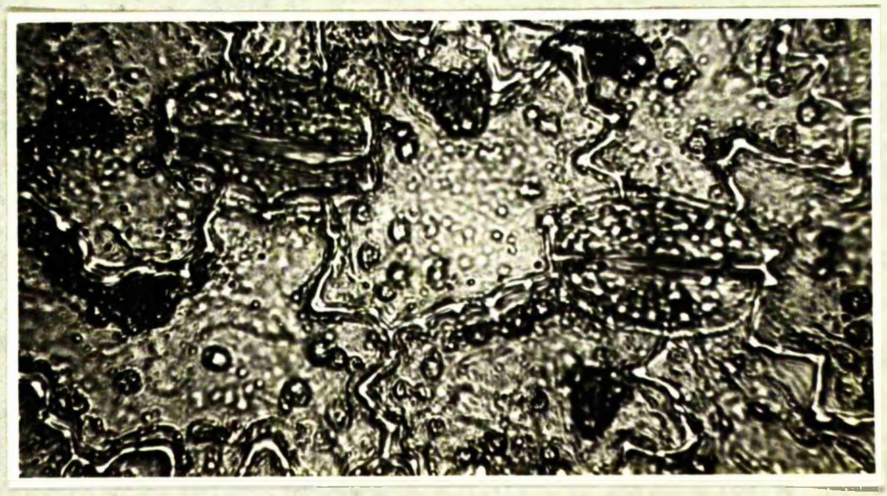


1. x 280

Leaf - Abaxial epidermis.



1. x 70

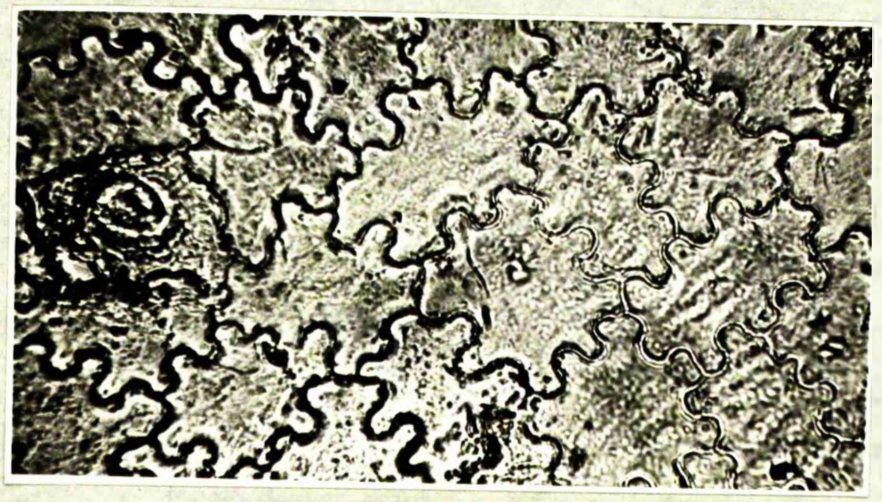


2. x 280

PLATE 66

Empetrum nigrum L.

Leaf - Adaxial epidermis.

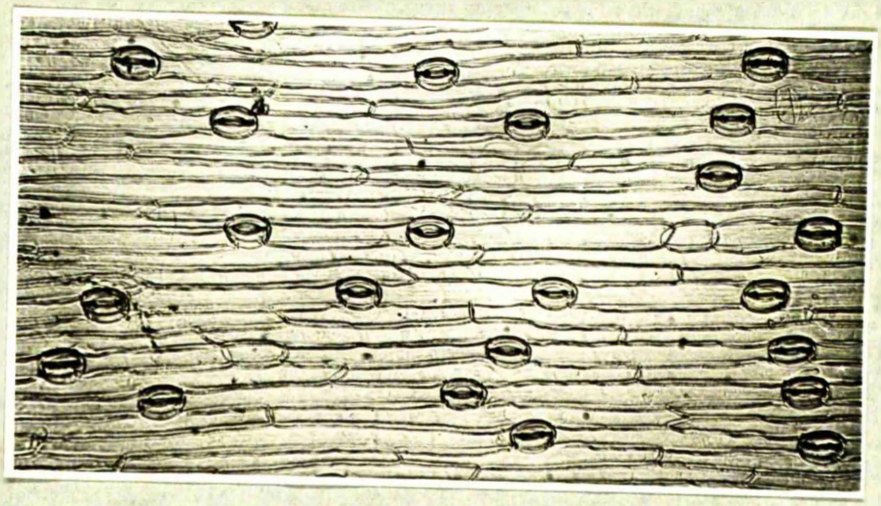


1. x 280

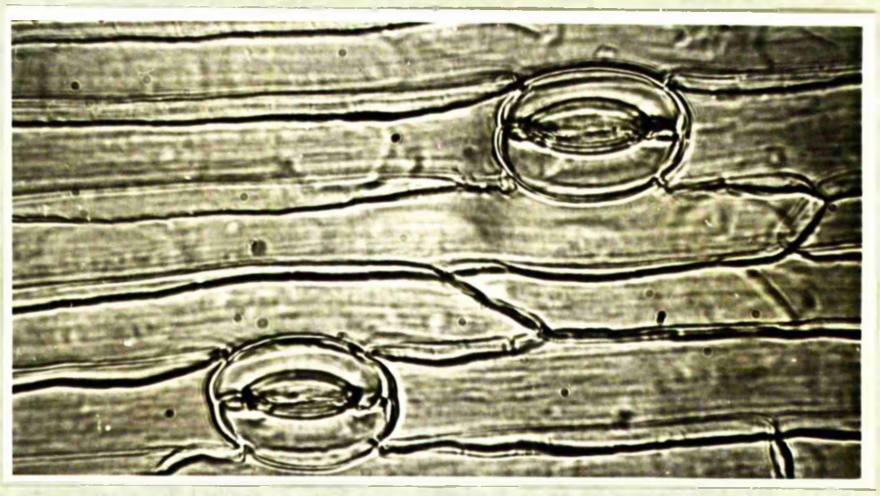
PLATE 67

Endymion non-scriptus (L.) Garcke

Leaf - Adaxial and Abaxial epidermis.



1. x 70

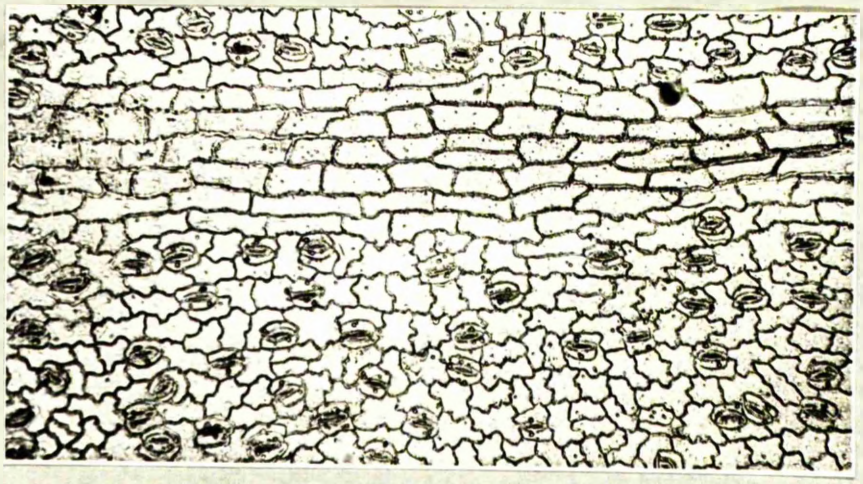


2. x 280

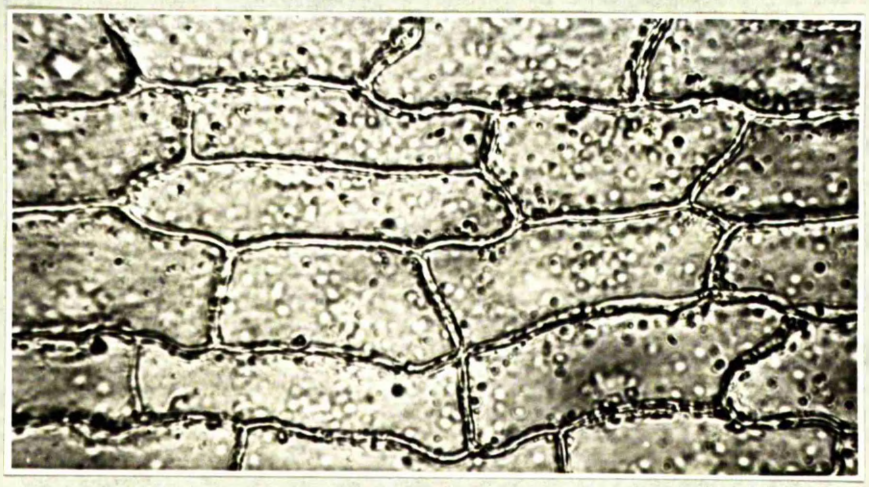
PLATE 68

Galium saxatile L.

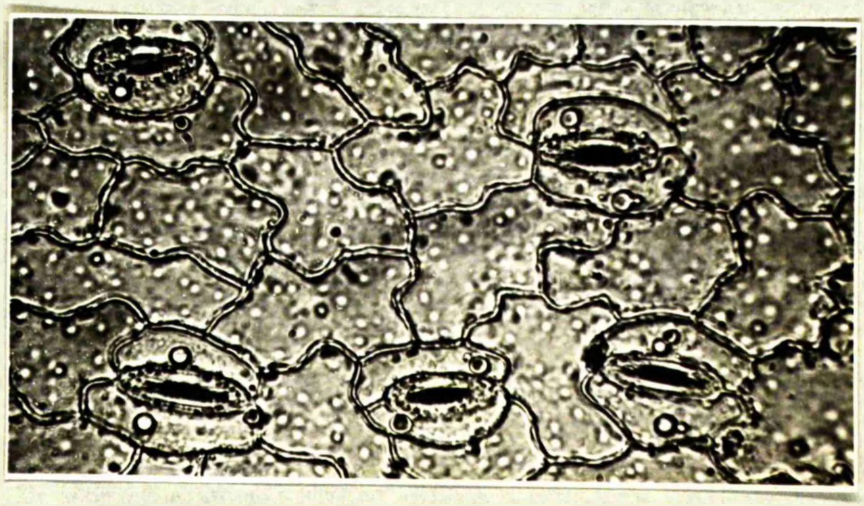
Leaf - Adaxial and Abaxial epidermis.



1. x 70



2. x 280



3. x 280

PLATE 69

Galium verum L.

Leaf - Adaxial and Abaxial epidermis.

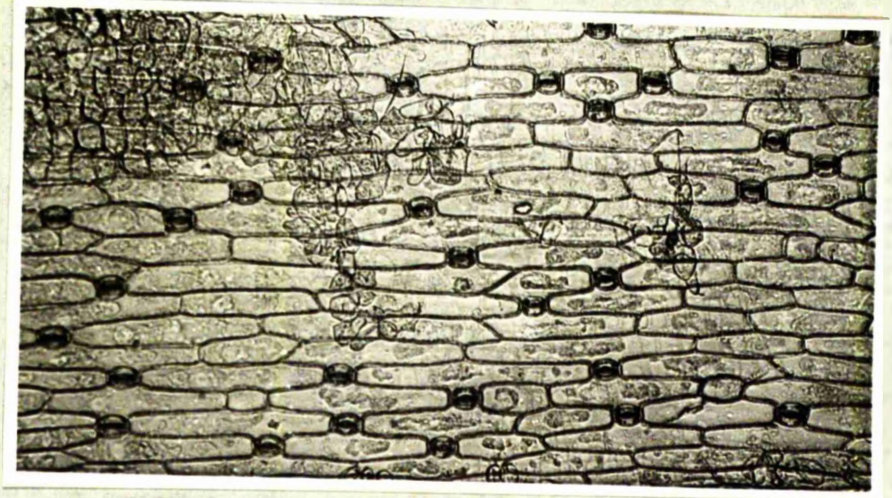
1. x 70

2. x 280

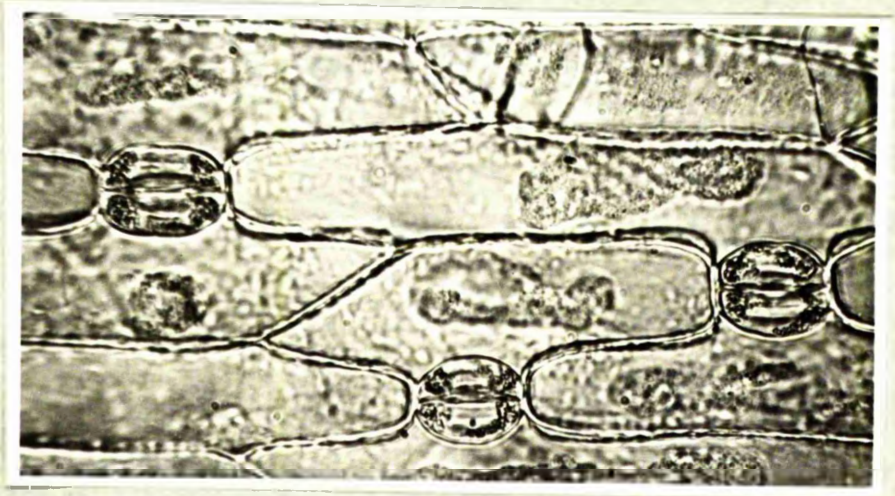
PLATE 70

Iris pseudacorus L.

Leaf - Adaxial and Abaxial epidermis.



1. x 70

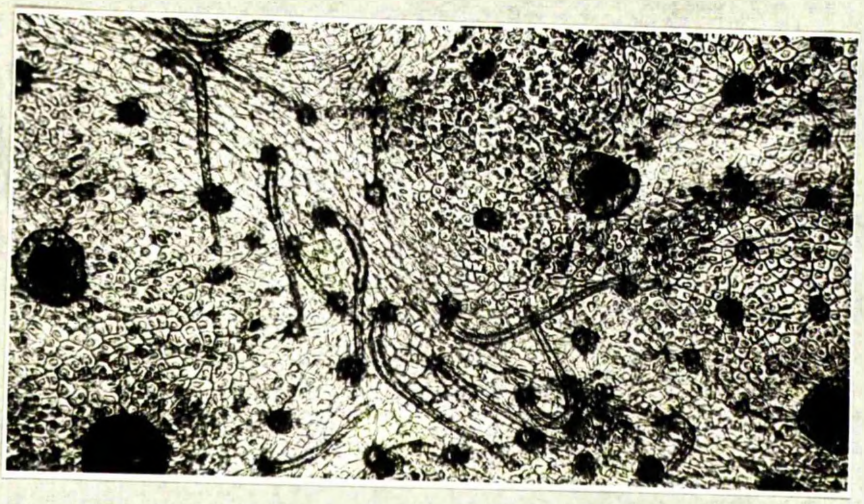


2. x 280

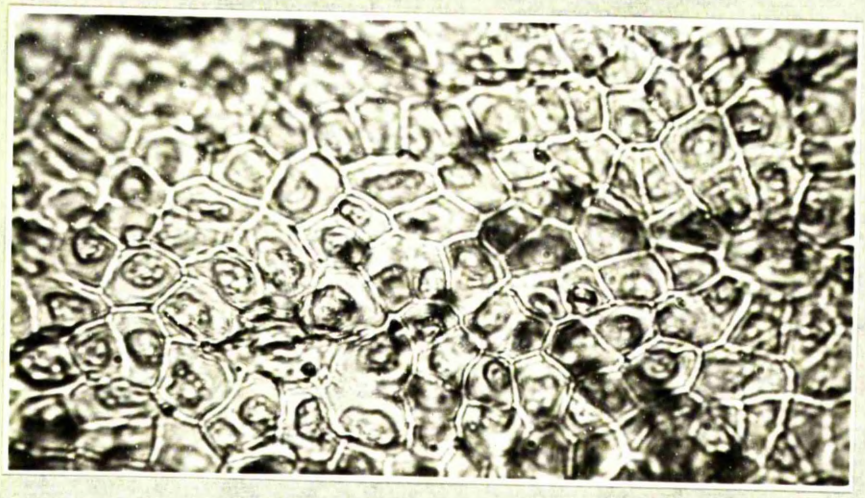
PLATE 71

Myrica gale L.

Leaf - Adaxial and Abaxial epidermis.



1. x 70

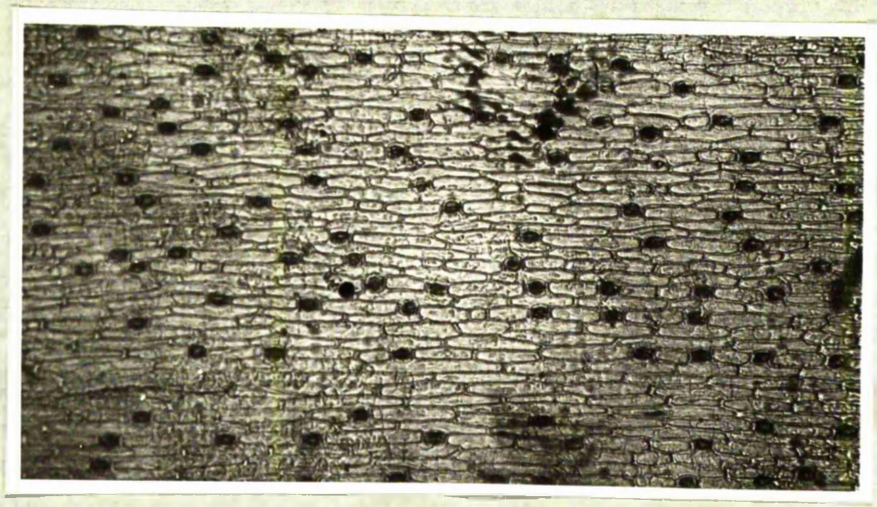


2. x 280

PLATE 72

Narthecium ossifragum (L.) Huds.

Leaf - Adaxial and Abaxial epidermis.



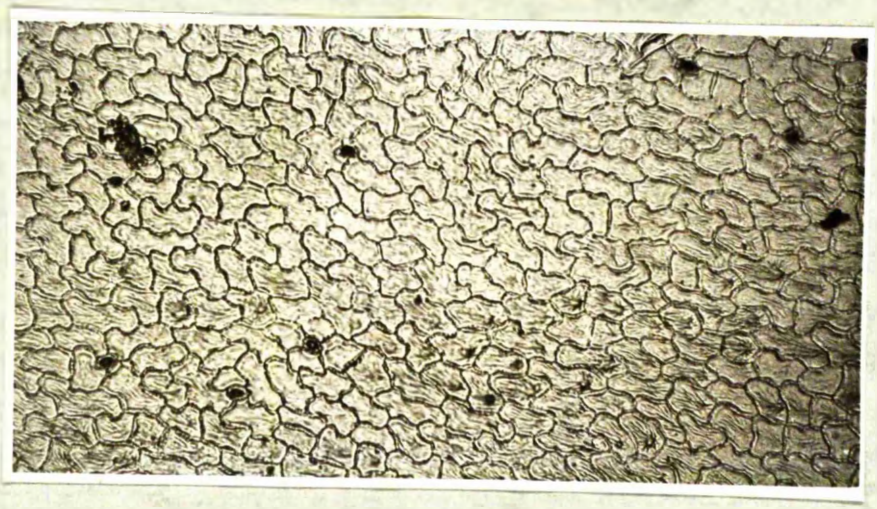
1. x 70

2. x 280

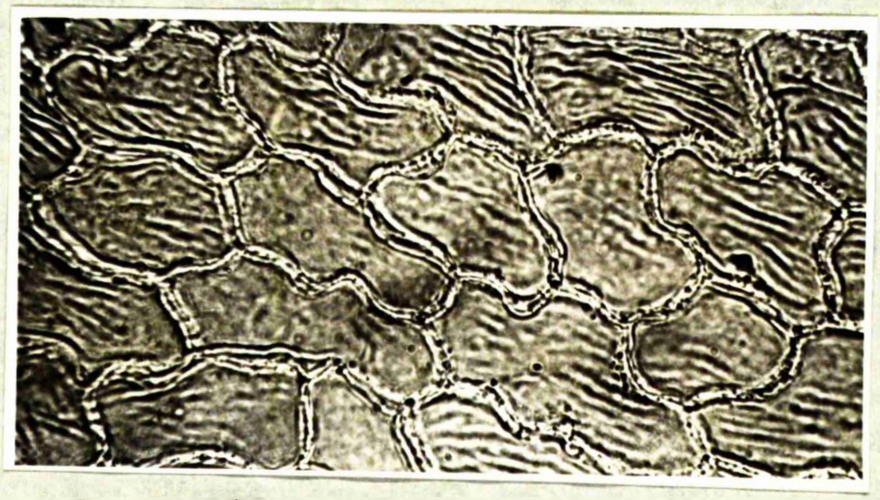
PLATE 73

Polygala vulgaris L.

Leaf - Adaxial epidermis.



1. x 70

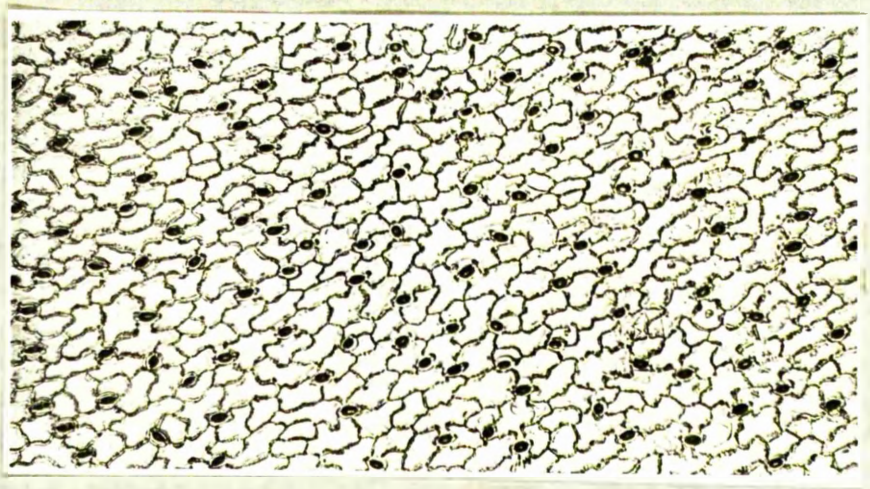


2. x 280

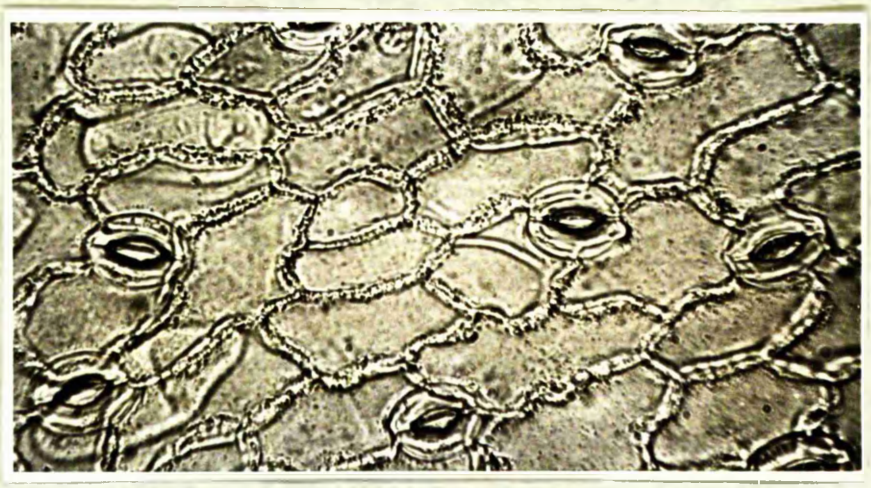
PLATE 74

Polygala vulgaris L.

Leaf - Abaxial epidermis.



1. x 70

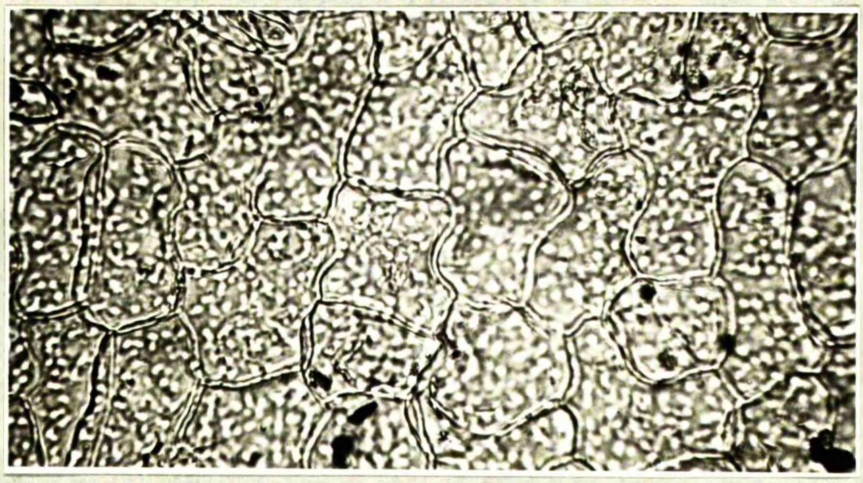


2. x 280

PLATE 75

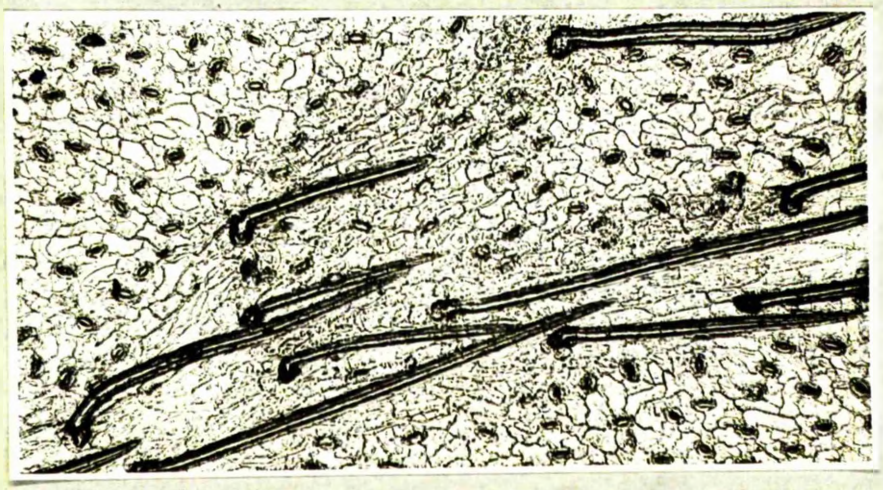
Potentilla erecta (L.) Rausch

Leaf - Adaxial epidermis.



1. x 280

Leaf - Abaxial epidermis.



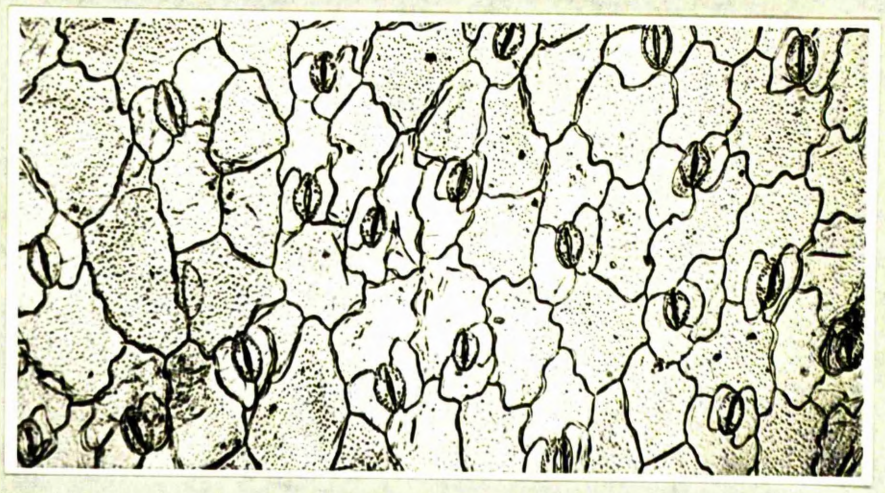
1. x 70

2. x 280

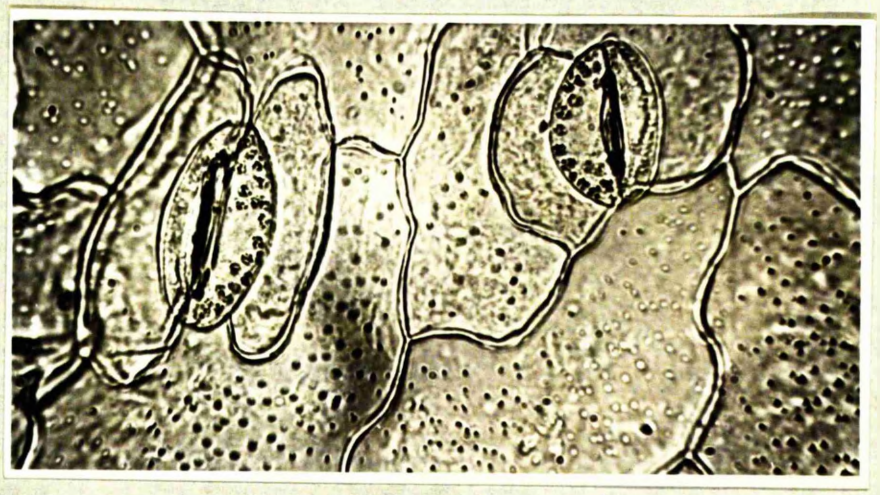
PLATE 76

Rumex acetosella L.

Leaf - Adaxial and Abaxial epidermis.



1. x 70

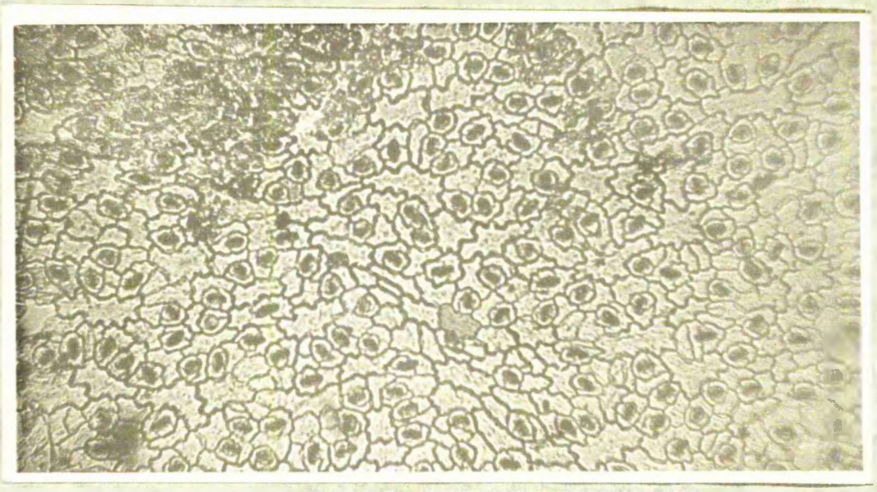


2. x 280

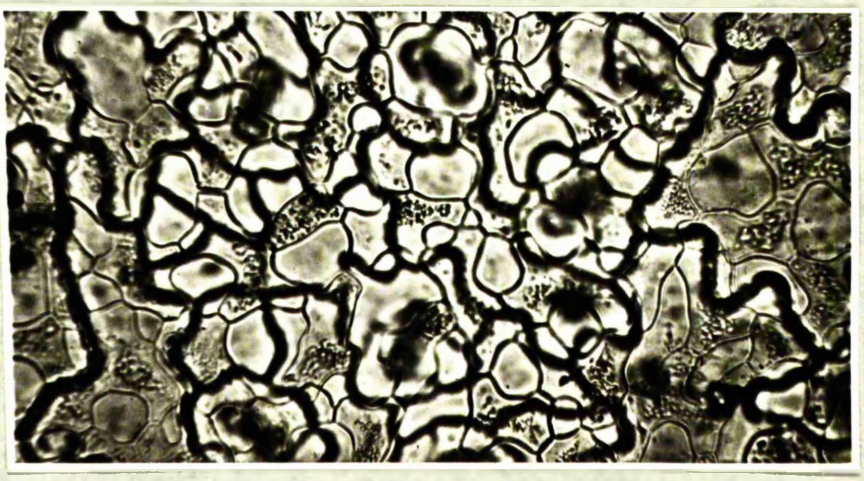
PLATE 77

Viola canina L.

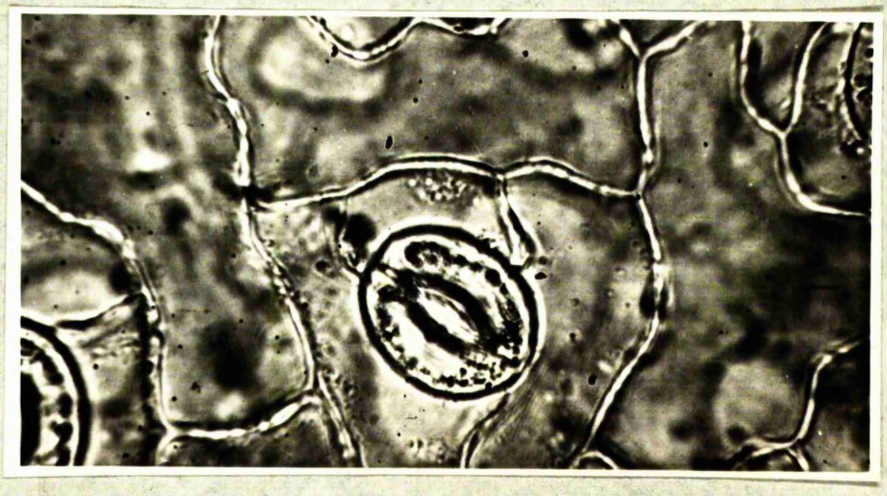
Leaf ♀ Adaxial and Abaxial epidermis.



1. x 70



2. x 280



3. x 750

7. Pteridophyta

Pteridium aquilinum L. Plate 78

On the adaxial surface of the frond the cells are jigsaw in type with thick walls.

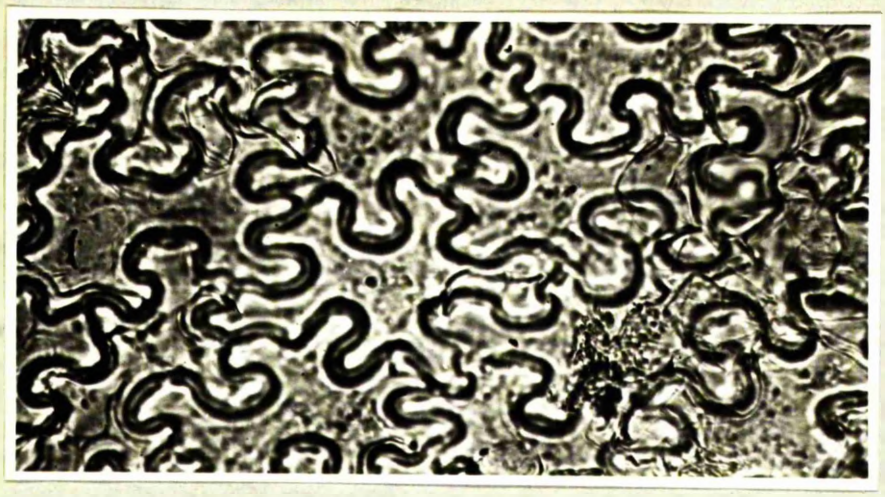
On the abaxial surface the cells are similar, slightly more contorted and with thicker walls.

The stomata are frequent. The stomatal cells measure 50 μ by 30 μ.

PLATE 78

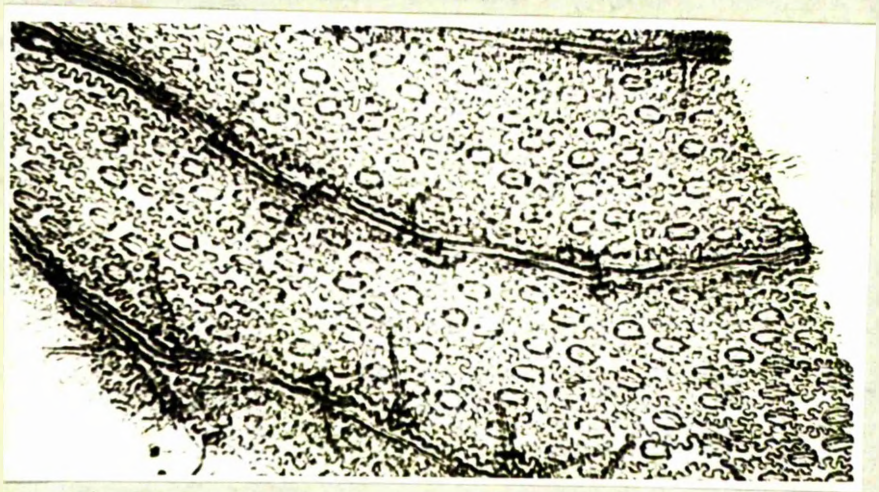
Pteridium aquilinum L.

Frond - Adaxial epidermis.



1. x 280

Frond - Abaxial epidermis



1. x 70

2. x 280

8. Bryophyta

Polytrichum aggregate Plate 79

In the leaf of this plant the cells are in regular rows. They have thin flexuous walls and measure about 10 μ square.

In the leaf sheath the cells are elongated and measure about 100 μ by 10 μ.

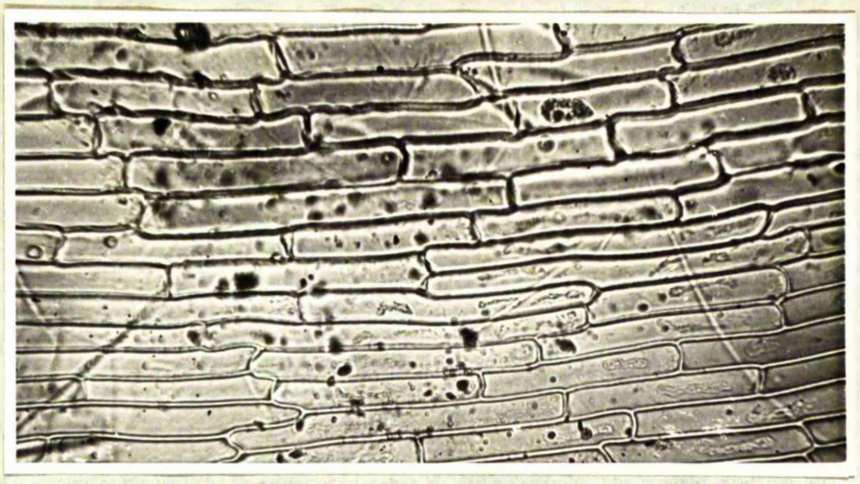
Sphagnum aggregate Plate 80

The cell groups in the leaves of this plant are irregular in shape, each group consisting of some 12 - 18 smaller cells. The walls are thin.

PLATE 79

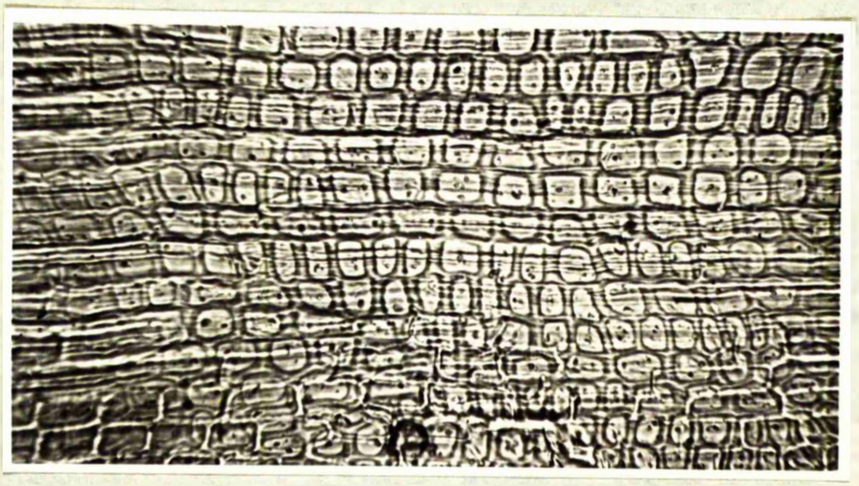
Polytrichum agg.

Leaf - Adaxial and Abaxial epidermis.



1. x 280

Leaf Sheath - Adaxial and Abaxial epidermis.



1. x 280

PLATE 80

Sphagnum agg.

Leaf - Adaxial and Abaxial epidermis.

1. x 280

PART III

INTRODUCTION

RESULTS

DISCUSSION

INTRODUCTION

Many workers have reported on the habits and diet preferences of sheep, utilising two main lines of approach to the subject. These are :

(a) an investigation of the grazing habits or flock movement with the actual species grazed as an incidental feature, and

(b) an investigation of the species grazed, with flock movement as an incidental feature.

In the present investigation the second type of approach was used but the results were correlated with data obtained from workers in the first type of investigation.

Hill sheep are gregarious creatures with an inborn flocking instinct and they therefore tend to stay close to one another and to their own grazing area. Each heft tends to have its own regular system of movement over its rake or hirsel and this again appears to be an inborn instinctive movement, modified locally by the climatic conditions and by the herbage available. In general, hill sheep tend to move towards the upper slopes of a hirsel as darkness approaches and prefer to spend the nights on/

/on the higher ground, as a defence against low-ground predators. This is evident in some cases where the change in altitude is only a few feet. In the mornings, at or before dawn, they move downhill rather quickly to graze the lower and usually more succulent herbage of the lower slopes and burn-sides (Heddle 1948).

Investigations by observation have been made on the specific grazing habits of sheep. Tribe (1948) in an analysis of three factors (general behaviour, specific choice of herbage and the reasons for such a choice) found that hill sheep had a working day of approximately 14 hours. More than half of this time was spent in actual grazing, nine to ten hours each day being spent in resting and rumination. The distance travelled was about three miles each day, this distance being little affected by change in botanical constituents of the pasture.

Further investigations by the same author (Tribe 1950b) on Blackface sheep showed that their day could be split into three activities - grazing, lying and idling. The amount of time devoted to these occupations was fairly constant throughout the day. Results from his study showed that there were 9½ hours grazing, 13 hours lying and 1½ hours idling. In winter more grazing took place from 7 a.m. to 7 p.m. than during the/

/the summer and less from 7 p.m. to 7 a.m. The average distance travelled was 2.6 miles, this being covered mostly in daytime. This distance was greatest in spring and autumn and least in summer. The distance travelled after dark was greater in summer than in winter despite the longer nights of winter.

He further showed that when bad weather is imminent a downwards movement from the higher slopes may be seen or if the sheep are already on the lower slopes they will stay there (Tribe 1950b).

Hughes & Reid (1951) give data for a similar observational experiment. They quote a grazing period of 9 hours (7.80 - 10.47 hours). In the period June - August 95-100 % of this grazing time occurs during daylight hours whereas during December only 60 % occurs during the day. Idling, lying down and ruminating occupied 11.4 hours (8.97 - 12.59 hours). In summer much of this occurred in daylight whereas in winter a greater proportion took place in darkness. Standing idle occupied 3.4 hours and walking idle 1.8 hours. All the idling time took place during the day in summer while in winter some took place during the hours of darkness.

Willmann (1955) suggests that younger sheep prefer higher ground and that in general sheep can go/

/go for longer periods without water as such than any other farm animals.

Robinson (1953) considers that the Blackface breed of sheep must display a more energetic grazing behaviour for foraging over difficult territory than any other breed.

Hunter (1954a) observed the behaviour of Scottish Blackface sheep on hill pasture in south-east Scotland. He noted that apparently the sheep knew the location on the hill of any specific community e.g. heather, and would frequently move directly towards it for a considerable distance although out of sight of it. Only in the spring and at lambing time did the ewes respond to bad weather by seeking shelter.

Comparisons of the resting periods of these sheep with those of the lowland sheep investigated by Tribe (1949) showed that the Blackface sheep were more active during the daylight. The actual location of grazing varied seasonally, due, as the author suggests, to the interaction of instinctive or acquired behaviour with the nature of the grazing, to meteorological or nutritional factors and to the presence or absence of lambs. Idle periods were related to sunset and sunrise, there being more time spent in resting during the longer days.

Both Wallace (1884) and Crofton (1949) have stated that hill sheep move and graze very little during the hours of darkness in summer but Wallace (loc. cit.) considers that a significant amount of both occurs between the hours of 11 p.m. and 2 a.m. during the winter months.

Investigations have also been carried out to determine the actual species grazed by the sheep. It is a commonly expressed view that sheep are 'selective' feeders, but it is not always made clear as to what each writer implies by using the term 'selective'.

Sheep may eat selected parts of plants; they may eat selected plants or types of plants or they may eat plants only at a selected stage of growth. In each of these instances the sheep may be termed 'selective' feeders; the problem then is to determine which of these criteria apply, if any, in a particular case.

The major factors in determining the selective feeding habits of sheep would appear to be :

(a) the age and breed of sheep.

(b) the time of year.

(c) the climatic conditions.

(d) the abundance or scarcity of types of herbage.

(e) the proximity of other members of the flock.

Sheep tend to prefer the finer herbage, and this frequently implies also the younger herbage, and have been shown to eat coarser herbage at the beginning and the end of the day, grazing on the grasses and other softer plants in the middle of the day (Fenton 1949). In wet weather they will avoid moving amongst rank vegetation whether or not they would normally eat it, although at such times coarse-leaved plants in open situations are eaten which in dry weather would be rejected (Tribe 1950a,b).

The reasons for sheep taking or rejecting any particular plant are difficult to determine and at times there appears to be no connection between palatability and selection. Tribe (1950a) reviews work by Linnaeus in which sheep were offered 618 different plants. Of these, 137 (22 %) were never eaten. Plants belonging to the families Saxifragaceae, Ericaceae and the order Filicales were always rejected and selection against harsh, strongly aromatic and hairy plants was also exhibited. It was concluded that sheep showed the least discrimination of all types of stock tested, this including sheep, cattle and goats.

Tribe & Tribe (1949) report on sheep from the islands of North Ronaldshay and Lewis which eat widely of a range of seaweeds available to them.

Cockayne (1919) has shown that under the conditions prevailing in New Zealand the sheep, in general/

/general, preferred to eat Hypochaeris radicata, Crepis capillaris, and Holcus lanatus before any other herbs or grasses followed in preference by Danthonia species, Poa colensoi, Dactylis glomerata and Poa pratensis in that order.

Armstrong & Thomas (1952) showed that sheep, when grazing heather, ate only the tips of the plants to an average of three-quarters of an inch in length. On another area under investigation by the same workers, which was composed half of heather land and half of white land, the sheep grazed noticeably longer on the latter area, stool bent (Juncus squarrosus) in particular being heavily grazed.

Davies (1925) has shown in an investigation concerning Kerry Hill and Suffolk ewes and lambs that more of the herbage was eaten when it was available as a simple mixture than when the same constituents were available separately as pure stands. This applied particularly to grasses in a clover mixture. Hairy plants were not relished as much as glabrous species. In red clover at flowering time the sheep preferred the flower heads and stem tops to the leaves, whereas white clover maintained a high and uniform attraction at all times of the year. Davies considers that the stage of growth of a plant is the dominating factor in its selection in grazing in/

/in that the younger and hence more succulent plants of a species tend to be preferentially grazed. Selection for species is only exercised during the late spring and the early summer when keep is relatively abundant. He does, however, indicate that there is a selection within the species since sheep prefer leaf lamina to leaf sheaths and flowering stems, and erect plants are more heavily grazed than those with a supine habit of growth. He comments that grass inflorescences, especially of Avena fatua and Lolium perenne, were occasionally heavily grazed.

Davies (loc. cit.) indicates three main grazing periods in the year : January to April; May to September; and October to December. In the first of these the sheep would prefer the winter-green species such as Lolium perenne, L. italicum, Poa pratensis and Cynosurus cristatus. The second period may be sub-divided into pre-flowering time, when there is a certain amount of selective grazing, into flowering time when most selection is exercised, and into the post-flowering period when there is more leaf growth and hence less selection. In the last period of the year the sheep will graze particularly on those plants with a good aftermath.

Davies (loc. cit.) also showed that these breeds of sheep (Kerry Hill and Suffolk) did not relish red fescue. He showed the following relative palatability series :

Clovers	100
Timothy	88
Cocksfoot	87
Perennial Rye Grass	86
Crested Dogstail	79
Italian Rye Grass	74
Sweet Vernal	73
Rough Stalked Meadow Grass	61
Red Fescue	35
Tall Fescue	30

Arnold (1961) has shown that merino sheep will select leaf material in preference to stem where this is possible. Furthermore they invariably chose the leaf or stem material containing most nitrogen.
In another experiment a direct relationship was found between the amount of pasture available and the time spent by the sheep in grazing. On pastures of low fodder availability some sheep stopped grazing due to fatigue before they were satisfied and as a result they lost body weight. He considers that differences between individual sheep in their capacity to graze for longer periods on poorer pastures could have practical implications.

As Woodman, Blunt & Stewart (1926) have shown, young grass had a marked richness in protein. This is the type of herbage shown to be preferred by sheep in the investigations carried out by Davies (1925) and Arnold (1961).

Tribe (1949b) has shown that the sense of smell in sheep is of importance in the initial stimulation of appetite but does not influence the selection of particular herbage species. He has also shown that sheep are colour blind (Tribe 1949c).

Linton (1918) has shown that any feeding at night cannot be selective except where feel or touch is brought into play and that sheep appear to be more voracious feeders at night. He disagrees in this respect with Crofton (1949) and Wallace (1884). He considers that Blackface sheep in particular will eat more of the rougher plants than will any other breed. He also points out that the presence of abundant or obvious clumps of a plant or plants in a pasture indicate that these are the plants which are not being eaten and of which full use is not being made.

Hunter (1954b) applied the methods of Boulet (1939) to Blackface sheep grazing part of a hirsel in Midlothian which could be kept und r direct observation.

Boulet's thesis was that each sward type has a characteristic comparative grazing intensity (C.G.I.) calculated from the number of sheep grazing the sward type in relation to its area as compared with the total grazing area of all sward types available. If the sheep showed no preference for a sward type (i.e. no selectivity) then the percentage of sheep grazing that sward type would be in direct proportion to the percentage of the total area occupied by that sward type.

From the calculation "100 multiplied by the percentage of sheep grazing the sward type area, divided by the percentage of the total area occupied by the sward type", the amount of over- or under-grazing of the sward in relation to others can be calculated. A C.G.I. of 100 implies no selective grazing while a C.G.I. of less than, or more than, 100 implies under-grazing and over-grazing respectively.

Hunter (loc. cit.) indicates the factors which he considers influence the preference for any particular sward type as follows :

1. Botanical composition of the sward:

(a) productivity of different species, on different soils and with different management.

(b) palatability of species varying with the stage of growth.

(c) seasonal availability, where winter-

/green species will retain a high C.G.I.

2. Seasonal changes in the location of grazing :

These are related to the regular flock movements, e.g. the low ground in the daytime, high ground at night pattern of movement usually shown by sheep but not by those in this particular experiment.

3. Location :

This involves the exposure of the sward and its position in relation to other swards.

4. Proportion :

A small proportion of a usually preferred sward type e.g. regenerating heather, will induce a high C.G.I.

Later the same author (Hunter 1958) indicated a further factor influencing the position of individual sheep on a pasture and therefore of their choice of herbage. This was the flock factor, caused by the sheep distributing themselves over the hirsel not only in relation to vegetation and shelter but also in relation to each other.

In general Hunter concluded that the seasonal utilisation of a sward type was unlikely to vary between pastures situated on different areas as other work showed that the same seasonal changes occurred at Sourhope and at Lammermuir in the Cheviots. (Hunter 1958).

The results showing the C.G.I. values of various sward/

/sward types are shown in Figure 3; 1-5, where they are compared with results of analyses from the present study.

Braid (1954) considers sheep to be 'notoriously improvident'. On hill pastures the bulk-producing grasses are absent or poorly represented but he suggests that nevertheless the grasses are the most important part of the vegetation, followed by the heathers and the heaths, sedges and rushes in that order.

There is thus general agreement among many workers that sheep are indeed selective feeders - selective in the species that they graze and in the particular part of the plant eaten.

As a result of this selective grazing by sheep there has been noted in many cases a marked increase in hill pasture of such plants as Molinia, Nardus, Deschampsia caespitosa and D. flexuosa and of Pteridium as well as Juncus species and Carex species. Although the floristic change has not lowered the fertility of hill pasture it has rendered the hills less productive (Wannop 1958).

All of the above results have been obtained by direct observation of the sheep and of the species grazed. The following workers have utilised rumen or faecal samples in the investigation of diet.

Norris (1943) examined rumen samples from sheep eating a herbage mixture as hay whose composition was known. Examination revealed that the rumen samples gave accurate qualitative results but that quantitative results were misleading, and no constant correction factor could be applied to them.

Tribe (1950a) similarly investigated this problem, but again his quantitative results were not in accordance with the diet actually fed to the animals. Much of the variation was due to the large proportion (48 - 65%) of material which was too fragmentary to be quickly identifiable. Tribe (loc. cit.) considered that an analysis of this fragmentary material would be too time-consuming to be practicable under normal conditions.

Godfrey (1953) investigated the diet of Microtus agrestis L., the field vole. Microtus is an herbivorous genus and the faecal pellets were found to be a good source of plant epidermal material. The voles were on a Brachypodium pinnatum L. - dominant area. It was found that the eight species of grasses and the single sedge growing on the study areas could be distinguished from one another by the microscopic structure of their epidermal cells. The characters used were the linear proportions of the cells and the character of the cell walls, with the presence of hairs and spines as additional diagnostic characters. Godfrey's results suggested a reflection of seasonal/

/seasonal differences in grazing intensity on different species and also differences between areas consistent with the differences in species distribution. She also notes that Helictotrichon pubescens (Huds.) Pilger occurred more frequently in pellets than would be expected from its known distribution and concluded that voles showed a marked preference for eating it.

The present author (Martin 1955) investigated rumen and faecal samples from Blackface sheep and Highland cows. Some forty species of hill plants were prepared as check material, and the counts from the samples for sixteen of these were tabulated. The qualitative diet of the animals was shown for one year in the case of the sheep, and a corresponding sample for one month from the Highland cow. He points out that, where digestive effect is similar for many species, the faecal samples may give a more accurate estimate of the qualitative and quantitative diet, since the fragments in such samples are more free of underlying leaf tissue which may partly or wholly obscure the epidermal pattern. The use of faecal material also obviates any surgical or mechanical interference with the sheep with its possible effect of alteration of the normal movement and diet habits. He also notes that some plant epidermises may be completely digested by the animal, and as a result no trace be found of them in the rumen or faecal/

/faecal samples, giving an erroneously negative result. Martin also considers that there may be instances of plants appearing in the samples with a relatively high frequency, and yet not being deliberately grazed by the animals. ' In particular, he feels that this is true of Sphagnum spp. and Polytrichum spp.

MacLeod (1955) investigated the rumen contents of sheep with the object of assessing their seasonal grazing selectivity for Calluna vulgaris and Erica species. In quantitative terms, summer samples contained 20% of their total weight as C. vulgaris while winter samples contained 40%. In qualitative terms, 77% of the samples taken in the period May - September contained C. vulgaris as compared with 93% of the samples from October - April. In these latter samples some E. tetralix was found but no E. cinerea. MacLeod inferred from these results that sheep showed little preference in grazing particular parts of the heather plant during winter, since many samples contained entire shoots up to two inches long. In summer samples only shoot tips of that season's growth were found.

Huxley (personal communication) investigated the food of woodlice, by analysis of the gut contents for epidermal fragments of plants. No published data are available for this work.

Hercus (personal communication) applied the methods of Martin (1955) to sheep grazing on New Zealand hill pastures. Later the results of this and other investigations by the same author (Hercus 1959) showed the method to be a promising system of gaining information on the self-selected diet of the free-ranging sheep. She utilised faecal samples collected from two areas, one a fescue community with 35-inch yearly rainfall and the other a 'depleted' area with 16-inch yearly rainfall. She was able to separate 19 species by means of an artificial key based on epidermal characters, while the rest of the 50 species involved were sufficiently different to be separable visually. Both Monocotyledons and Dicotyledons were listed in her analyses.

Her analyses showed three groups of counts per species per sample (Hercus 1959). The first group was represented by ten or more epidermal fragments per sample and was provisionally taken to represent those species always grazed at the time of sampling. The second group was of a few fragment counts, representing species occasionally grazed, while the third group was of species giving infrequent fragments in the samples, probably being species which were perhaps accidentally eaten with others or were very infrequent in the pasture. Some epidermal fragments/

/fragments from the samples could not be matched with material from plants collected on the area, and she concluded that these came from plants occurring rarely in the flora, yet which might be heavily grazed by a particular sheep, giving a high count in its sample.

Charles (personal communication) has applied the techniques of epidermal character recognition to a study of the diet of voles in central Scotland. Results of this investigation have not yet been published.

Hercus (1960) reviews the basic principles underlying the use of epidermal characters in diet estimation and reports on the result of the extension of earlier work on sheep in New Zealand. Work on tussock grassland has shown that the method could give an accurate qualitative result i.e. a list of the plants eaten and digested. There was surprisingly little variation between animals on the same area and each sample thus gave a similar list of species grazed in similar proportions. This suggested the same pattern of grazing by each animal. No quantitative estimate was at that time available from these results; experiments were therefore put in hand in order to find the correlation, if any, between epidermal fragment counts in the faecal sample and the amount ingested of the corresponding species.

In the course of this work Hercus (loc. cit.) showed that: a) the cuticle was completely resistant to rumen digestive processes over a period of at least two days; b) that epidermal fragment counts could reflect a change in diet (in this case due to the onset of the rainy season) within at least 13 hours of the change in diet; and c) on plots of a single species, where the sheep grazed for 2½ - 3 days, the relevant species (Medicago sativa L.) formed 89% of the fragment counts, weed species 3%, other grasses 4% and unknown fragments 3%.

On another plot, where Lolium perenne L. gave a count of 90% by herbage dissection, the percentage of this species in the faecal samples was 82%. Similarly, Festuca elatior L., 87% by herbage dissection, gave a sample count of 85%.

On a plot containing one grass and one clover, the relevant figures were:-

	Dry Weight %	Fragment Count %
L. perenne	90	81
Clover	11	15
Unknown	0	3

The proportions of the fragments in the faeces were thus of the same order as those obtaining in the original herbage. She suggests that the small difference in proportion in the clover result could be due to selection for/

/for it on the first day of grazing, or to differences in the relative digestibility of the grass and the clover.

Investigations with a more complex diet available to the animals gave results as below :

	Dry Weight %	Fragment Count %
Holcus lanatus	59	35
Lolium perenne	28	20
Other grasses		10
Clovers	13	21
Weeds	0	9
Unknown	0	

From these results Hercus suggests that there could have been selection against H. lanatus (due to its hairy nature) or that it could be less digestible than the clovers. (In this experiment the animals were on a free range and were therefore not being fed a completely known diet. This would perhaps account for the discrepancies, particularly with regard to weeds and unknown plants.)

In further simple grass/clover feeds of 3/1 ratio, the ratio of epidermal fragments of these species in the faeces varied from 2.5/1 to 3.3/1, with an average of 2.8/1.

Further investigations are in hand by Hercus (personal communication) to determine the relationship among/

/among epidermal fragment counts, relative digestibility of grazed species and weight of species eaten.

Phillipson (1952) has shown that approximately 32 % of sheep faeces is composed of the residue, both coarse and fine, of the ingested food. The remainder consists of glandular and body waste materials. Lignified and cuticular structures are particularly prominent in the undigested residues of fodder plant materials, other tissues of the plants being digested in a certain order and at widely differing rates (Baker & Nash 1947).

Goss (1943) has shown that there is no glandular secretion in the first three stomachs of the ruminant animal, breakdown of ingested material at this stage being due to infusorial and bacterial attack, accompanied by a restricted amount of lipolysis.

Phillipson (1953) endorses this view showing that the degradation of cellulose is due almost entirely to the effect of cellulolytic bacteria in the first three stomachs.

From the above review it is clear that the analysis of cuticular fragments in rumen or faecal samples, can, with some qualifications, give an adequate picture of the self-selected diet of herbivores.

RESULTS

The tabulated results of the diet analyses are shown in Appendix Tables 1 - 27 (Pages 257-292).

In 1957 ewe sampling commenced in May and continued at monthly intervals, except when for various reasons samples were not available, until September 1960 (June 1960 on Low End hirsel).

During the period 1957 - 1959 lamb samples were taken monthly from birth to speaning i.e. from May to October. No lamb samples were taken in 1960.

In the following preliminary presentation of the results the thirty-seven originally investigated species have been restricted to those showing important similarities or variations within groups and between hirsels or animals.

For the sake of convenience abstracts from Appendix Tables 1 - 27 are shown here relative to the species discussed (Tables 1 - 12). These abstracted Tables show the average fragment count in monthly samples over the period of study, for each of four groups of animals :

Barnacarry Ewes..... BE
Low End Ewes..... LE
Barnacarry Lambs..... BL
Low End Lambs..... LL

TABLE 1

Festuca rubra

	J	F	M	A	M	J	J	A	S	O	N	D
BE	11.5	12.5	21.0	14.6	9.1	11.7	17.3	12.6	13.7	12.8	11.5	13.3
LE	10.25	12.0	19.3	15.6	12.7	12.8	16.5	13.9	13.0	12.1	11.0	12.7
BL					10.2	13.3	16.3	14.7	13.9	14.2		
LL					13.0	14.5	17.7	15.0	12.6	14.0		

From Barnacarry ewe samples a maximum sample count is found of 21 % in March with a minimum of 9.1 % in May and a secondary maximum of 17.3 % in July. At most times of the year fragments of F. rubra are the most frequent components of samples being superseded by Calluna in January, August November and December and by Agrostis and Eriophorum in May.

In Low End ewe samples the maxima are again in March (19.3 %) and July (16.5 %) with a minimum in January (10.25 %). It is superseded in importance during January, February, September, November and December by Calluna.

The Barnacarry lambs show a maximum sample count of 16.3 % in July and from this month onwards have a higher sample count than the ewes.

Similarly the Low End lambs have a maximum of 17.7 % in July and a greater sample count than the ewes thereafter except in September.

TABLE 2

Agrostis stolonifera

	J	F	M	A	M	J	J	A	S	O	N	D
BE	10.5	11.75	13.0	11.6	10.3	9.0	6.6	6.0	6.2	6.5	8.2	6.9
LE	9.0	10.3	11.3	7.4	8.9	6.3	5.0	5.6	6.5	6.7	7.75	9.3
BL					9.6	10.9	9.6	10.1	11.2	8.6		
LL					7.9	7.7	5.9	4.5	4.9	6.4		

Barnacarry ewe samples show a maximum of 13.0 % in March and a minimum of 6.0 % in August. Grazing of this species shows no abrupt changes in sample count and it is reasonable to conclude that there was no intensive selection for it by this group of animals.

Low End ewe samples show a maximum of 11.3 % in March declining to a minimum of 5.0 % in July.

Barnacarry lamb samples show a relatively higher sample count as compared with the ewe samples from this hirsel, with a mean of 10.0 % (Appendix Table 27). The occurrence of maxima in June and September suggest a different grazing pattern from that of the ewes on this species.

Low End lambs have a sample count greater than that of the ewes only in June and July and an average over the sampling period of 6.3 % compared with a ewe average of 7.7 % (Appendix Table 27). This contrasts with the comparison for Barnacarry ewes and lambs.

TABLE 3

Juncus species

	J	F	M	A	M	J	J	A	S	O	N	D
BE	12.5	12.25	7.0	4.4	2.6	3.1	2.2	2.8	4.4	6.5	10.6	12.5
LE	14.25	12.5	10.0	7.6	5.9	3.9	4.75	3.7	4.3	7.9	11.5	15.1
BL					1.0	0.6	0.1	0.7	1.9	3.5		
LL					4.5	2.8	2.9	3.3	3.4	5.7		

A maximum of 12.5 % in December and January is shown in the Barnacarry ewe samples with a minimum of 2.2 % in July. This variation holds in general for the three *Juncus* species studied.

Low End ewes show a maximum intake of 15.1 % in December and a minimum of 3.7 % in August. Over the period of study the average amount grazed was greater than on Barnacarry (7.8 % : 5.6 %) especially in the case of *J. squarrosus* (2.2 % : 1.2 %) (Appendix Table 27).

At all times over the sampling period the Barnacarry lamb samples showed a smaller fragment count than that of the ewes (1.4 % : 5.6 %).

Similarly the Low End lambs had a lower intake than the ewes (3.9 % : 7.8 %) particularly in the case of *J. squarrosus* (0.5 % : 2.2 %) (Appendix Table 27).

TABLE 4

Eriophorum species

	J	F	M	A	M	J	J	A	S	O	N	D
BE	7.5	6.75	7.0	10.2	12.4	8.4	4.0	4.2	3.4	2.0	1.8	4.9
LE	8.75	8.2	8.6	8.1	9.0	9.2	5.75	4.7	4.5	2.4	2.75	6.8
BL					11.4	10.3	8.0	4.7	3.5	1.9		
LL					8.6	7.5	7.7	6.2	4.1	3.3		

Barnacarry ewes show a maximum intake in May of 12.4 % and a minimum in November of 1.8 %.

Low End ewes have a maximum in May - June of 9.0 % - 9.2 % and a minimum in October - November of 2.4 % - 2.75 %. Overall these ewes utilised these species to the same extent as the Barnacarry ewes (6.7 % : 6.4 %) (Appendix Table 27).

The Barnacarry lambs show an almost constant intake of these species from May - July (11.4 %; 10.3 % and 8.0 % respectively) while the ewe intake is declining rapidly (12.4 %; 8.4 %; 4.0 %). Also, they would appear to eat more E. angustifolium than did the ewes (1.2 % : 0.8 %) (Appendix Table 27).

A similar picture of Low End lamb diet exists with the lambs maintaining their intake from May - July (8.6 %; 7.5 %; 7.7 %) while the ewe intake declines (9.0 %; 9.2 %; 5.75 %). The difference in total intake is, however, not well-marked (1.3 % : 1.1 %) (Appendix Table 27).

TABLE 5

Carex species

	J	F	M	A	M	J	J	A	S	O	N	D
BE	5.0	5.0	6.5	10.0	7.0	3.6	2.9	4.2	2.8	3.8	7.4	8.1
LE	6.0	6.3	5.8	8.6	6.8	4.3	4.0	4.5	3.9	6.9	8.5	6.6
BL					4.3	4.6	3.7	4.7	3.8	3.5		
LL					7.7	8.6	7.0	8.2	8.4	7.6		

Barnacarry ewe intake shows two maxima, in April of 10.0 % and in December of 8.1 %. There is a significant amount of *Carex* species in the diet at all times of the year, the average over the period of study being 5.3 %.

Low End ewes also show a maximum in April, of 8.6 %; their second maximum occurs in November at 8.5 %. The average intake over the study period was 6.0 % (Appendix Table 27).

Barnacarry lamb intake remained remarkably constant varying from a maximum of 4.7 % in August to a minimum of 3.5 % in October. This compares with a decreasing ewe intake over the same period.

The intake of Low End lambs varied from 8.6 % to 7.0 % with an average of 8.0 %. Again this compares with a decreasing ewe intake at this time of the year.

TABLE 6

Molinia caerulea

	J	F	M	A	M	J	J	A	S	O	N	D
BE	3.5	7.5	7.5	6.0	7.4	4.5	1.3	2.4	1.0	0.8	1.3	1.7
LE	4.25	6.3	7.3	7.3	6.4	5.7	3.5	2.9	2.5	2.3	1.75	3.9
BL					6.8	7.4	5.4	2.2	1.3	1.0		
LL					5.8	6.4	4.4	1.7	0.9	1.1		

In Barnacarry ewe samples this species formed an important part of the count from February to May, ranging from 6.0 % to 7.5 % and thereafter falling off rapidly to a minimum of 0.8 % in October.

Similarly the Low End ewe samples show a high incidence from February to May of 6.3 % to 7.3 % with a minimum of 1.75 % in October.

In both lamb groups the percentages and grazing patterns follow much the same course of a high May - June intake followed by a fairly regular reduction.

TABLE 7

Calluna vulgaris

	J	F	M	A	M	J	J	A	S	O	N	D
BE	17.0	19.25	6.0	3.2	2.4	3.1	4.7	14.4	13.4	11.9	12.7	14.8
LE	19.0	21.0	11.0	8.1	6.3	4.2	7.0	12.6	13.4	10.4	13.5	16.3
BL					5.1	1.1	1.7	4.3	6.9	10.3		
LL					4.1	3.1	2.9	3.2	4.5	9.3		

In Barnacarry ewe samples this species forms the second most frequent component of the diet analyses over the sampling period. It is at a maximum count in February samples of 19.25 % and shows a secondary maximum from August - November (11.9 % - 14.4 %). It is least common in May samples at 2.4 %.

A similar situation exists in the Low End ewe samples with a February maximum of 21.0 % and an autumn range of 10.4 % - 13.5 %. Minimum intake is found in June at 4.2 %.

From the high May record of 5.1 % the Barnacarry lamb sample count falls to 1.1 % in June and slowly rises to 10.3 % in October. This contrasts with the earlier (August) maximum found in the ewes.

The Low End lamb diet shows a similar variation, ranging from 4.1 % in May to 2.9 % minimum in July and later rising to 9.3 % maximum in October.

TABLE 8

Trifolium species + *Lotus* species

	J	F	M	A	M	J	J	A	S	O	N	D
BE	0	1.25	1.5	2.0	3.3	5.4	6.3	2.8	5.0	7.2	4.7	1.1
LE	0	0	0.7	0.9	2.3	5.6	6.75	10.3	10.0	6.8	1.0	0.1
BL					4.4	7.6	9.5	9.0	7.8	8.7		
LL					3.1	6.0	6.0	10.3	11.2	8.5		

These species are apparently eaten in amounts according to their stage of growth, their intake rising accordingly to a maximum in July - September. The ewe diet maximum is 6.3 % on Barnacarry hirsel in July and 10.3 % on Low End hirsel in August.

The lambs eat a high proportion of these species on both hirsels, and this is maintained through much of the sampling period. Barnacarry lambs have a maximum intake of 9.5 % in July; Low End lambs have a maximum intake of 11.2 % in September.

Over the total period of study the lambs ate considerably more of these species than did the ewes; 8.4 % : 4.0 % on Barnacarry hirsel and 7.1 % : 4.2 % on Low End hirsel (Appendix Table 27).

TABLE 9

Sphagnum species + Polytrichum species

	J	F	M	A	M	J	J	A	S	O	N	D
BE	1.5	2.75	4.5	3.0	3.5	4.7	6.3	4.8	4.1	4.2	5.7	4.9
LE	2.5	3.2	4.1	4.4	5.8	7.0	5.5	4.6	6.1	5.6	4.0	3.3
BL					2.0	3.1	3.2	3.3	3.4	3.4		
LL					7.4	7.2	6.2	7.7	7.9	5.6		

The intake of these species is fairly constant throughout the year within each group of animals, but the level of intake varies from group to group. The average intake over the study period was : Barnacarry ewes 4.3 %; Low End ewes 4.9 %; Barnacarry lambs 3.0 %; and Low End lambs 6.9 % (Appendix Table 27).

TABLE 10

Myrica gale

	J	F	M	A	M	J	J	A	S	O	N	D
BE	0	0.5	0.5	0.8	0.7	1.2	1.7	3.0	0.9	0.3	0.7	0.2
BL					0	0	0	0	0	0.1		

This species occurs in quantity only on Barnacarry hirsel. No fragments were found in any of the samples from the Low End animals.

TABLE 11

Gramineae + Juncaceae + Cyperaceae

	J	F	M	A	M	J	J	A	S	O	N	D
BE	54.0	66.9	74.0	79.4	74.3	64.0	56.5	53.0	51.9	48.6	52.9	60.2
LE	63.75	65.1	75.8	75.4	73.3	66.1	61.5	55.5	55.1	58.9	59.5	65.2
BL					67.5	74.2	68.4	59.7	56.7	52.7		
LL					70.2	71.9	70.3	64.5	58.3	60.5		

The above Table is a summation of the results from the narrow-leaved plants of importance on the hill.

In general the ewe results rise to a maximum in April and fall to a minimum in September, following the spring flush and increasing maturity pattern of growth of the constituents.

The lamb samples are at almost all times higher.

TABLE 12

Other Forage Herbs

	J	F	M	A	M	J	J	A	S	O	N	D
BE	28.5	27.25	15.0	10.6	15.0	22.6	27.0	31.2	33.1	36.9	32.5	31.0
LE	27.75	28.8	19.8	18.3	21.3	27.1	28.5	38.3	39.0	32.1	26.25	25.6
BL					17.2	17.0	19.7	23.4	28.0	36.2		
LL					20.3	23.7	24.2	33.2	37.5	33.1		

This Table represents the summation of the results from the petalloid Monocotyledons and the herbaceous Dicotyledons. It follows a pattern over the year which is almost the reverse of that shown in Table 11. The high winter values are due to the inclusion of the results for Calluna vulgaris.

Unclassified and Unknown

Under the heading of 'unclassified' come those plants which occurred infrequently in the samples. There were many genera represented in this group, mostly Dicotyledons, and included Achillea, Alchemilla, Carduus, Cirsium, Crepis, Narthecium, Orchis, Pedicularis, Polygala, Rumex, Veronica, Viola etc. Occasionally fragments were encountered which were not quite typical of known patterns; these also were included in this group. Each genus above noted was separately an insignificant part of the total count but when summed the 'unclassified' entry gave an average of 6 % over all samples. The percentage varied from month to month, due mainly to the varying frequency of uncommon grazing constituents of the herbage; it tended to be higher in lamb samples than in ewe samples.

The 'unknown' classification was applied where an epidermal fragment in the samples could not be matched with the reference material collected from the hirsels. In most cases these fragments would come from plants which were relatively rare in the flora, from immature herbage or from additional winter feed. This group accounts for 3.5 % of the total over the study period.

An entry of '0' against any species can be interpreted in various ways:-

1. The plant/

/1. The plant is not present on the hirsel. In the present study this does not apply.

2. The plant may be present but may not have been eaten.

3. The plant may have been eaten but fragments may not have appeared in the samples due to the complete disintegration by digestion of the epidermis and cuticle.

4. The plant may have been eaten, appeared in the bulk sample but not in the analysed fraction.

It is evident then that little or no importance can be attached to the absence from samples of any given plant, unless its frequency on the hirsel and its known ability to withstand digestion is such that it is improbable that it be overlooked in samples. In such cases a consistent '0' entry indicates complete rejection by the grazing animal. An example of this is shown by the results from lamb samples on Barnacarry hirsel for Myrica gale; out of fifty-six samples only one showed one fragment of this species.

The above Tables 1 - 12 show the average fragment count in monthly samples over the period of study. Certain qualifications must be borne in mind when consideration is being given to results of this type.

1. There is at present no known correlation between qualitative results as presented here and a quantitative assessment of the weight eaten of any particular species. Therefore an entry of 10 % for F. rubra is not directly equivalent, in terms of weight, to an entry of 10 % for C. vulgaris at the same time of the year.

2. The analyses show the percentage of the total diet which is represented by the fragments for any given species. Therefore a result of 10 % for a given species in winter samples, when there is relatively little bulk of any plants available, will not indicate the same amount of the plant as an entry of 10 % during summer when the total weight of plants grazed may be many times that during the winter.

3. When a plant is at its least palatable it tends to be broken into smaller fragments than when it has become less fibrous (Hercus 1960). Thus, at its period of greatest palatability one would expect a lower fragment count for a given weight ingested of any particular species. In fact, in most cases in the analyses, the highest counts are found at the period of greatest palatability and digestibility; it follows that the present results therefore underestimate the selection for a plant at its palatable period or, conversely/

/conversely, overestimate its true value in the diet at periods of low palatability. Since the conclusions drawn from the results are based on the variation over the year of the percentage of fragments of a species in the samples, the evidence in favour of the conclusions is greater than at first appears.

DISCUSSION

1. Yearly Grazing Pattern

The results obtained from three species, Festuca rubra, Agrostis stolonifera and Calluna vulgaris, over the period of study are shown in Figure 1; 1 - 4. The results are expressed as the average fragment count in samples for each successive year, compared with the average fragment count over the whole period.

Ewe sample results are shown at bi-monthly intervals, lamb sample results are shown at monthly intervals.

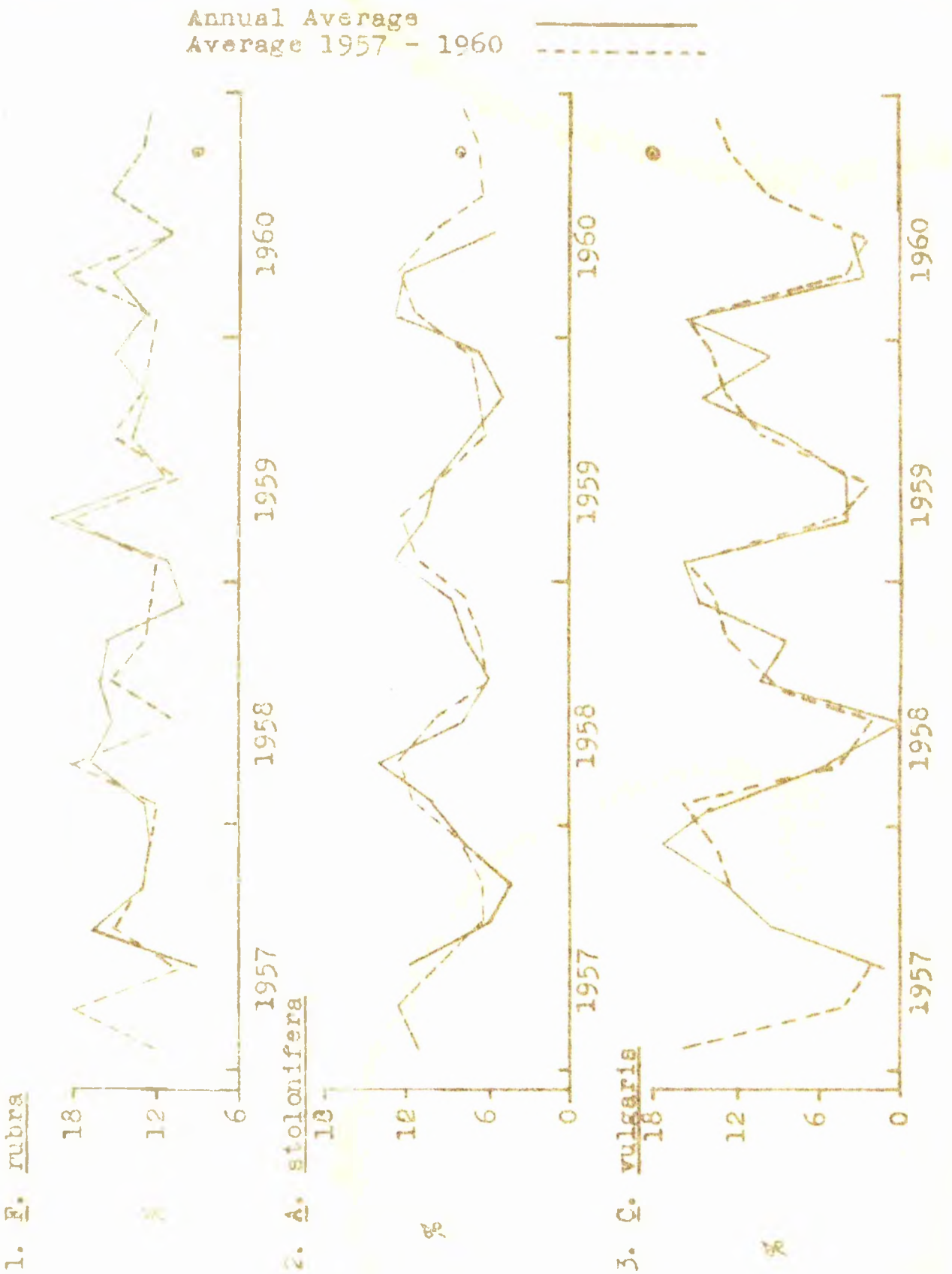
These three species were chosen for illustration because of their importance in the flora and diet of the animals.

It can be seen that there is a close parallel in each year to a set pattern of grazing on these species, indicating that there is an annual grazing cycle. This is particularly the case with the ewe results. In some cases the lambs do not show so constant a grazing pattern but this may well be due to the different grazing system of the lambs as compared with the ewes (see later) and to their unfamiliarity with the grazing area.

It can be concluded that, for the species shown,/

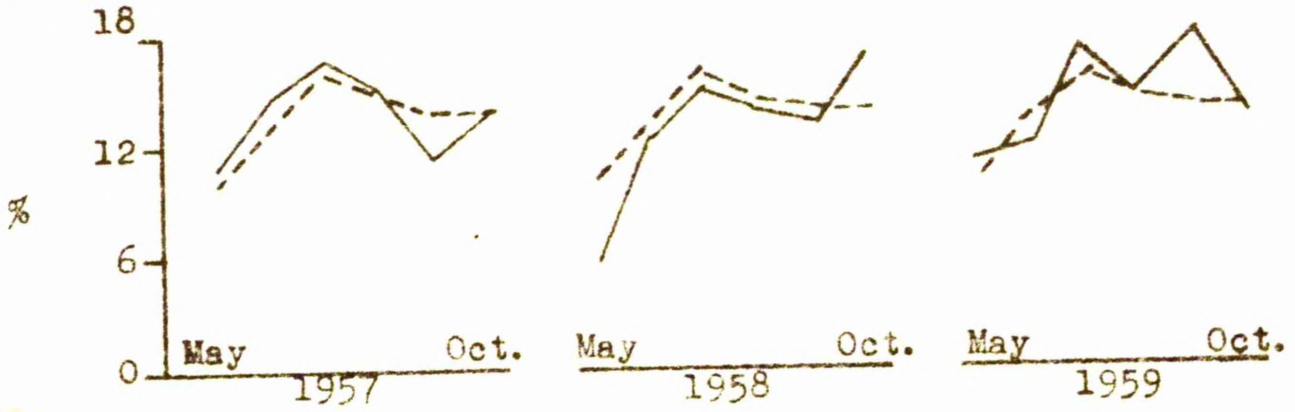
FIGURE 1

Comparison of Annual Averages with Average of 1957 - 1960

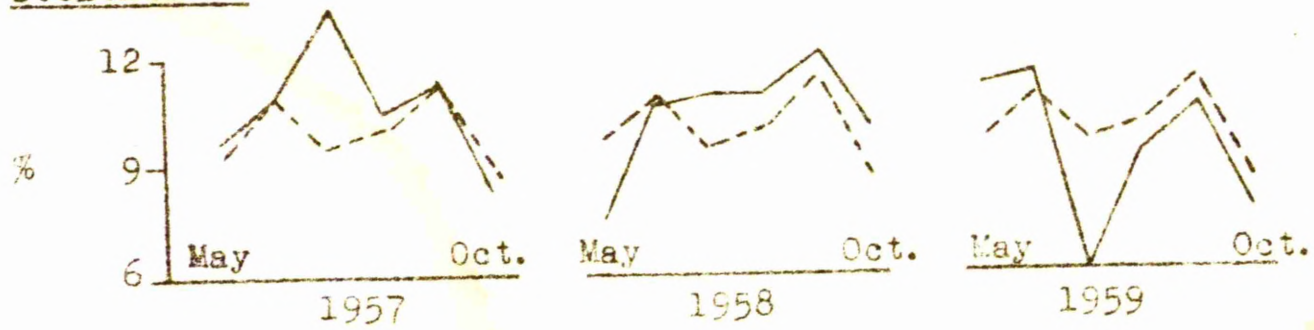


2. Barnacarry Lambs - Monthly

1. F. rubra



2. A. stolonifera



3. C. vulgaris

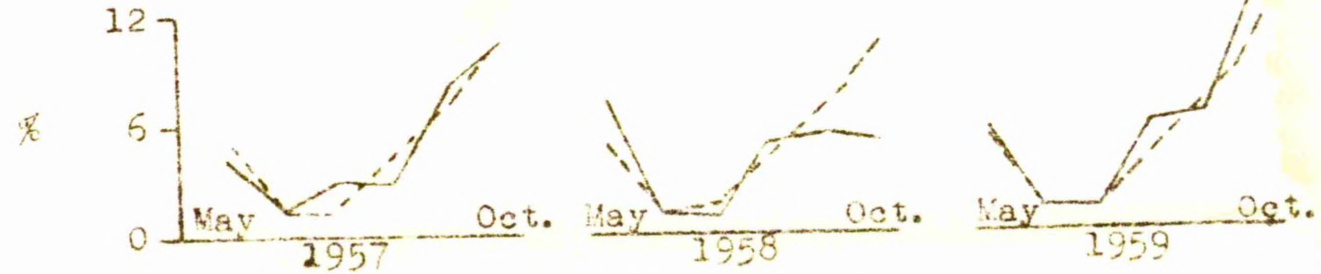
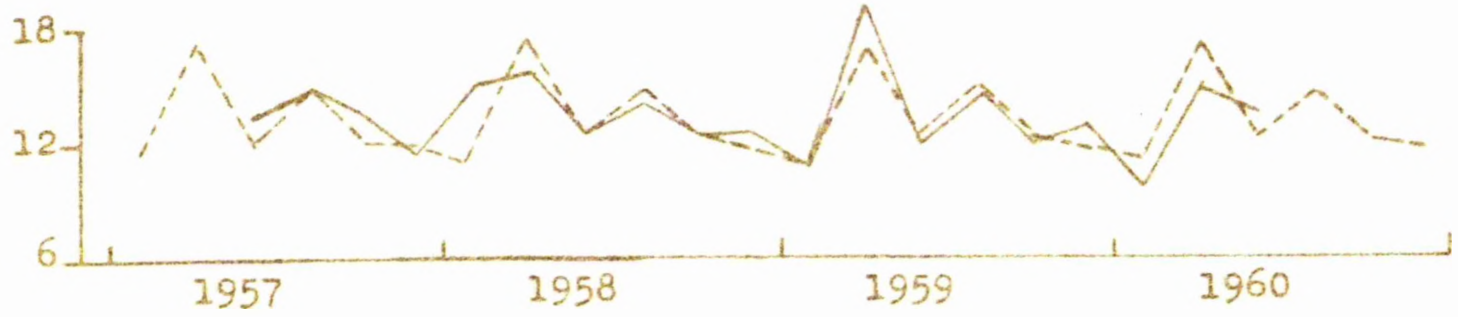


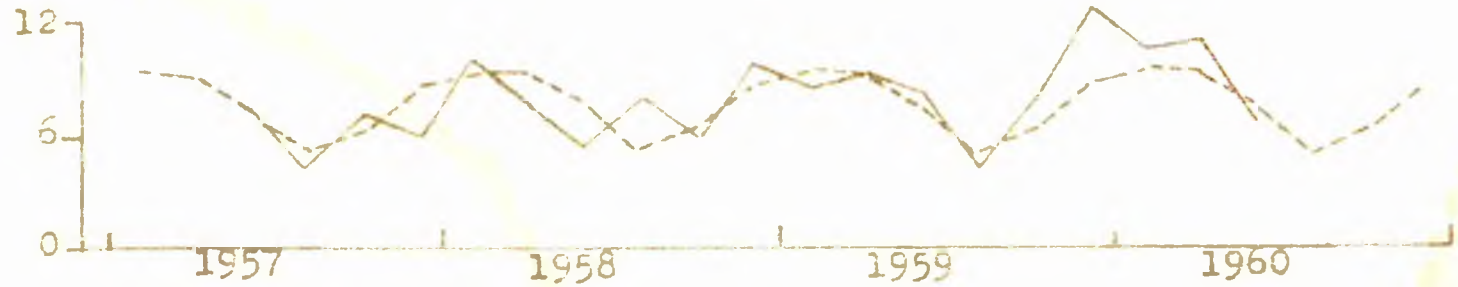
FIGURE 1 continued

3. Low End Ewes - Bimonthly

1. F. rubra



2. A. stolonifera



3. C. vulgaris

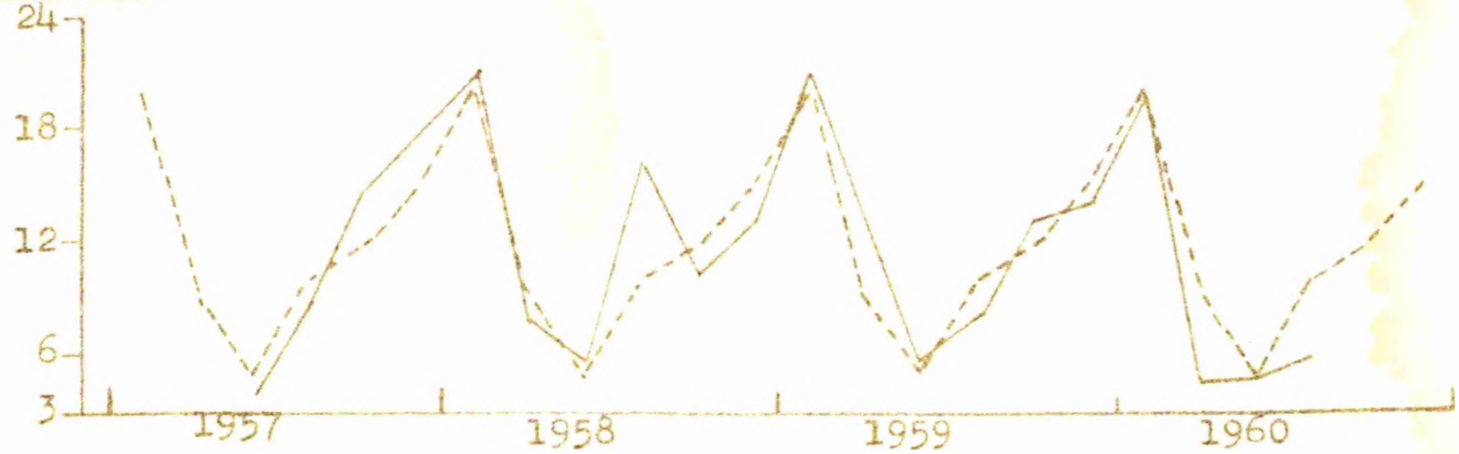
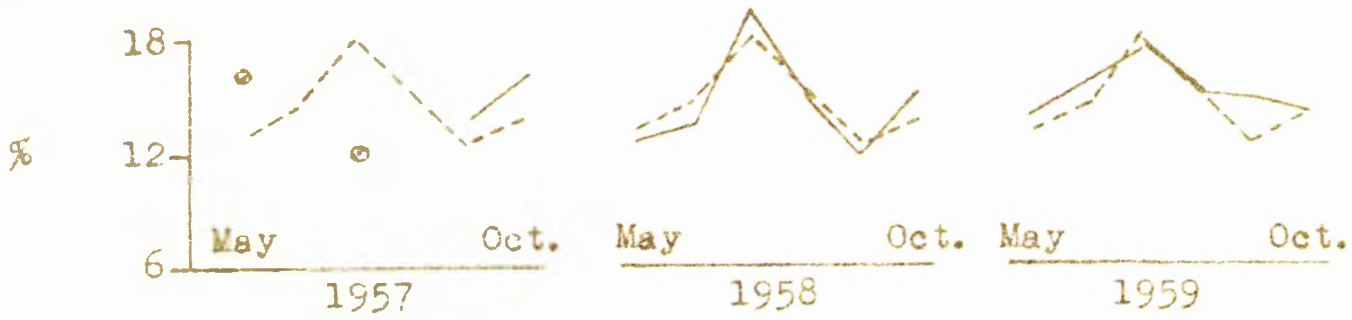
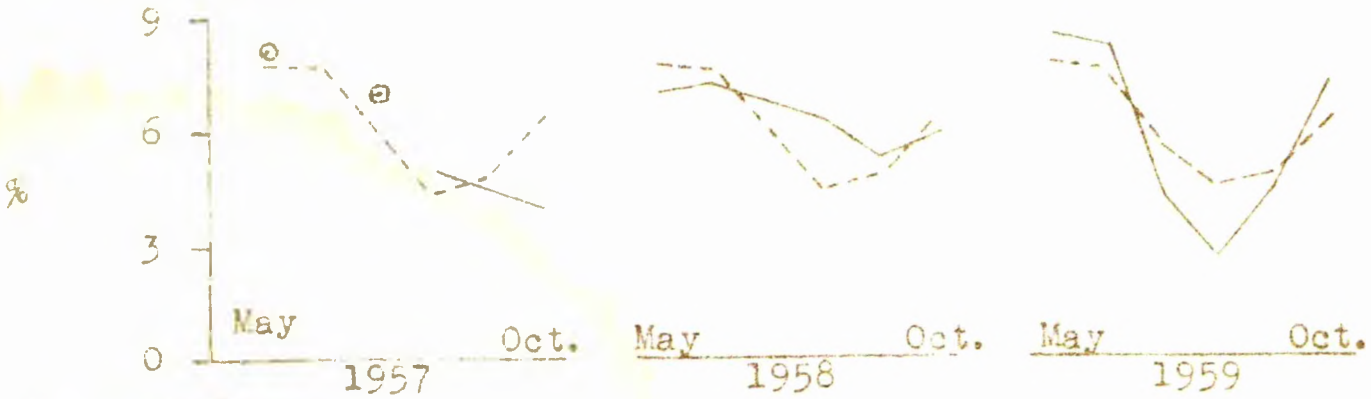


FIGURE 1 continued

1. F. rubra



2. A. stolonifera



3. C. vulgaris

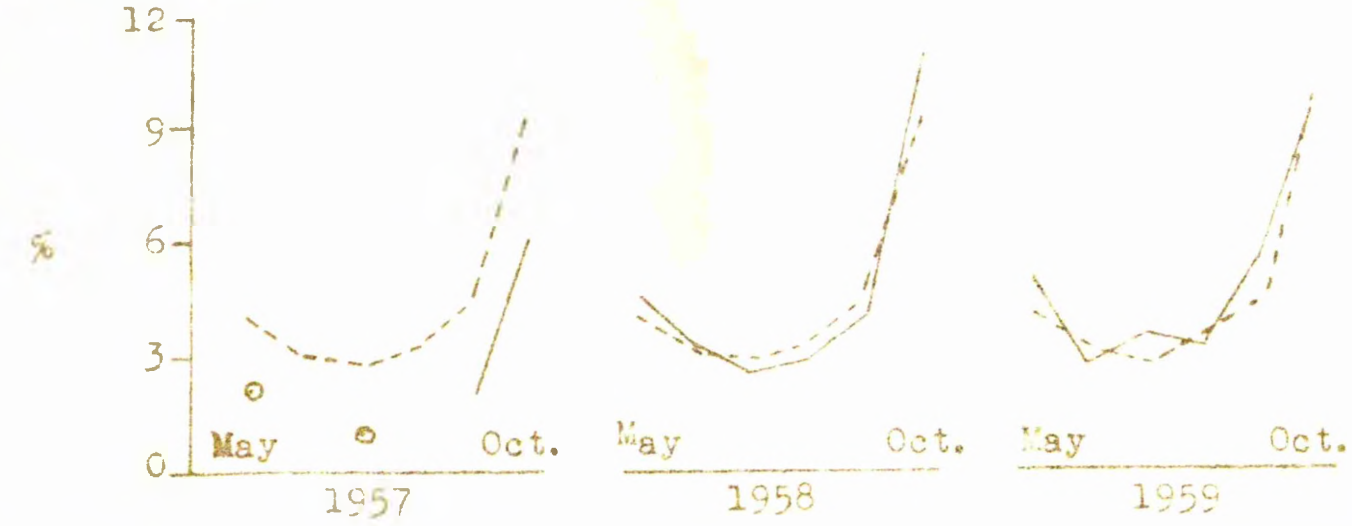


FIGURE 1 continued

/shown, the sheep exhibited a grazing pattern which was repeated in its essentials each year. The same is true of most of the species investigated but not illustrated.

It can also be shown that there is an annually recurring resemblance in the intensity of grazing on groups of plants e.g. on grasses, rushes or sedges.

There is some variation between the results for individual ewes and lambs which is not obvious from Figure 1 or from the Appendix Tables. Over the period of study, however, the average diet of ewes or lambs on either hirsel was remarkably alike. Hercus (1960) has also commented on this similarity over a period of time. As Hunter (1958) has pointed out, the diet of individual sheep may differ due to the flock factor, the result of which is the tendency for a heft of sheep to segregate into units which graze different parts of a hirsel. In the present study the faecal samples were taken from all members of the flock on each hirsel and thus represent the mean diet on that hirsel.

Variations which do arise in any one hirsel will be partly due to the flock factor and partly to individual preferences of the sheep.

2. Seasonal Use of Selected Species

Figure 2; 1 - 11 shows the comparisons between the four groups of animals (Barnacarry ewes and lambs and Low End ewes and lambs) of the average monthly percentage fragment count.

Festuca rubra (Figure 2:1)

Red fescue is at almost all times of the year the most frequent component of samples. On both hirsels and in ewe and lamb samples there was a regular grazing sequence of this species. In March the intake was highest when young fresh growth of this plant was appearing. This selection disappeared to an extent from April till June, rising again to a peak in July. This trend was evidenced by both the ewes and the lambs, the latter retaining a higher sample count at almost all times of their sampling period.

The low intake period of May - June may not be a reflection of decreasing palatability of this species at that time, but of a greater availability of other species which are by then showing a spring flush. In particular there are indications that plants such as Eriophorum species, Carex species, Nardus and Molinia may well be those which contribute to the spring decline in fescue utilisation.

Figure 2

Comparison of Monthly Averages over the Study Period

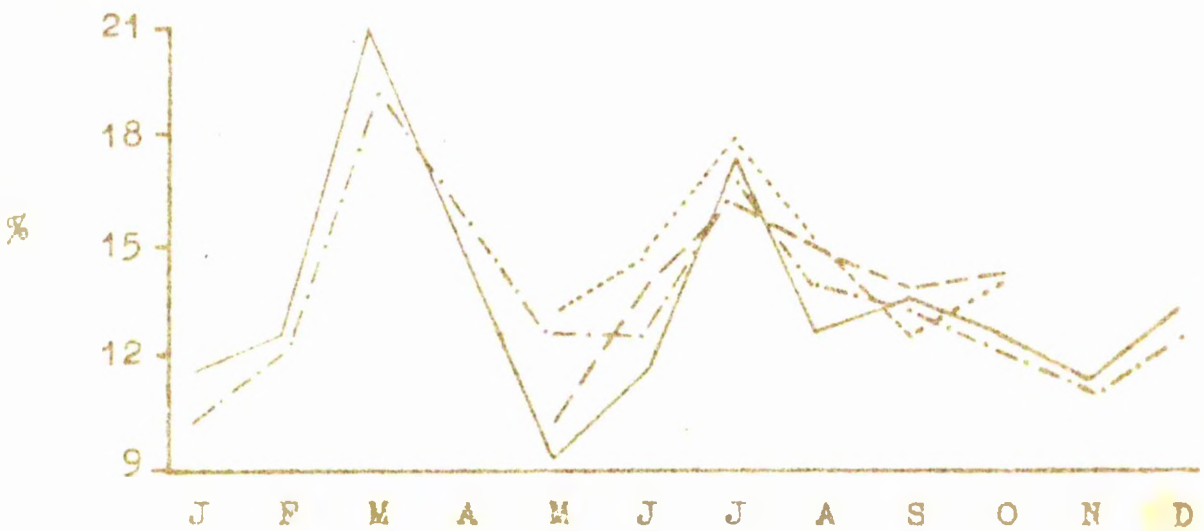
Barnacarry Ewes _____

Barnacarry Lambs _ _ _ _ _ _ _ _ _

Low End Ewes _ . _ . _ . _ . _

Low End Lambs .....

1. F. rubra



2. A. stolonifera

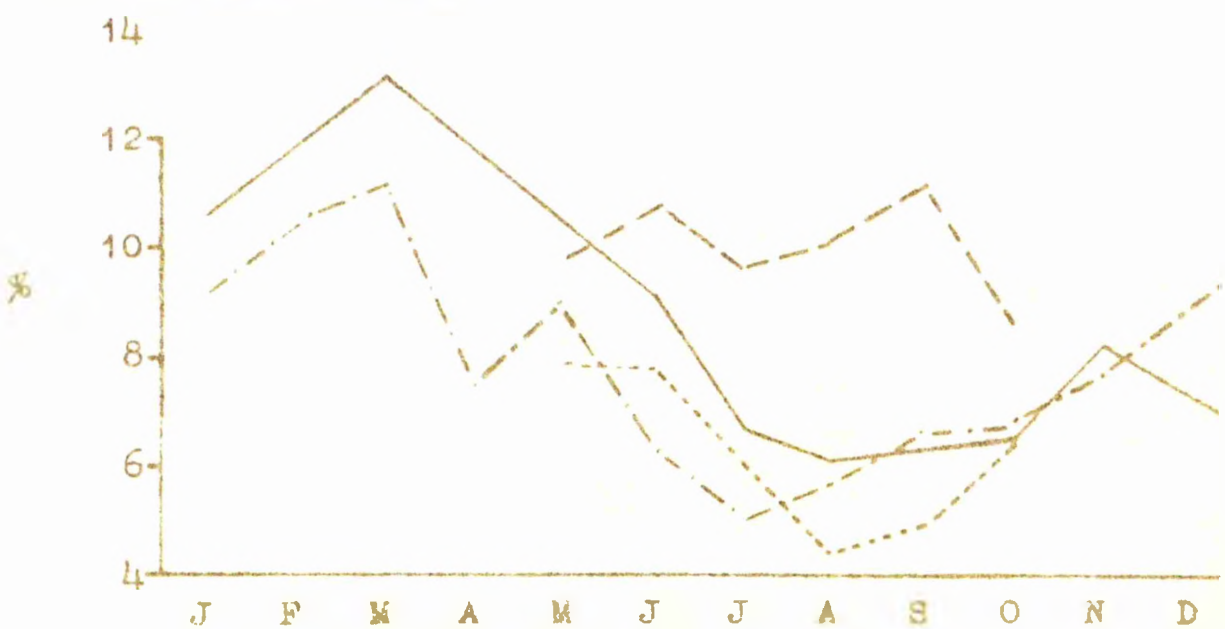
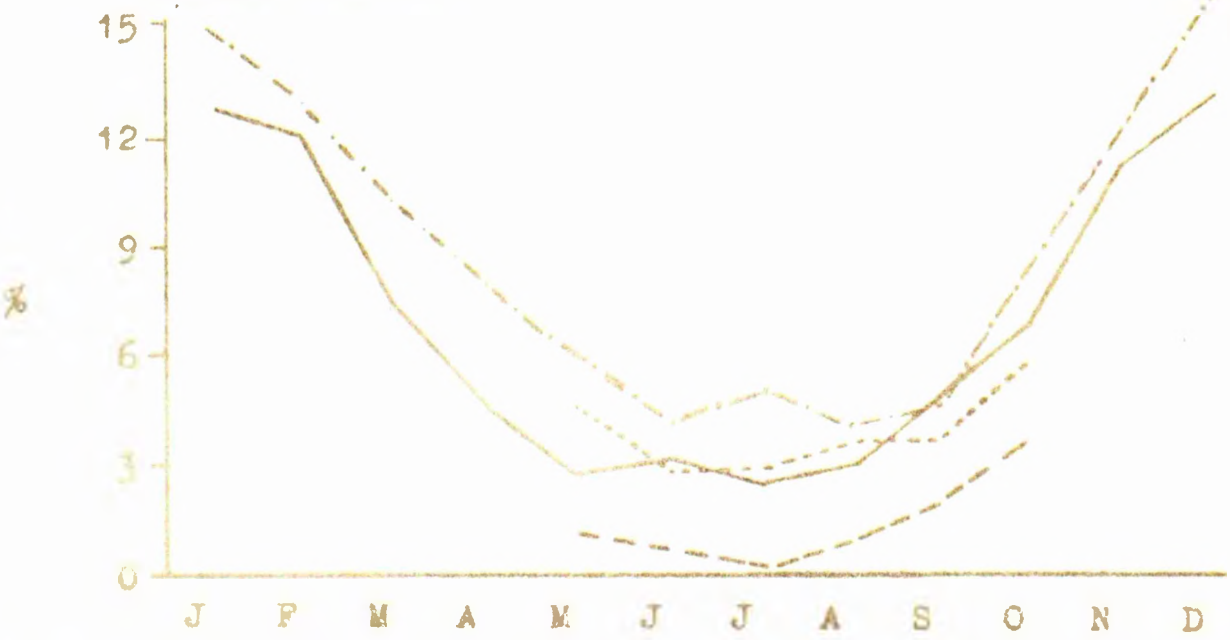
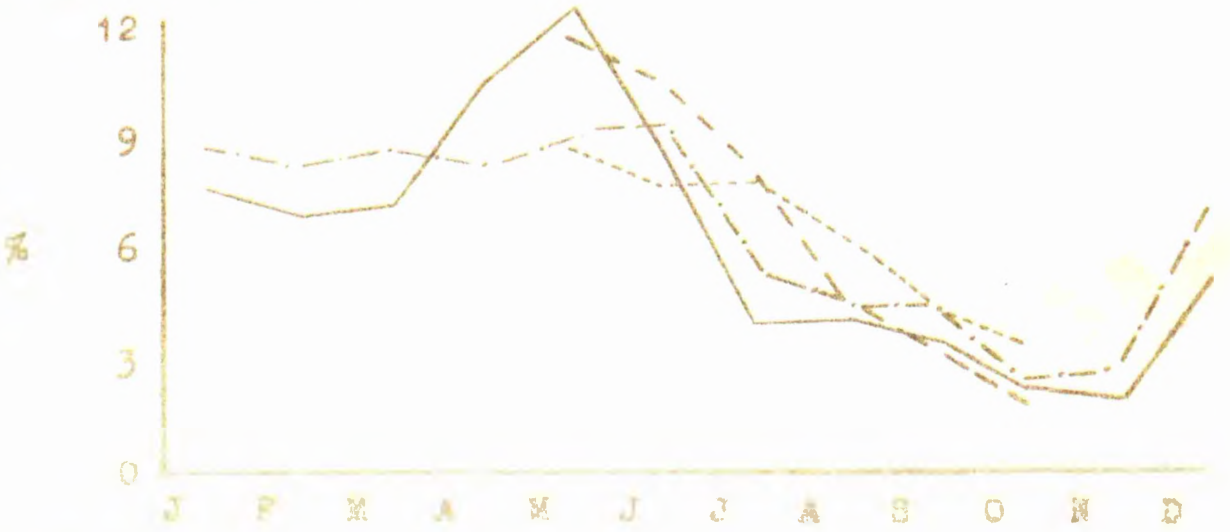


Figure 2 continued

3. Juncus species.



4. Eriophorum species



5. Carex species

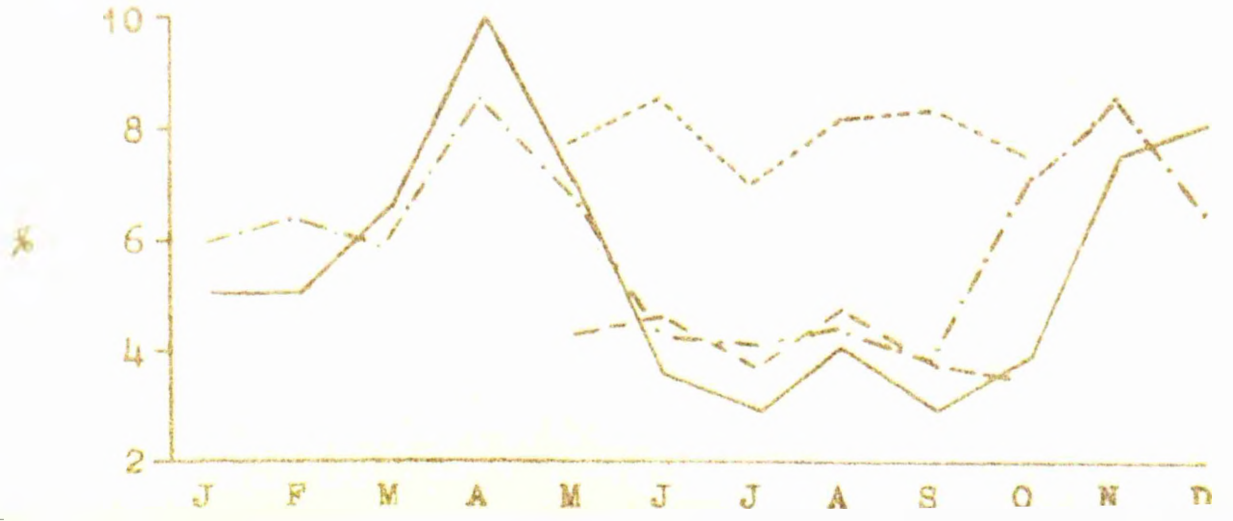
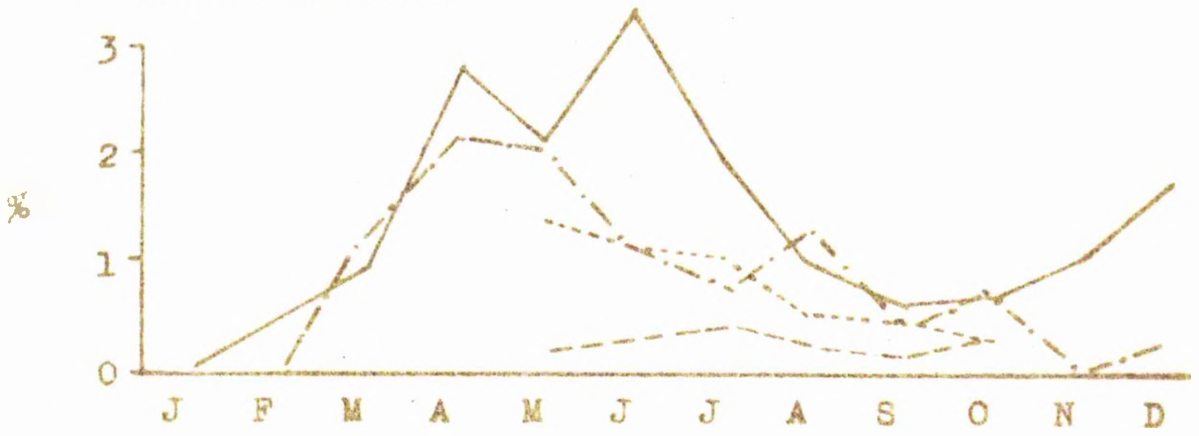
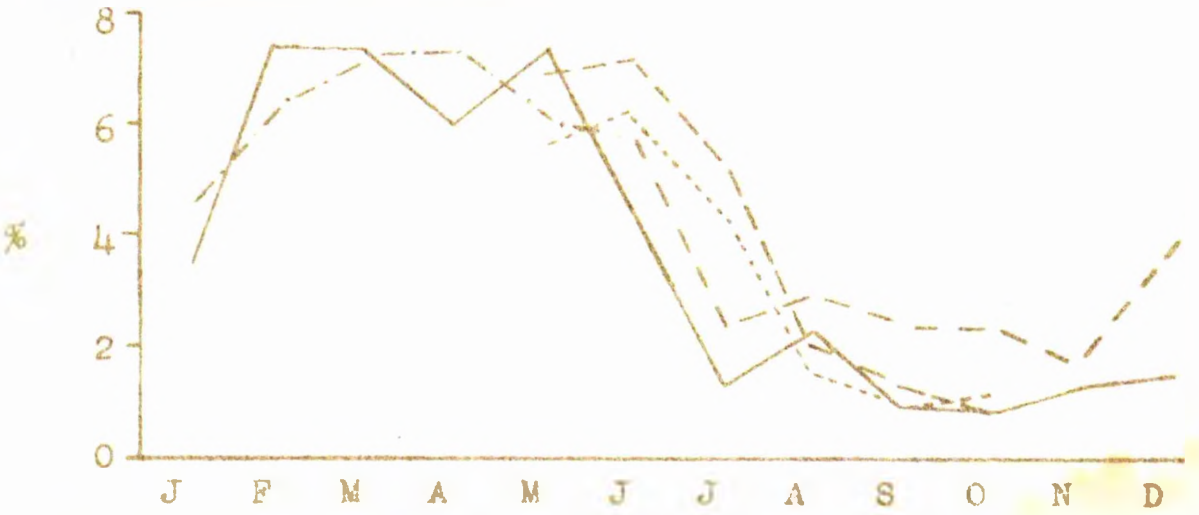


Figure 2 continued

6. Nardus stricta



7. Molinia caerulea



8. Calluna vulgaris

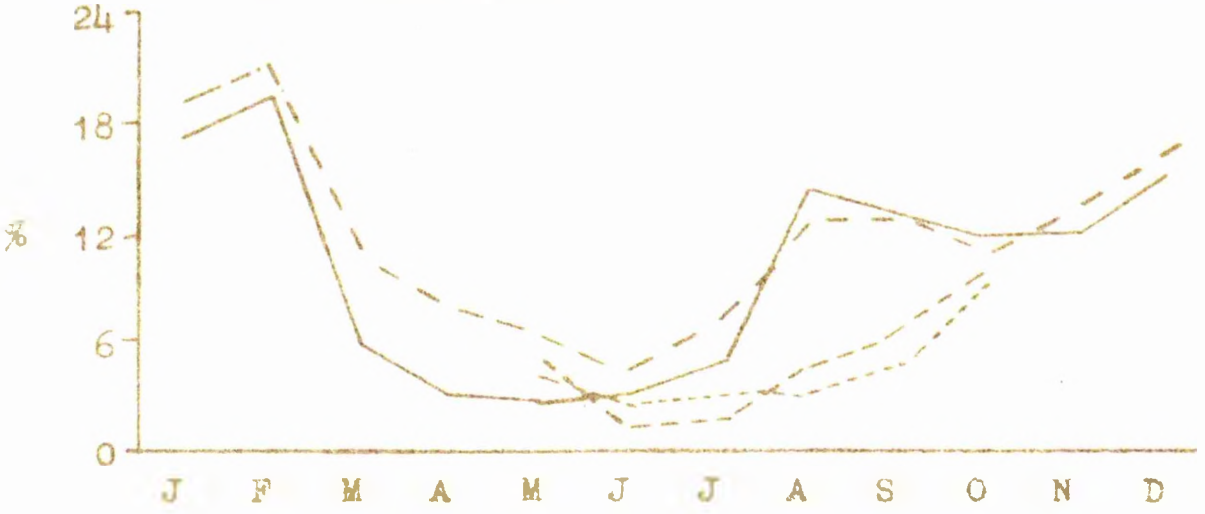
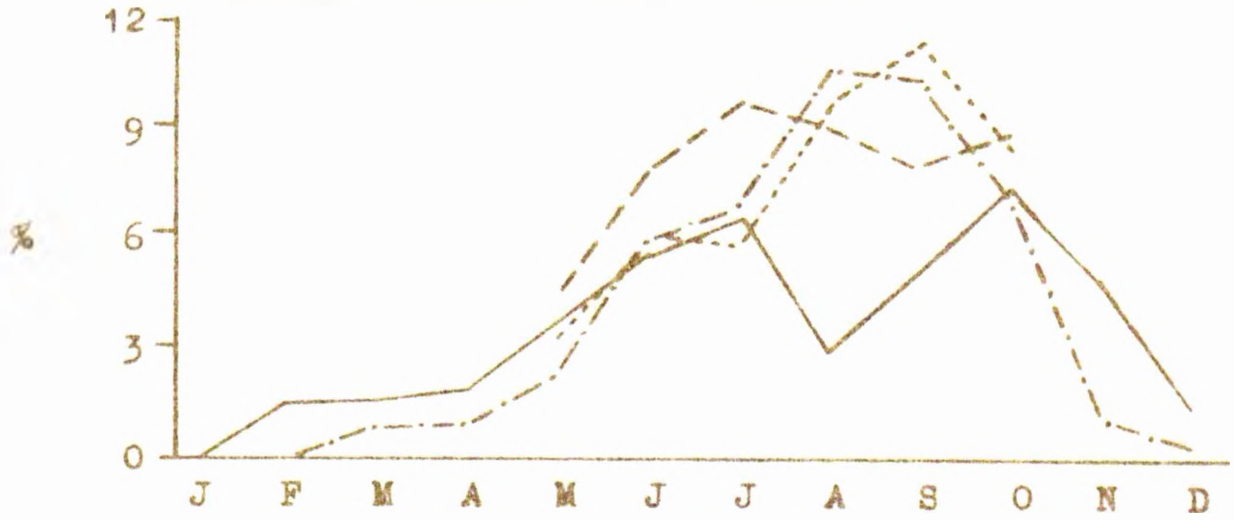
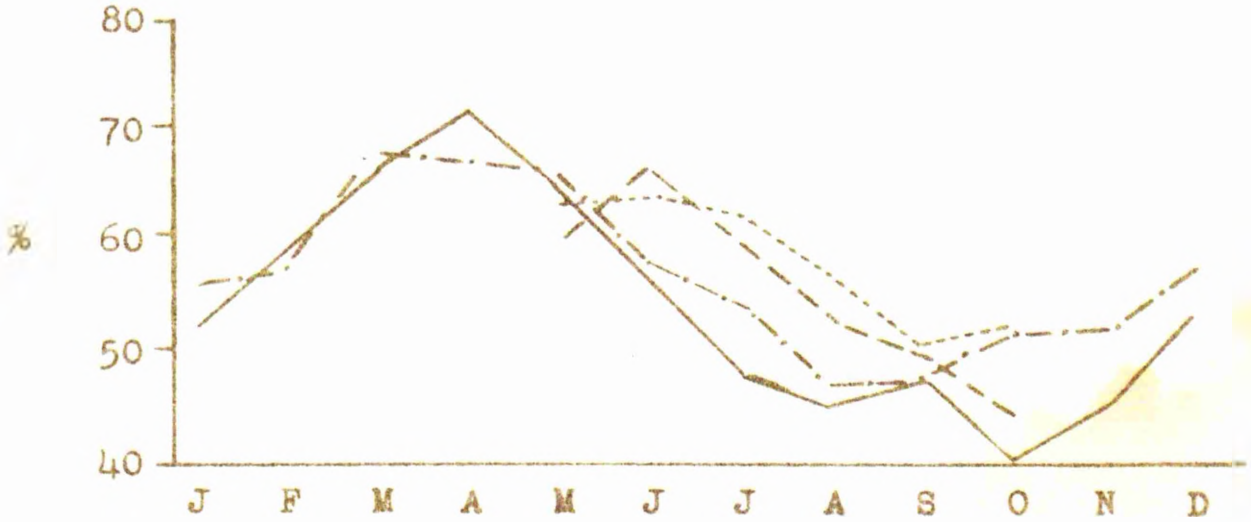


Figure 2 continued

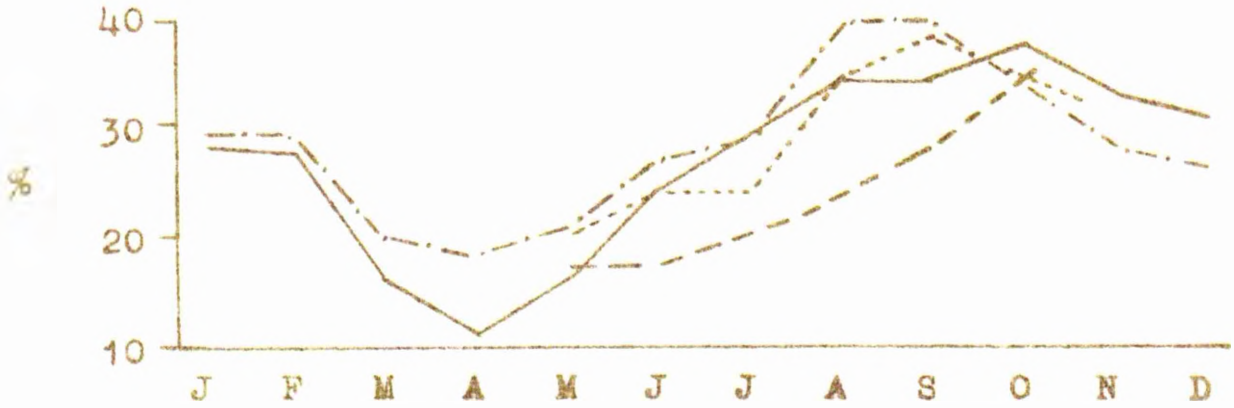
9. Trifolium species + Lotus species



10. Gramineae + Juncaceae + Cyperaceae



11. Other forage herbs.



It should be noted that the maximum intake period as shown for F. rubra occurs in March, at a time when this species has not reached its major period of spring growth at Lephinmore. The implication of this is that heavy grazing occurs on this species at an early stage due to a real scarcity of herbage, accentuated by the imminence of lambing time.

The results shown by Hunter (1954b) also indicate an early period of heavy grazing on this species in Midlothian and it would appear that this is a general phenomenon.

Agrostis stolonifera (Figure 2;2)

In this species there was a tendency towards major use at only one period of the year, from February to April, decreasing to a very low incidence in autumn samples. The spring use coincides with an early start of spring growth and the autumn low is at the time of increasing amounts of dying leafy blades in this species when there is still a relative abundance of more palatable species available to the animals, in particular the forage herbs.

The two ewe groups follow an essentially similar pattern of grazing. On the other hand, the lamb grazing results differ considerably from one another. The Low End lambs follow the ewe pattern fairly/

/fairly closely, whereas the Barnacarry lambs show an intake considerably higher than any other group, for a reason at present unknown. Since the results were obtained from different lambs in successive years the variation cannot be entirely due to personal preference of particular animals or to sampling error. There may be an unknown factor in operation on Barnacarry hirsel influencing the lambs to a higher intake of A. stolonifera.

Juncus species (Figure 2;3)

These species were shown to be very valuable in the period October - March. They are winter-hardy, easily found in extreme weather conditions, and J. squarrosus in particular can be pulled from the ground to give succulent basal material. Of the three species included in this group J. effusus appeared to be the most frequent component of samples over the year, but J. articulatus and J. squarrosus were present in samples to the same extent as J. effusus in January and February. During these months of the year there is little else of a herbaceous nature available on the hill, and the animals must overcome their more usual reluctance to graze on J. articulatus. This species grows on ground which, at other times of the year is/

/is soft and marshy, but during winter is comparatively hard and the sheep can then move freely on to it. Braid (personal communication) also points out that J. articulatus is one of the first plants to show green, in January or February. On both hirsels there was considerable evidence that J. squarrosus had frequently been pulled out by the roots and eaten, only the hardest basal portion being untouched.

The lambs also graze on these species but never to the same extent as their dams. By the time that the lambs are on the pasture there is, of course, other herbage available, the leaves of the Juncus species are well developed and tough and areas carrying J. articulatus will have reverted to their normal marshy constitution.

Eriophorum species (Figure 2;4)

Fragments of these species, mostly of E. vaginatum, occurred most frequently in samples from April - June, but also formed an important part of the samples from December - April. The material eaten in this latter period must have been rather unpalatable, much of it being of dead growth from the previous season.

It can be seen that the lambs ate slightly more/

/more of this species than the ewes during most of the period of study, while retaining essentially the same pattern of grazing as the ewes.

Carex species (Figure 2;5)

In these species the most frequent sample counts were found in the periods March - May and October - December. At such times they formed an appreciable part of the diet. Even during spring and summer they were by no means a negligible factor in the diet analyses. As occurred with A. stolonifera it can be seen that one group (Low End lambs) showed an intake appreciably higher than any other. Carex species occur on Low End hirsel in larger quantities than on Barnacarry and in reasonably pure communities. It is probably this factor of amount and availability which causes the greater lamb intake on Low End.

Nardus stricta (Figure 2;6)

At no time did this species form an important part of the diet and indeed it was only in the period April - July that it was grazed to any extent. This corresponds to its early growth period after which it becomes wiry and completely unpalatable. The lambs ate consistently less of this species than did the ewes/

/ewes, and on Barnacarry hirsel in particular lamb sample counts were very few.

Molinia caerulea (Figure 2;7)

From January - June this species appeared to be relatively palatable and acceptable to the sheep. For much of this period, until about March, they must have been grazing on old leaves of the previous year's growth or on early current year's growth protected by leaf litter. Thereafter the flush of Molinia growth occurs and accounts for the high April - June results.

It is of interest to note that the lambs showed a higher preference for this species than did the ewes, until about August.

Calluna vulgaris (Figure 2;8)

Considerable importance has always been attached to this species as part of the diet of hill sheep. The results from the present study substantiate its value. The counts for Calluna fell below 6 % in the period March - July only and it was the most frequent fragment during January - February and September - December in Barnacarry ewe samples. In Low End ewe samples similar results were found in the periods January - February, September and November - December.

The November - December intake occurs at a time when/

/when there is little herbaceous material available and while the current year's growth is still unfrosted and palatable. During severe winter months the bushy heather tips are of course the prime material available during periods of snow cover, whether or not they are frosted.

Consumption of heather quickly declines as other herbage becomes available in the spring. During the period March - July other species are more readily available and the heather is relatively little sought after. At and after flowering time there appears to be an increase in the amount eaten, this increase rising gradually to the main winter intake.

The lambs consistently ate less than the ewes, emphasising more strongly the downward tendency of intake in the April - June period. Gradually their diet content of Calluna approached that of the ewes until, at the end of the sampling period in October, the heather intake is almost the same for lambs and ewes.

Trifolium species and Lotus species (Figure 2;9)

The intake of these species appeared to follow very closely their growth and availability over the year. The Figure shows that there was a considerable increase/

/increase in consumption from April onwards, at the time when fresh growth of these species starts in any quantity.

The Barnacarry lambs in particular had a much higher intake than their dams although the Low End lambs ate much the same amount as the ewes.

Consumption in all cases fell off rapidly after September, when these species had reached their final growth for the year, the plants were becoming more fibrous and the flowering heads had formed fruits.

These species are infrequent over much of the grazing areas and it must be considered that the present results indicate a high degree of selection for them, particularly by the lambs.

Gramineae, Juncaceae and Cyperaceae (Figure 2;10)

At all times these, the narrow-leaved plants of importance on the hill, formed the greater part of the diet analyses. The period March - May corresponds with the spring flush of most of the components and later a decline in intake reflects, in part, the lesser attractiveness of the maturing plants and the greater availability of other forage herbs. As the autumn approached the intake again increased.

It was noted that the lambs almost consistently had a higher intake than the ewes.

Other Forage Herbs (Figure 2;11)

This group comprises almost all the plants not in the group immediately above and is mainly composed of the herbaceous Dicotyledons and the petalloid Monocotyledons.

During the least intake of this group, in April, the grasses and their allies are at their most palatable while the forage herbs are relatively few in number and small in bulk. A gradual increase in consumption was evident carrying on through to October at which time the forage herbs are abundant while many of the grasses have flowered and become less attractive to the grazing animals. Thereafter a decline occurs owing to the more fibrous nature of the mature herbs. Much of the winter levels shown in Figure 3;11 is due to Calluna intake.

Green, Sharp, Cook & Harris (1951) investigated the winter grazing diet of sheep. They showed that over the winters of 1946 - 1948 the average utilisation of grasses and forage herbs was about the same, approximately 24 % for each class. During the first part of the winter grazing season the forage herb species received heavier use than the grasses but with the advancement of the season the use of grasses increased. A similar type of grazing sequence is shown by/

/by the present results, except that the overall grass consumption is at a higher level.

The utilisation of many species which are not illustrated by Figure 2 is discussed below.

It is evident that Deschampsia caespitosa was not relished by either ewes or lambs, forming as it did an average of only 0.3 % of all sample counts. Although frequent on both hirsels there was obviously a rejection of this species except during the period November - February.

The Luzula species, almost entirely L. pilosa and L. campestris, were occasionally encountered in samples. The lambs ate more than did the ewes on both hirsels. Sandison (1948) has commented on the predilection of Blackface ewes in Shetland for Luzula species, particularly in winter. In the present study the reverse trend appears, in that almost all the Luzula fragments were found in summer and autumn samples.

Trichophorum caespitosum was quite frequent in samples with an average count of 2.8 %. This species was commonly grazed in April - July. Linton (1918) considers that ' it is not a favourite with sheep' while Tribe (1950a) states that it is grazed in April and May.

The Poa species are regarded as very palatable, early, but seldom plentiful (Linton 1918; Braid 1954). The frequency of these species in samples was rather low (ewes 0.9 %; lambs 2.2 %) but they are infrequent on the hirsels in question. It is noticeable that the lamb samples showed a much higher intake of these species than did the ewe samples.

The Erica species were grazed intermittently throughout the year. Wallace (1884), Linton (1918), Fenton (1949) and MacLeod (1954) indicate that in comparison with Calluna vulgaris these species are little used. MacLeod (loc. cit.) suggests that E. cinerea is less well-liked by sheep than E. tetralix and the present results would support both comments.

Although occurring to an extent in samples at all times of the year the Vaccinium species were eaten mainly in the winter months. On both hirsels the lamb samples showed smaller counts than the ewes. The high count of V. oxycoccus is mainly due to grazing from May - October by Barnacarry ewes. Fenton (1949), Tribe (1950a) and Wallace (1884) refer to these species as being evergreen and grazed at almost all times of the year.

Galium species show the variation over the year which is typical of the smaller herbaceous plants, with an increasing count from late spring until autumn/

/autumn, and a higher lamb sample count than ewe.

Ulex europaeus did not figure frequently in samples and the lambs in particular made almost no use of it. Earlier writers have commented on the feeding value of young plants and the shelter value of older plants. In Easter Ross heavy grazing of this species by sheep has been shown (Bruce 1871; Ritchie 1919).

Potentilla erecta showed the frequency in samples typical of the smaller herbs. Lamb grazing was again heavier and greater use of it was apparently made on Low End hirsel.

The mosses, Sphagnum and Polytrichum, have been considered to be pulled with other plants and not to be eaten for their own sake (Martin 1955) although Linton (1918) notes that they are deliberately eaten when the animals are really hungry. In the present investigation the sample frequencies are quite high and it is probable that there are occasions throughout the year when they are deliberately eaten, perhaps for their water content, although there is no visual evidence to support this at present.

Grasses not so far considered are all rather infrequent on the study areas and the low sample counts/

/counts are attributable to this factor. Closer examination shows that the grazing attention paid to them is similar to that in the case of the grasses already considered.

The shrub Myrica gale occurs in quantity only on Barnacarry hirsel and it can be seen that although the ewe samples occasionally showed traces of it there was complete rejection by the lambs except in the last month of sampling.

As has been mentioned above the group 'unclassified' includes many plants whose frequencies in samples was very low. Consideration must also be given to plants which were present on the hirsels but which never appeared in samples.

Of these the only one of importance is Pteridium aquilinum. This is common on both hirsels and easily available to the animals. No fragments of this plant were found in any of the samples. From this two conclusions may be drawn :

1. The fragments were completely destroyed by the digestive processes, or

2. The plant was not grazed.

From rumen and faecal samples seen in cases of suspected/

/suspected poisoning of stock by bracken it is possible to state that fragments do appear in such samples. One is led to the conclusion that this plant was not grazed to any extent by the experimental animals, in contrast to recent reports of heavy grazing of bracken by sheep in Brecon (Anon 1961; Garrett-Jones 1961).

3. Diet Analyses and Comparative Grazing Intensity.

As noted earlier Hunter (1954a,b) has investigated the movement of Blackface sheep over an ecologically well-marked hillside in Midlothian. His results were expressed as Comparative Grazing Intensities (C.G.I.) and showed both the relative incidence of grazing on any particular area at the time of study and also the pattern of grazing and flock movement throughout the year.

It is possible that although a sheep may be moving in a Callunetum for example, it may not in fact be grazing the Calluna, particularly as hill pasture contains few pure stands of any particular species. A correspondence between Hunter's results and the present results would indicate that when the sheep were moving over a Callunetum they were in fact grazing mainly on Calluna.

In some cases the present results can be compared/

/compared with those of Hunter (loc. cit.) in order to elucidate this point. This has been done and is shown in Figure 3; 1 - 5.

Since Hunter's results were obtained from Blackface ewes on an unrestricted hill it has been thought advisable to compare them with those of the present work for the ewes on Barnacarry hirsel only.

Agrostis/Fescue (Figure 3;1)

In this comparison there was a rough correlation in that both systems of measurement indicated a falling consumption of these species over the year. Of especial interest was the position of the maxima which in both cases appeared in the period February - March. As has already been noted this is prior to the major spring flush of the fescue component of the pasture.

Agrostis stolonifera (Figure 3;2)

A similar pattern of grazing over the year is shown by the two methods, with the faecal sample counts indicating a higher intake in the earlier part of the year and a lower intake from July - October than the C.G.I. assessment. Again the maxima occur close together (February - March), and the rise in October shown/

FIGURE 3

Comparisons of Average Monthly Sample Counts and Comparative Grazing Intensities (C.G.I.)

Sample Counts _____

C.G.I. Values _ _ _ _ _

C.G.I. values are taken from Hunter (1954b)

1. F. rubra + F. ovina + A. stolonifera and Agrostis/Fescue

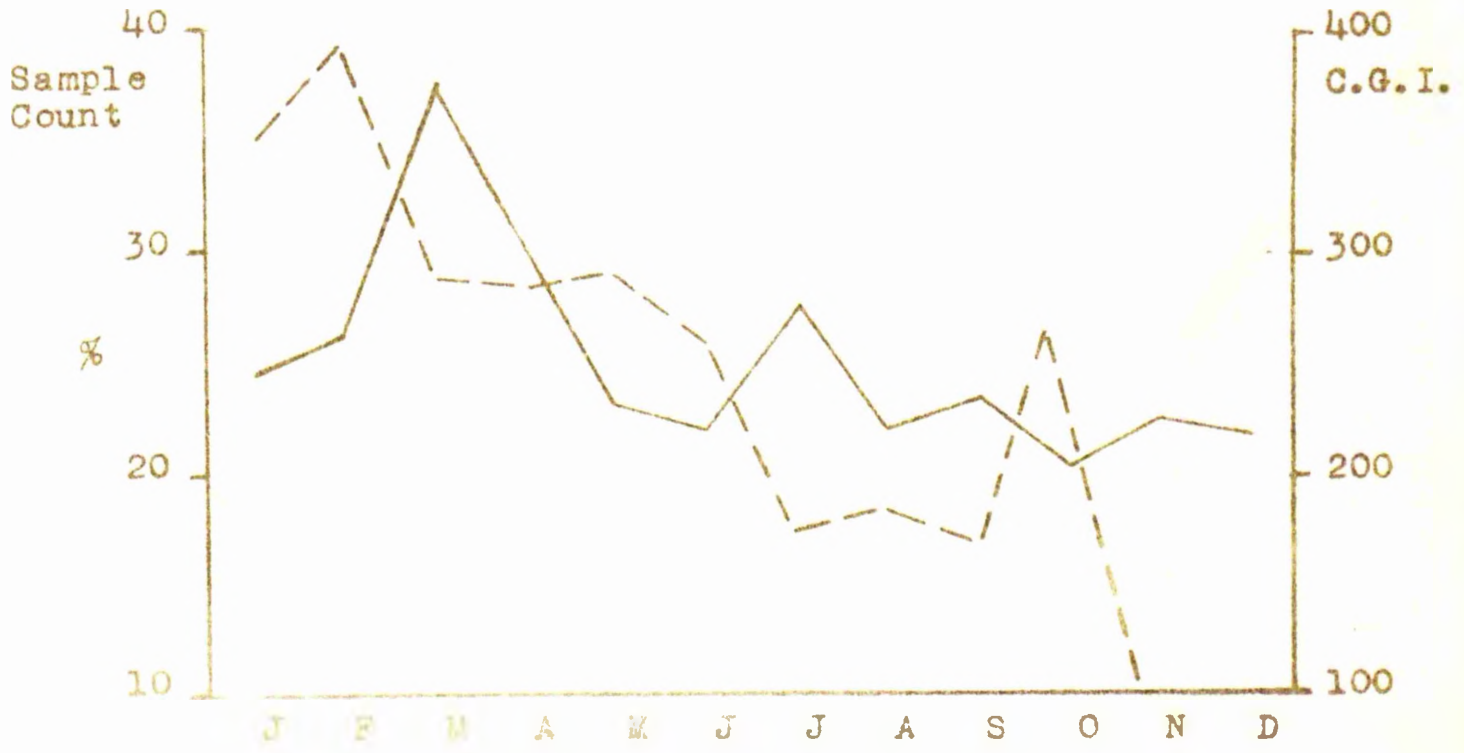
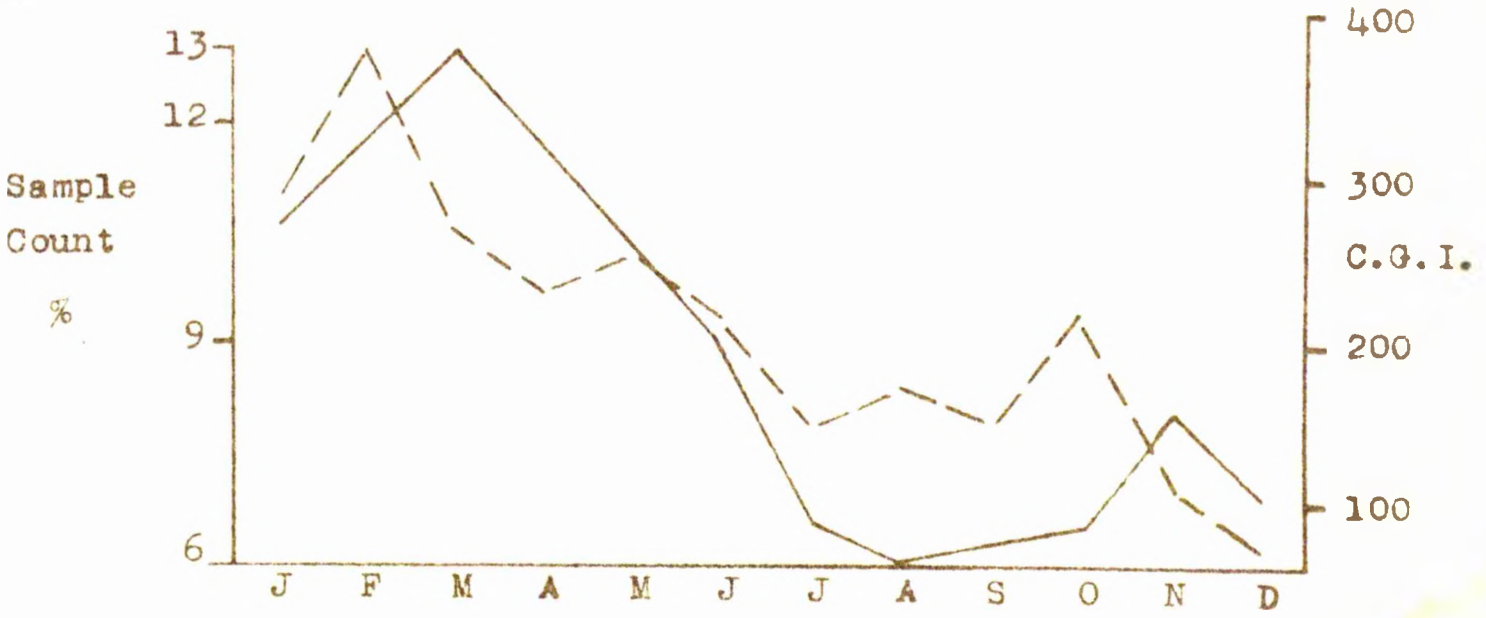


FIGURE 3 continued

2. A. stolonifera against Agrostis/Fescue



3. Eriophorum vaginatum against Eriophorum

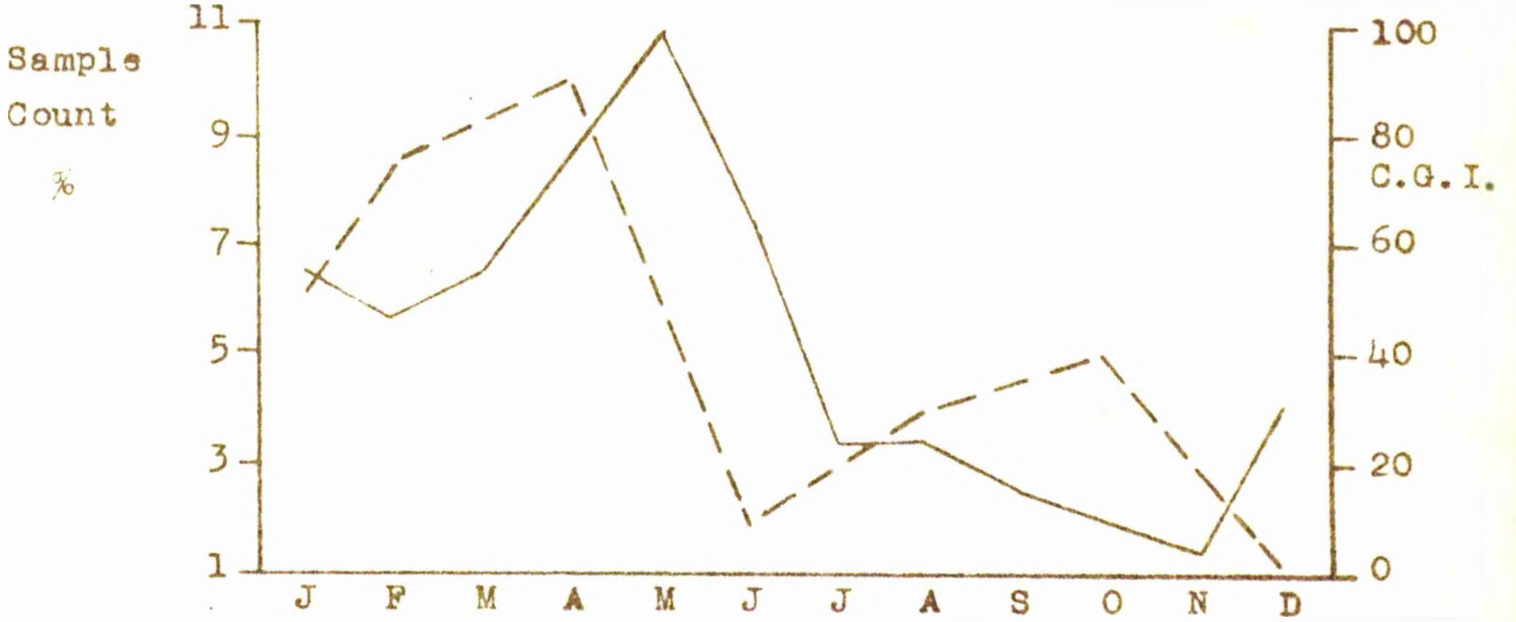
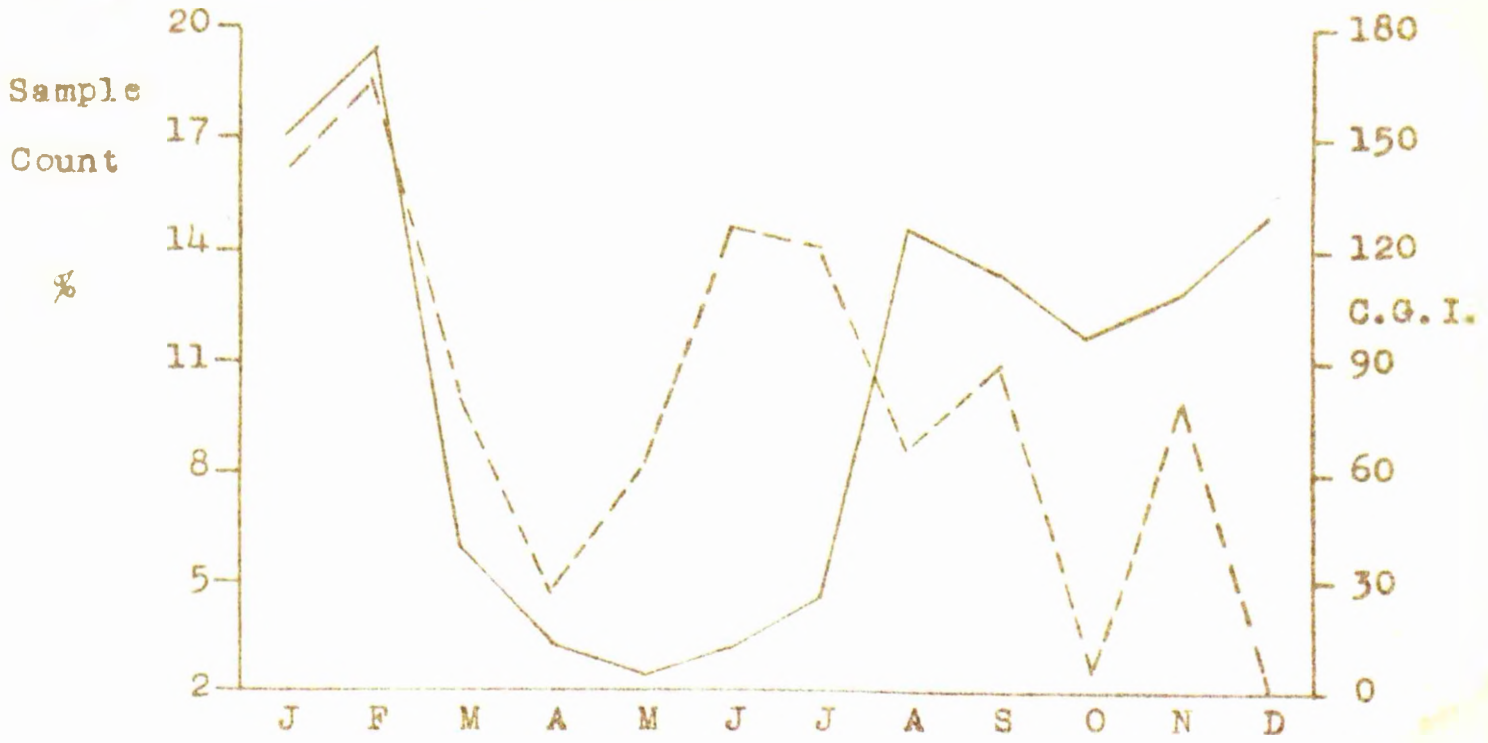
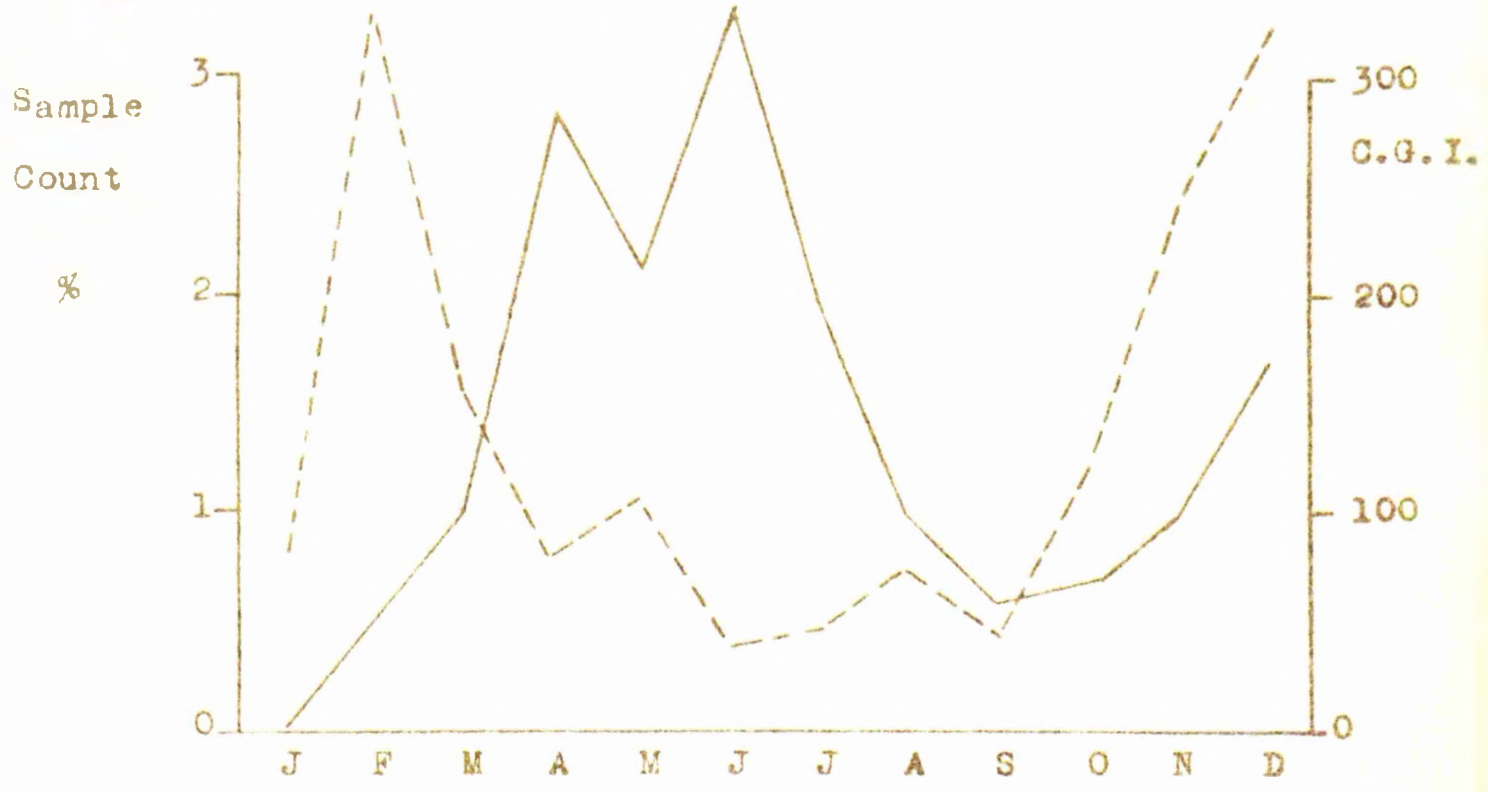


FIGURE 3 continued

4. C. vulgaris and Lea Heather



5. N. stricta against N. stricta



/shown in Hunter's results was followed by a rise in November by the present results.

Eriophorum vaginatum (Figure 3;3)

A roughly similar type of grazing pattern over the year is indicated by both sets of results.

Calluna vulgaris (Figure 3;4)

In this case Hunter's results for lea heather, described as being younger heather, but more than twelve years old, growing on shallow, well-drained peat, have been used in the comparison.

Correspondence was good especially in the months January - April. From this time until July the present results indicated less heather intake than the C.G.I. results, and after July they indicated a greater intake than the C.G.I. results. Some of this higher intake may well have been due to the intake of fresh young shoots in the autumn months and of the older bushy heather during the winter. Hunter notes that his results for lea heather during the winter months do not include those days on which the free choice of herbage by the sheep was affected by snow cover. If these days had been added he notes that the heather values as shown by the C.G.I. system would have been increased at that time.

Nardus stricta (Figure 3;5)

Comparison between the two sets of results was in this case much less well marked. Hunter's results indicated a maximum intake in February and December whereas the present results showed a maximum fragment count in April and June with a December increase corresponding in part to that shown by Hunter.

This discrepancy can not be attributed to species other than Nardus being grazed in the Nardetum at Midlothian since the present results show a higher intake than that shown by the C.G.I. assessment.

There is, however, the probability that spring drought conditions are more severe in their effect on the herbage at Lephinmore than they are in Midlothian. This would lead to a greater intake of those plants which could withstand such conditions, of which Nardus is an example.

It can be seen from the above comparisons that the general sequence of grazing on the illustrated species is shown to be similar by the two methods of analysis.

Hence it can be concluded that the amount of time spent on any particular species can be related to the amount eaten and that when the animals are

in/

/in a Festucetum, for example, they graze mainly on the dominant species and pay only casual attention to others.

Conversely, the correspondence of results by the two methods shows that analysis of faecal samples can assess the past movements of sheep over various communities, provided that these communities are relatively pure.

The correlation shown in Figure 3 between the results for the two methods does not imply that the sheep at Lephinmore ate the same amount of any particular species as the sheep at Midlothian. Neither system of analysis measures the amount of the species eaten, and both scales have been chosen to give the best correlation. The correspondence then relies on the patterns traced by the graphs and not on absolute values.

Variations between results obtained by the two systemson the same area at the same time would indicate that the sheep were ignoring the main constituent of any community and selectively grazing a minor member. This would be so particularly where the faecal counts were consistently below the C.G.I. assessment at the same period of the year. Where the/

/the faecal counts are consistently above the C.G.I. value the implication is that much of the species under consideration is being grazed from impure stands.

It can be seen that the maxima and minima of the present results are frequently found at approximately one month later than those shown by the C.G.I. results. The following reasons would account for the discrepancy :

1. That the seasonal growth, and hence the availability and palatability, of the same species is about a month later at Lephinmore than in Midlothian, due to climatological factors.

2. That there was an inherently later grazing pattern in one set of experimental animals. This could be due either to two strains of the same sheep type being investigated, or to the fact that the same grazing pattern was modified by climatological factors.

3. That one worker sampling near the end of a month and the other sampling near the beginning of the subsequent month would naturally present the results in such a way that there was an apparent time gap of about a month, whereas, in fact, this gap might be only a few days. In the present study there was no set time in the month for sampling thus this explanation would be partly negated.

It is felt that the difference in time shown by the results is due to the second possibility mentioned, namely, that different strains of Blackface sheep were in use, under different climatic conditions, which also affected the growth and maturity of the plants.

It can be seen from the above discussion that there is a definite pattern of grazing for any particular type of plant and at times this appears to be present down to species level.

In every case maximum intake of a species is found to be either at or near the time of its greatest palatability or at a time of scarcity of any really palatable species.

Fenton (1949), Davies (1925) and Arnold (1961) are in agreement that sheep prefer the finer, younger and more palatable herbage. The present results bear out these conclusions.

The results also indicate to what extent and for how long a period this preference is shown. Of particular interest are the following points.

Festuca rubra and Calluna vulgaris gave the highest fragment counts in samples at almost all times of/

/of the year. While the results do not indicate the amounts of these plants eaten they do show that these are of importance at all times.

The Juncus species contribute a not unimportant part of the diet, particularly in autumn and winter.

Eriophorum species are relished prior to lambing and almost immediately show a drop in intake. This corresponds with the shepherds' view that this species is valuable to ensure a good milk yield in the ewe. There are, however, many hill sheep farms with little or no Eriophorum available and yet they have a good lamb marking percentage, so that the grazing pattern as shown here and the proximity of lambing time to it may be purely fortuitous.

Carex species have been occasionally mentioned by other workers as important in the diet of sheep and other herbivores. Braid (1954) places the Cyperaceae as the third most important group of plants on hill pasture, after the grasses and heather. Dougall (1951) regards C. panicea as an important feature of the winter feed of sheep, especially after grazeable heather has been lost to them by burning. The present results show that these species are of value particularly in the early winter and in spring.

Molinia caerulea also is perhaps more widely grazed/

/grazed than has hitherto been realised, although Wallace (1884) comments that 'sheep fatten and do well on Molinia, living on little else for a month or more and continuing all summer to eat a part.' As with some other species this heavy grazing is at a particular time of the year only and at a particular point of palatability of the species. Thus an increase in the amount of species on the hill would not necessarily lead to better grazing conditions for the animals.

4. Ewe Diet Comparison

As has been mentioned in the General Introduction and elsewhere, the two hirsels under consideration varied in herbage cover and in the frequencies of the components. Also, the sheep on Low End hirsel were to an extent restricted in their movements by fencing and natural barriers so that the plants on the lower slopes of this hirsel were not available to them.

Despite these factors the average species counts from the ewes on the two hirsels are, in many cases, alike in their percentages. Considering the more important dietary components, as based on sample counts, it can be shown that only in the case of Nardus stricta and Calluna vulgaris is there any significant/

/significant difference, at the 0.05 % level, in the sample counts between the two hirsels for the ewes (Table 13).

The numerical analyses indicate that the ewes on Barnacarry hirsel ate more Calluna vulgaris than did the ewes on Low End hirsel, and this is in accordance with the observed occurrence of Calluna on the two hirsels.

The significant difference found in the amounts of Nardus stricta in the diets of the two sets of animals as obtained by faecal sample analysis, may be no more than a reflection of the proportion of Calluna vulgaris in the ewes' general diet; that is, it is probable that the Low End ewes ate less Nardus because they already had an ample fibre supply available from Calluna vulgaris.

Perhaps the non-significant results are of greater importance, because although there is a difference between hirsels in the amounts of Festuca species, Eriophorum species and Juncus species for example, no such difference appeared in the samples to a significant level.

5. Lamb Diet Comparison

When a similar analysis is applied to the lamb diet/

TABLE 13

EWE DIET

COMPARISON BETWEEN HIRSELS

Average count over period of study

Species	Barnacarry	Low End	t
F. rubra	12.8	13.7	0.03
A. stolonifera	8.6	7.7	0.97
D. flexuosa	6.2	6.0	0.42
Juncus species	5.6	7.8	1.62
Eriophorum species	6.3	6.7	0.35
Carex species	5.3	6.0	1.79
N. stricta	1.6	0.9	<u>4.12</u>
M. caerulea	3.6	4.6	1.30
C. vulgaris	8.7	10.9	<u>2.67</u>
Trifolium species + *Lotus* species	4.0	4.2	0.21

Values of t underlined are significant at 0.05 % level with 6 degrees of freedom.

TABLE 14

LAMB DIET

COMPARISON BETWEEN HIRSELS

Average count over period of study

Species	Barnacarry	Low End	t
F. rubra	13.4	14.6	1.12
A. stolonifera	10.0	6.3	10.53
D. flexuosa	6.9	6.5	1.40
Juncus species	1.4	3.9	5.00
Eriopheram species	6.8	6.3	1.19
Carex species	4.1	8.0	7.69
N. stricta	0.2	0.8	2.65
M. caerulea	4.1	3.5	0.91
C. vulgaris	5.2	4.5	0.80
Trifolium species	8.4	7.1	1.46

+ Lotus species

Values of t underlined are significant at 0.05 % level with 4 degrees of freedom.

/diet results (Table 14), it is found that the Low End lambs ate significantly more of the Juncus species and Carex species and significantly less Agrostis stolonifera than did the lambs on Barnacarry hirsel.

Juncus species and Carex species are more frequent on Low End hirsel and occur in larger communities. This factor of availability probably influenced the higher lamb intake. As has been mentioned previously, the lambs on Barnacarry hirsel showed an intake of Agrostis stolonifera greatly in excess of that of any other group, for a reason at present unknown. The significant difference shown for this species arises because of this very high sample count.

It appears from the above results that the animals have an overall diet preference, in that they tend to eat the same type of diet even when under different grazing conditions, to the extent of intensive selection for infrequent species or the rejection of abundant species except in some few cases.

This supposition is less well shown by the lamb sample results, and it appears that in their case the amount of a species available is a greater factor in determining/

/determining the amount they will eat of it.

6. Ewe and Lamb Diet (Barnacarry)

It is of interest to note from Appendix Table 27 that the lamb diet over the sampling period varied considerably in some species from that of the ewes. However, the ewe samples covered the complete year while the lamb results are based on six months sampling in the year. In order to abtain more accurate comparisons Table 15 has been prepared, showing the ewe sample average counts as calculated from the six-months periods May - October in the years 1957 - 1959 corresponding to the lamb sampling period. The value of t between the ewe and lamb samples has also been entered.

It can be seen from Table 15 that the lamb diet on Barnacarry hirsel is appreciably different from the ewe diet for some species.

7. Ewe and Lamb Diet (Low End)

Table 16 has been prepared from the results of the Low End analyses in the way described above for Barnacarry.

Significant differences again arise in the relative amounts eaten of some species by the ewes and lambs.

TABLE 15

Barnacarry Hirsel : Ewe sample Averages (%)

Amended to six-month values.

Value of t between ewe and lamb samples.

Species	Ewes	Lambs	t
F. rubra	12.8	13.4	0.28
F. ovina	3.0	4.2	2.86
A. stolonifera	8.0	10.0	2.97
Juncus effusus	2.3	1.0	5.80:
Juncus articulatus	0.5	0.2	1.44
Juncus squarrosus	0.3	0.2	1.40
Luzula species	1.3	1.2	0.50
E. vaginatum	6.0	5.6	0.59
E. angustifolium	0.7	1.2	1.85
C. nigra	2.1	3.4	2.78
N. stricta	1.7	0.2	8.03:
M. caerulea	3.4	4.1	1.52
P. pratensis	2.1	3.9	6.13:
P. trivialis	0.4	1.5	6.00:
C. vulgaris	7.2	5.2	1.69
Trifolium species	2.3	4.0	6.79:
Lotus species	2.4	4.4	1.97

All t results are at 4 degrees of freedom.

Underlined values are significant at P = 0.05.

Underlined and : values are significant at P = 0.01.

TABLE 16

Low End Hirael : Ewe sample Averages (%)

Amended to six-month values.

Value of t between ewe and lamb samples.

Species	Ewes	Lambs	t
F. rubra	13.2	14.6	1.83
F. ovina	3.7	4.4	0.89
A. stolonifera	6.6	6.3	1.76
J. effusus	2.9	2.7	0.78
J. articulatus	1.3	0.7	2.27
J. squarrosus	0.9	0.5	1.50
Luzula species	1.1	1.0	0.45
E. vaginatum	5.2	5.0	0.85
E. angustifolium	0.9	1.3	3.33
C. nigra	2.4	4.0	2.42
N. stricta	1.1	0.8	0.33
M. caerulea	3.7	3.5	1.00
P. pratensis	1.8	1.9	0.55
P. trivialis	1.0	1.3	0.21
C. vulgaris	9.2	4.5	5.53:
Trifolium species	3.8	4.1	0.14
Lotus species	3.3	3.0	2.14

All t results are at 4 degrees of freedom.

Underlined values are significant at P = 0.05.

Underlined and : value is significant at P = 0.01.

It was noted that in many cases where there were significantly higher results in the lamb samples the species in question were relatively softer and more palatable, while those which were significantly lower were more often woody or otherwise unpalatable.

In an effort to establish a more sound basis for these differences the moisture content, fibre content and ash percentage of the species investigated were considered. The species could then be separated into 'hard' and 'soft' categories, considerations being given to the above criteria as tabulated by Way (1853), Kinch (1884), Hogg (1835) and Fagan (1927) as well as to palatability.

The resultant grouping is shown below :

'Hard' species	'Soft' species
D. caespitosa	F. rubra
J. effusus	F. ovina
J. articulatus	A. stolonifera
J. squarrosus	D. flexuosa
C. nigra	Luzula species
C. carvophyllea	E. vaginatum
C. panicea	E. angustifolium
T. caespitosum	M. caerulea
N. stricta	P. pratensis
C. vulgaris	P. trivialis
E. tetralix	Galium species
E. cinerea	Trifolium species
V. myrtillus/	Lotus species/

'Hard' species contd.

V. myrtillus
V. oxycoccus
U. europaeus
M. gale

'Soft' species contd.

Lotus species
P. erecta
Sphagnum species
Polytrichum species
Holcus species
C. cristatus
A. odoratum
D. glomerata
L. perenne

Using the hard/soft separation above and summing the average sample counts for each group at the monthly level over the period of study (ewes 1957 - 1959 only) enabled Tables 17 and 18 to be prepared. The results in these Tables are also shown in diagrammatic form in Figure 4; 1 and 2.

In Table 17, between ewe and lamb results, there is a significant difference at P = 0.01 for 'hard' species (t = 4.17) and for 'soft' species (t = 3.73) with ten degrees of freedom in each case.

In Table 18, between ewe and lamb results, there is a significant difference at P = 0.05 for 'hard' species (t = 2.57) and for 'soft' species at P = 0.01 (t = 5.1) both at ten degrees of freedom.

For 'hard' species Barnacarry ewe diet shows no significant difference at P = 0.05 (t = 0.515) when compared/

TABLE 17

Barnacarry Hirsel : Percentages of 'Hard' and 'Soft' Components in the Ewe and Lamb Diet.

	Ewes		Lambs		
	Hard	Soft	Hard	Soft	
January	45.5	43.0			
February	37.75	52.25			
March	24.0	65.5			
April	27.4	63.4			
May	23.4	65.0	19.6	65.3	15.1
June	26.0	62.4	12.0	79.3	8.7
July	22.0	63.1	10.9	77.3	11.8
August	32.6	54.6	12.7	70.6	16.7
September	29.5	58.4	16.9	67.9	15.2
October	32.7	53.3	23.9	66.1	10.0
November	41.5	44.5			
December	47.7	43.5			

TABLE 18

Low End Hirsel : Percentages of 'Hard' and 'Soft' Components in the Ewe and Lamb Diet

January	47.75	44.75			
February	46.3	48.3			
March	32.9	62.6			
April	33.6	60.1			
May	30.3	64.3	25.5	65.9	8.6
June	24.6	65.8	20.9	73.5	5.6
July	24.75	64.25	21.6	72.9	6.5
August	29.4	58.0	22.7	74.8	2.5
September	26.9	67.25	24.5	72.5	3.0
October	30.5	60.4	27.7	65.7	6.6
November	39.5	46.25			
December	45.0	46.5			

/compared with Low End ewe diet; similarly with 'soft' species at $P = 0.05$ ($t = 0.47$) both at 22 degrees of freedom.

In the lamb results there is a significant difference between the 'hard' results for Barnacarry and Low End at $P = 0.001$ ($t = 5.47$); for 'soft' results there is no significant difference at $P = 0.05$ ($t = 0.689$) both at ten degrees of freedom.

It can be seen that no significant difference was found between the ewe diets on the two hirsels for either 'hard' or 'soft' species, despite the differences in herbage. This agrees in general with the conclusions reached above, since in this case the effect of single species is lost in the summation.

For lamb diet there is a significant difference in the amount of 'hard' species eaten by the lambs on Low End; as has been mentioned previously, Juncus species, Carex species and Calluna are of higher frequency on Low End, and it is probably the intake of these species which caused the significantly higher results.

On both hirsels the lambs show significantly different intakes of both 'hard' and 'soft' species from the ewes. This implies that the lambs in fact select a different diet from the ewes during at least their first six months. This will be discussed in the next section.

8. Lamb Diet

From Appendix Table 27; Tables 14 - 18; Figure 2, 1 - 11 and Figure 4, 1 - 2 it can be seen that for certain species or groups of species the lamb sample counts are consistently lower or higher than those for the ewes. These differences are due to selection by the lambs for species not eaten to the same extent by the ewes.

A detailed study of the results indicates that there is a sequence in the degree of selection. From the time of birth and during the first two or three weeks of grazing the lamb sample diets gave almost the same results as those of the ewes. A similar range of species was present in the samples, of the same order of importance and frequency. As the lamb aged, and at about 4 weeks old, the diets began to diverge. Fewer of the harder, less palatable species occurred in the lamb samples, their place being taken by softer and more palatable plants. This difference existed for much of the lamb sampling period, and there were indications that by September the lamb and ewe diets were again approaching one another as to the range of species grazed and their relative frequencies.

The sequence over the six-month sampling period may/

/may conveniently be divided into three phases:-

1. An imitative phase during the first few weeks of grazing, when the lamb diet is based on that of the ewe, since the lamb is closely following her much of the time, and presumably grazing on the same species.

2. A diverging phase, when the lamb appreciates that it is not capable of dealing efficiently or comfortably with some of the species and refrains from grazing them to the same extent as before. During this phase the relative change in palatability of any particular species may or may not be a determining factor in its grazed frequency, in that although a species may be becoming more palatable at this time it may well still be outwith the range of what the lamb appears capable of dealing with.

3. A converging phase when, as the lamb grows and its mouth hardens, it becomes more capable of dealing with the adult diet and slowly returns to it.

It has not been possible to follow the diet of the lambs to the point where it has reached a diet indistinguishable from that of the adult ewes, but in lambs kept on their hirsel of birth this type of diet would in any case be forced upon them by the exigencies of winter.

Tribe (1948) notes that it had been suggested

in/

/in the past that the feeding habits of the young are largely influenced by imitation of the parent. He made a comparison to disclose food preferences of lambs which had the opportunity to imitate older sheep and those which had not. It was concluded that imitation was of little importance in sheep.

The present results are in accord with these findings, in that, after a short initial imitative phase, the lambs pursue a diet selection different from that of their dams although the same species in the same proportions are available to both ewes and lambs.

Katz (1953) suggests that the diet of an animal may to an extent depend on its previous experience of the components of that diet; it learns that some are suitable to it and that others are not. This he termed environmental selection of diet. Conversely, a nativistic theory of diet implies that feeding behaviour is determined by the inborn structure of the animal i.e. by heredity. Katz (loc. cit.) suggests also a homeostatic theory of diet whereby the grazing animal has inborn diet tendencies modified by trial and error.

From this he develops the avidity theory of appetite which assumes that what an animal has eaten in the past is a determining factor in its choice of food in/

/in the future, dependent to a great extent on the senses of smell, flavour and palatability and little on the physiological effect of diet components on the animal.

The importance of palatability in diet selection as compared with availability is obscure (Ivins 1952; Norman 1957) and whilst Stapledon (1947, 1948) and Ellison (1948) claim that the grazing animal selects those species which it instinctively feels will benefit it, Tribe and Gordon (1950) reject this view and quote their results from rats, where the animals became less healthy on a freely-selected diet because they did not eat sufficient of the foods which contained the diet elements necessary for their well-being.

In the present case it is very doubtful that physiological requirements are directing the change in diet pattern between the ewes and the lambs, and more likely that the major influencing factor is that of oral sensation in the lambs.

9. Quantitative Diet

The work of Hercus (1957, 1960) draws attention to the possibility that qualitative investigations of the present type may lead to a quantitative estimate of the diet. That this extension may be valid depends on thefollowing factors:-

1. That there is good correlation between fragment counts and quantity of ingested material. This may vary from species to species, in that species which are easily digested and are broken down into large fragments will have a lower fragment count per unit intake than those which are not easily digested and broken into small fragments. Species which are subjected to prolonged digestion and produce fragments too small for accurate identification will lead to inaccurate results. Conversely, species which are ingested but are not digested at all, or very little, are rendered opaque by the action of the digestive juices and their fragments would be listed as 'unclassified'. In both these latter cases large counts in the 'unclassified' group would indicate that either or both of these factors were operative.

2. That there are no features of the respective fragments which tend to lead to selective identification; e.g. fragments of Calluna vulgaris can be identified by their characteristically partially opaque appearance and not primarily by their epidermal pattern. A fragment of grass with the same characters would be listed as 'unclassified' as it would be difficult to identify accurately.

Hercus (1960) has shown that an easily digested species gives large fragments, while in scouring animals the fragments are too small for identification.

Drapala et al. (1947) show that the increase in the number of undigested fragments of tissues and their increase in size in faecal samples is correlated with the increase in maturity of the forage eaten and with its increasing lignification, thus confirming Herous' view.

Herous (1960) also shows, by means of the figures here reproduced (Figures 5,6), that the percentage dry weight of grass fed is closely comparable with the proportion of cuticle in the faeces 2 days later (Fig. 5) and that there is a close correlation between the comparisons of digestibility by the two methods (a) by faecal nitrogen techniques and (b) by proportion of faecal cuticle (Fig. 6).

Her work also indicates that a more reliable estimate of quantitative diet may be based on the sum area of fragments rather than their frequency, but at present she is not prepared to relate qualitative results to quantitative.

Within any species the values obtained from faecal sample analysis over a period are comparable at similar times of the year, and this may be extended further depending on the variation in digestibility from month to month.

It is evident that little is at present known of the relations obtaining among weight ingested, digestibility/

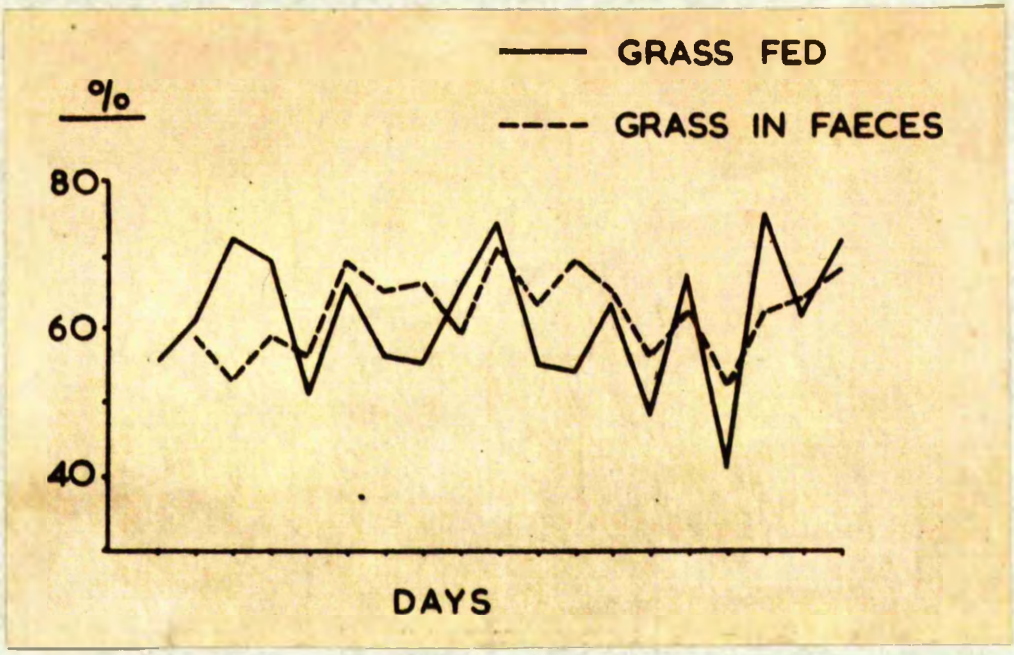


FIGURE 5 : Comparison of % dry weight of grass fed with the proportion of cuticle in the faeces two days later. (After Mercus 1960)

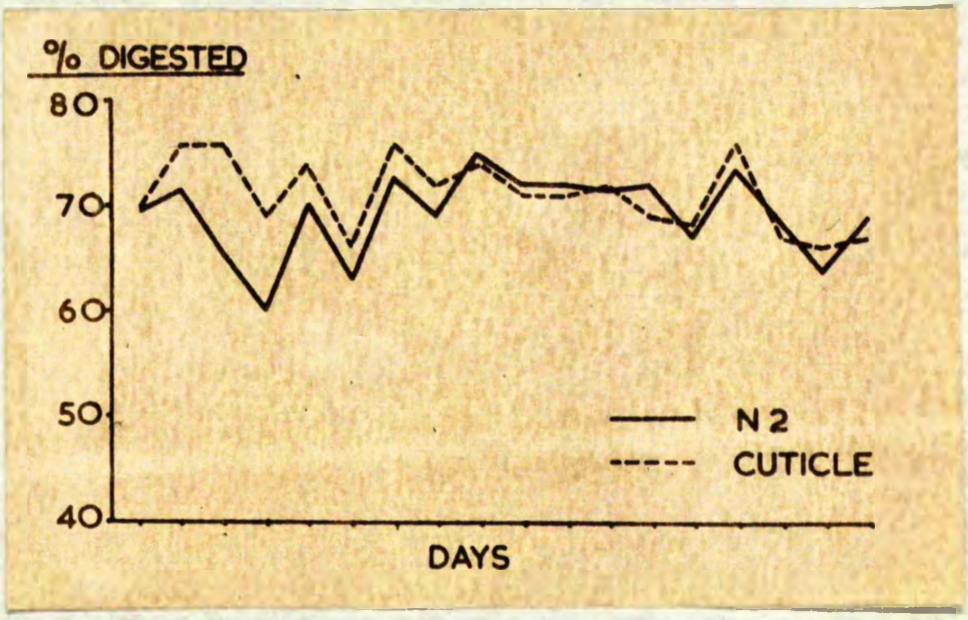


FIGURE 6 : Comparison of estimates of digestibility by the faecal nitrogen technique and by the proportion of faecal cuticle.
(After Mercus 1960)

/digestibility and faecal fragment counts or fragment area counts. The present system of analysis of diet is still in a relatively immature state and further work on stall-housed animals fed a weighed and known diet will be necessary to find the required correlations.

The results, and the above discussion, show that the problem of the self-selected diet of Blackface sheep is complex, depending to a great extent on availability and palatability of the herbage and on the seasonal preferences and age of the sheep. It may also be that the diet of Blackface sheep, as shown by the present results, differs from another breed on a similar hirsel, and probably also differs further from that of another breed, say Cheviot, on a southern uplands hirsel, as suggested by Tribe (1948) and Hunter (1958).

Variation between the diet of individual sheep was wide in many cases, indicating that there are personal preferences underlying the overall selection of diet. Hunter (1961) suggests that a sheep learns its grazing range from its mother, and that a sheep does not utilise the whole area of a heft available to it, but that different parts of the heft are grazed by different sheep.

The pattern of grazing by the experimental animals appears to be a distinctive one, particularly in lambs, and at first glance it would appear that, in order to make the best use of hill pasture, the flora should, where necessary, be modified to provide the optimum grazing conditions at any time of the year. However, as comparisons between the two hirsels show, the animals have the ability to select a similar diet from different available herbage. Therefore a wide range of hirsel types as regards the species present will adequately supply the components of the diet. Nevertheless, there remains no doubt that many hirsels should be improved and brought more closely to the flora range which affords the necessary diet. But every hirsel presents its own problems, apart from the basic ones of low soil fertility, bracken, lack of winter feed, excess of worthless herbage and the economic and geographic difficulties of improvement.

It would appear from the results that of prime importance is the amount of fescue, bent and heather on the hirsel, and that increase or selective benefit to these can do nothing but good, except where they may be already abundant. As Linton (1918) points out 'the abundant and obvious plants in a pasture are those which are/

/are not being eaten'; this concept is true so long as they are abundant at all times of the year. Secondary plants which are of great benefit at some times of the year and yet may be 'abundant and obvious' at others are still of great value as for example Juncus spp., Carex spp., Eriophorum spp., Molinia and the forage herbs, particularly legumes.

Many of the present hill land improvements, in particular drainage, affect the physical qualities of the soil to the extent that some plants may no longer be able to survive, and thus what in certain circumstances could be valuable grazing material will be lost.

On the other hand the deliberate increase of these plants must be approached with caution; as has been shown they are mostly of seasonal value, and at other times take up valuable ground. At present there would appear to be a good case for an increase in the amount of legumes on hill pasture, as those at present growing there tend to be limited in growth, low in grazing potential and especially difficult to establish.

PART IV

Previous literature regarding animal diet

SUMMARY

The epidermal characters of the plants found on Scottish rough grazings have been investigated. It is shown that the differentiated cells of the epidermis, such as stomatal guard cells, cork cells, silica-containing cells and asperities vary in their frequency and pattern of distribution among the undifferentiated cells of the epidermis.

The characters of an epidermis, based on these variations, are uniquely attributable at generic or specific level and can be utilised in the identification of epidermal fragments of such plants.

A key to the identification of epidermal fragments of the common plants of rough grazing is presented with photomicrographic illustrations of the epidermis of the species investigated.

In faecal samples from ruminant animals, epidermal fragments are the only specifically identifiable remnants of the plants which have been eaten and digested. They can be utilised in an investigation of the diet of such animals.

An investigation has been carried out, and comparisons made, of the diet of Scottish Blackface ewes and lambs on free range over two ecologically different rough grazings in Argyllshire, using the above technique. The result of/

/of the analysis of 254 faecal samples are presented. These samples were obtained over a period of forty successive months from four sets of experimental animals:

1. Ewes on free range from sea-level to 1100 feet.
2. Their lambs.
3. Ewes on restricted range from 600 to 1500 feet.
4. Their lambs.

The results indicate that there is a recurrent annual pattern of grazing exhibited by the ewes. This can be shown to occur on groups of plants, for example on grasses, rushes, sedges and other forage herbs, and also on particular species. The lambs also show a recurrent pattern of grazing, differing to some extent from that of the ewes.

The seasonal and yearly utilisation of the more important components of the sward was investigated and attention is drawn to the grazing patterns which emerge; in particular, to the prevalence in the diet at various times of the year of Juncus species, Carex species, Eriophorum species and of Molinia caerulea.

It is shown that a correlation exists between the results of diet analyses by the observation of flock movements over ecologically distinct areas and by analysis of plant epidermal fragments in faecal samples.

The results show that the ewes tended to select a similar diet although grazing on ecologically different areas. It is concluded that they can exercise a selective preference in their diet depending on the available grazing.

The analyses indicate that lambs of successive years exhibit basically similar habits and ~~that they show~~ a higher degree of preference for certain species in ~~their diet than~~ do the ewes.

Compared with the ewe diet, the lambs show imitative, diverging and converging phases in their diet selection.

The relationships between qualitative and quantitative diet are discussed. The significance of the results to rough grazings is considered.

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PART V

APPENDIX TABLES 1 - 27

LIST OF TABLES

HIRSEL		BARNACARRY		LOW END		
GROUP		EWES	LAMBS	EWES	LAMBS	
NUMBER OF SAMPLES		76	56	78	44	(254)
		TABLE NUMBER				
Average Counts per Month	1957	1	7	12	18	
	1958	2	8	13	19	
	1959	3	9	14	20	
	1960	4	-	15	-	
Monthly Totals	1957-1960	5	10	16	21	
Monthly Averages	1957-1960	6	11	17	22	
Comparison of Yearly Averages for All Groups	1957	23	23	23	23	
	1958	24	24	24	24	
	1959	25	25	25	25	
	1960	26	-	26	-	
Comparison of Averages of All Groups	1957-1960	27	27	27	27	

KEY TO TABLES

SPECIES

1. Festuca rubra L.
2. Festuca ovina L.
3. Agrostis stolonifera L.
4. Deschampsia flexuosa (L.) Trin.
5. Deschampsia caespitosa (L.) Beauv.
6. Juncus effusus L.
7. Juncus articulatus L.
8. Juncus squarrosus L.
9. Luzula campestris (L.) DC.
   Luzula pilosa (L.) Willd.
   Luzula sylvatica (Huds.) Gaud.
10. Eriophorum vaginatum L.
11. Eriophorum angustifolium Honck.
12. Carex nigra (L.) Reichard
13. Carex echinata Murr.
14. Carex panicea L.
15. Trichophorum caespitosum (L.) Hartman
16. Nardus stricta L.
17. Molinia caerulea (L.) Moench
18. Poa pratensis L.
19. Poa trivialis L.
20. Calluna vulgaris (L.) Hull
21. Erica tetralix L.
22. Erica cinerea L.
23. Vaccinium myrtillus L.
24. Vaccinium oxycoccus L.
25. Galium saxatile L.
    Galium verum L.
26. Ulex europaeus L.
27. Trifolium pratense L.
    Trifolium repens L.
28. Lotus corniculatus L.
    Lotus uliginosus Schkuhr
29. Potentilla erecta (L.) Rausch.
30. Sphagnum aggregate
31. Polytrichum aggregate
32. Holcus mollis L.
    Holcus lanatus L.
33. Cynosurus cristatus L.
34. Anthoxanthum odoratum L.
35. Dactylis glomerata L.
36. Lolium perenne L.
37. Myrica gale L.
38. Unclassified
39. Unknown
40. Total

TABLE 1

Hirsel..Barnacarry Group..Ewes Year,,1957

Average Counts per Month

Month	May	Jun,	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	6	4	2	1	2	1	2	2
No.1	7.8	10.25	19.0	14	13.0	13	12.5	12.0
2	6.0	0.25	3.5	5	4.5	1	2.5	2.5
3	12.7	11.0	5.5	7	3.5	5	5.0	10.0
4	8.3	5.0	4.0	4	5.5	3	3.5	5.0
5	0.1	0	0	0	0	0	1.5	1.0
6	2.5	0.75	1.0	1	7.0	3	3.5	5.0
7	0.5	0	1.0	1	1.0	1	0.5	3.0
8	0	0.25	0	0	0	4	3.5	4.0
9	0.1	1.0	2.5	0	0.5	6	0	0
10	13.9	8.0	3.5	2	4.5	2	0.5	4.5
11	1.0	0	0.5	3	1.0	1	0	1.5
12	2.5	0	0	0	3.0	0	6.5	4.5
13	1.3	0.5	1.5	2	0	0	2.5	2.5
14	2.0	2.25	0.5	0	0.5	0	0.5	0
15	4.3	11.5	7.5	3	1.5	2	0	0
16	1.5	2.0	2.0	0	0.5	1	1.0	1.5
17	8.0	1.75	0	4	1.5	0	1.5	0
18	0.7	2.25	1.0	1	5.5	0	1.0	0
19	0.1	0.5	2.0	0	0	0	0	0
20	1.1	3.25	3.5	16	13.5	12	15.0	19.5
21	0.7	0.25	0	3	2.5	0	0	3.0
22	0.1	1.0	0.5	1	0.5	2	1.0	0.5
23	0.1	0	0	0	1.5	5	4.5	4.5
24	0.3	0.75	0.5	1	1.0	2	0	0.5
25	1.5	4.25	2.0	1	1.5	3	0	2.0
26	0	0.75	1.0	0	0	0	1.5	0
27	1.1	3.25	1.0	0	2.0	7	3.0	1.0
28	0.9	2.5	0.5	1	2.5	3	3.5	1.0
29	1.3	2.0	2.5	3	2.5	5	0.5	0
30	2.7	2.0	5.0	4	4.0	2	3.0	1.0
31	1.3	2.5	3.0	2	2.0	2	3.0	2.0
32	0.1	0.75	1.0	0	0	1	0	0
33	0.1	0.25	0.5	0	1.0	1	0.5	0.5
34	0.7	0.5	0	2	0.5	1	0	1.0
35	0.3	1.0	0.5	0	0	3	0	1.0
36	0.3	0.75	0	1	1.0	1	1.0	0
37	0	1.0	2.5	0	1.0	0	0	0.5
38	9.3	12.5	14.0	9	4.5	5	11.5	2.5
39	6.5	3.5	6.5	9	5.5	3	6.5	2.5
40	101.7	100.0	99.5	100.0	100.0	100.0	100.0	100.0

TABLE 2

Hirsel..Barnacarry Group..Ewes Year..1958

Average Counts per Month

Month	Jan.	Feb.	Mar.	Apl.	May	Jun.
Samples	0	2	1	2	0	2
No.1		12.5	18	14.0		15.0
2		2.5	2	2.5		2.5
3		10.0	16	11.5		8.0
4		4.5	6	7.5		7.0
5		1.0	0	0		0
6		4.0	3	3.0		3.0
7		3.0	1	0.5		0.5
8		4.0	2	0.5		0
9		0	0	0		1.0
10		5.0	8	8.5		6.5
11		1.0	1	1.0		3.5
12		4.0	5	5.5		3.0
13		1.0	0	4.0		1.0
14		0	0	1.5		2.5
15		0	0	4.0		6.0
16		0.5	2	4.0		7.0
17		7.0	11	5.0		7.0
18		0	0	1.5		0
19		0	0	0		1.0
20		13.5	7	3.5		0
21		2.0	0	1.5		0.5
22		0.5	1	0		1.0
23		0	0	0		2.0
24		0.5	0	1.0		2.0
25		0	0	1.0		1.0
26		0	0	0		2.0
27		0.5	0	0.5		3.5
28		0	1	1.5		0.5
29		0	0	0.5		2.0
30		1.0	1	0.5		1.5
31		1.0	4	2.5		0
32		0	0	1.0		0.5
33		1.0	1	0.5		1.0
34		1.5	1	2.0		2.0
35		0	0	0		0
36		0	0	0		0
37		0.5	0	1.5		1.0
38		12.0	5	6.0		3.0
39		5.5	4	2.0		2.0
40		100.0	100.0	100.0		100.0

TABLE 2 CONTD.

Hirsel..Barnacarry Group..Lwes Year..1958

Average Counts per Month

Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	4	2	3	4	2	2
No.1	16.25	15.5	18.6	13.0	9.5	10.5
2	4.75	2.5	1.3	1.0	1.0	2.0
3	7.0	5.0	8.0	7.25	11.0	6.5
4	6.0	5.5	10.6	5.75	2.0	7.5
5	0	0	0	0	0.5	1.0
6	1.75	1.5	0.3	4.5	5.0	6.0
7	0.5	0	0.6	0.5	1.5	1.5
8	0.25	0	0	0.75	2.0	4.5
9	0.5	2.5	5.0	1.0	0	0
10	4.0	2.0	2.6	1.75	2.0	4.0
11	0.25	0	0	0	0	0.5
12	1.0	3.0	2.0	4.25	7.5	6.0
13	1.0	0.5	1.0	0.5	0	1.0
14	1.25	0	0.6	0	0	0
15	3.75	2.0	3.0	1.0	0	0.5
16	1.5	1.0	0.3	0.5	0.5	1.0
17	2.0	3.5	2.0	0.75	2.5	5.0
18	2.0	4.5	2.6	3.75	0	0
19	0.5	0	0	0.25	0	0
20	5.25	15.5	4.3	12.25	15.0	14.0
21	0	1.0	0	0.5	0.5	2.0
22	0.75	0	3.3	2.25	0	0
23	0.5	1.5	2.0	2.25	3.5	1.5
24	1.5	2.0	3.0	0.75	0.5	1.0
25	2.0	2.0	0.3	4.25	1.5	2.0
26	1.0	0	1.0	0.75	0	0
27	3.0	2.5	3.0	1.75	2.5	0
28	6.0	3.0	2.0	3.0	0.5	1.5
29	5.25	0.5	1.3	2.5	1.5	0
30	3.0	0.5	0.3	3.5	3.0	2.5
31	2.25	0	2.0	1.25	3.0	3.0
32	0.25	0	1.6	0.25	0	0
33	0.25	1.0	2.3	0	1.5	0.5
34	0.75	2.0	0.6	0.5	0	0.5
35	0.25	0	0	0	0	0
36	0	1.0	0.6	0.5	1.5	0
37	1.0	4.0	2.3	0.25	2.5	0
38	6.25	12.0	8.3	11.75	8.5	5.5
39	6.5	2.5	2.3	5.25	9.5	8.5
40	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 3

Hirsel..Barnacarry Group..Ewes Year..1959

Average Counts per Month

Month	Jan.	Feb.	Mch.	Apl.	May	Jun.
Samples	0	1	1	2	4	3
No.1		11	24	15.0	10.5	11.6
2		0	5	5.0	2.0	2.3
3		13	10	11.5	8.0	11.0
4		7	4	9.5	6.75	5.6
5		2	0	0	0	0
6		5	3	2.5	2.0	2.6
7		3	2	0.5	0.75	0
8		6	3	0.5	0	0
9		0	0	0	0.75	2.3
10		7	5	6.5	10.5	8.3
11		1	0	2.5	1.75	0.6
12		4	5	5.5	3.25	2.3
13		1	2	2.0	0.25	1.0
14		0	1	1.5	2.75	0.6
15		0	0	5.0	7.5	3.3
16		0	0	2.0	3.75	1.3
17		8	4	7.5	7.75	6.0
18		0	0	1.0	1.5	0.3
19		0	0	0	0.5	0.6
20		16	5	3.0	5.0	3.0
21		3	3	0	0.75	1.0
22		1	1	0	0.75	1.6
23		0	0	0	0.25	0
24		0	0	0	1.5	1.6
25		0	0	0	0.5	1.3
26		0	1	0	0.25	0.6
27		1	2	1.5	2.75	2.6
28		1	0	1.0	2.0	2.0
29		0	0	0.5	1.5	0.3
30		2	4	2.5	1.0	4.0
31		2	0	1.0	0.75	3.0
32		0	0	0	0.5	0.3
33		1	2	0.5	0.75	0.6
34		2	1	1.0	2.0	0.6
35		0	0	0	0.75	0.3
36		0	0	0	0	0
37		0	1	0	1.75	1.0
38		2	10	4.5	5.0	6.3
39		1	2	4.5	2.0	5.0
40		100	100	100.0	100.0	99.8

TABLE 3 CONTD.

Hirsel..Barnacarry Group..Ewes Year..1959

Average Counts per Month

Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	1	2	3	1	2	2
No.1	18	9.0	12.3	12	12.5	17.5
2	0	4.5	4.0	2	4.5	1.0
3	7	6.5	5.0	5	8.5	4.0
4	4	9.0	5.0	3	7.0	4.0
5	0	0	0	0	0.5	2.0
6	1	4.5	3.6	4	8.0	5.0
7	1	0	0.3	1	4.5	4.0
8	0	0	0	3	3.0	4.5
9	2	0	1.3	0	0	0
10	1	6.0	1.6	2	1.5	4.0
11	2	0	0.3	0	1.0	0
12	2	3.0	1.3	2	5.0	7.0
13	0	1.0	1.0	1	0	0
14	1	2.0	0.6	1	0.5	3.0
15	7	0	2.0	4	3.0	2.0
16	3	1.5	0	1	1.5	2.5
17	1	0.5	0.3	2	0	0
18	2	3.0	3.6	4	0	0
19	0	1.5	0	0	0	0
20	5	12.5	19.0	10	8.0	11.0
21	0	3.5	1.6	2	1.0	2.5
22	2	1.0	0.6	1	1.0	2.0
23	1	0.5	1.3	4	5.0	5.0
24	0	2.5	0.3	3	1.0	0.5
25	4	1.0	3.6	0	1.5	0
26	0	0	0	2	2.0	2.0
27	4	0	1.6	5	2.5	0
28	1	1.0	2.0	9	2.0	0
29	3	3.0	6.3	0	2.0	1.5
30	2	5.0	1.6	0	3.0	3.0
31	5	3.5	1.3	2	1.0	3.0
32	2	0.5	0	3	0	0
33	1	0.5	0	1	0.5	1.0
34	1	0	0.3	0	1.0	0.5
35	0	0.5	0	0	0.5	0
36	2	1.0	1.0	2	1.0	0
37	3	3.5	0	1	0	0
38	8	3.0	13.0	4	4.0	4.0
39	4	3.0	3.3	4	2.0	3.5
40	100	100.0	99.0	100	100.0	100.0

TABLE 4

Hirsel..Barnacarry Group..Ewes Year..1960

Average Counts per Month

Month	Jan.	Feb.	Mch.	Apl.	May	Jun.	Jul.	Aug.	Sep.
Samples	2	1	0	1	2	2	0	0	2
No.1	11.5	13		15	10.0	11.5			9.0
2	2.5	3		5	5.5	2.5			5.0
3	10.5	14		12	7.5	3.0			8.0
4	6.0	5		6	9.0	8.0			4.5
5	1.0	1		0	0	0			0
6	4.0	5		4	1.0	7.5			4.0
7	3.5	3		2	0	0			2.5
8	5.0	5		1	0	0			0
9	0	0		0	0	2.0			3.0
10	6.5	6		9	5.0	6.5			2.0
11	1.0	1		1	1.0	0.5			2.5
12	4.0	3		5	5.5	0			0
13	1.0	2		2	4.0	0.5			0.5
14	0	0		3	3.0	1.5			0
15	0	0		5	5.5	5.0			1.5
16	0	1		2	0.5	5.0			2.0
17	3.5	8		5	5.0	5.5			0
18	0	0		0	1.5	0			3.0
19	0	0		0	0.5	0			0
20	17.0	14		3	1.0	6.0			18.5
21	4.0	4		2	3.0	0.5			1.0
22	1.0	1		0	0.5	1.0			0.5
23	5.0	0		0	0	0			1.5
24	0	1		1	0	2.5			1.0
25	0	0		0	3.5	0			2.0
26	0	0		0	3.0	1.5			0
27	0	1		0	2.0	2.0			3.0
28	0	1		1	2.5	5.0			4.5
29	0	0		0	1.0	2.0			0
30	1.0	2		2	3.5	5.0			5.0
31	0.5	1		0	2.5	0.5			1.5
32	0	0		0	0.5	0.5			0.5
33	0	1		0	0.5	0.5			1.5
34	0	1		1	2.5	0			0
35	0	0		0	0.5	1.0			0
36	0	0		0	0.5	1.5			0
37	0	1		1	0.5	2.0			0
38	7.0	0		9	6.0	6.0			4.5
39	4.5	2		3	2.0	3.5			2.5
40	100.0	100		100	100.0	100.0			100.0

TABLE 5

Hirsel..Barnacarry Group..Ewes Years 1957-1960

Monthly Totals

Month	Jan.	Feb.	Mch.	Apl.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	2	4	2	5	12	11	7	5	10	6	6	6
No.1	23	50	42	73	109	129	121	63	137	77	69	80
2	5	8	7	20	43	18	26	19	35	7	16	11
3	21	47	26	58	123	99	46	30	62	39	49	41
4	12	21	10	40	95	67	36	33	67	29	25	33
5	2	5	0	0	1	0	0	0	0	0	5	8
6	8	18	6	15	25	32	10	13	34	25	33	32
7	7	12	3	4	6	1	5	1	10	4	13	17
8	10	19	5	3	0	1	1	0	0	10	17	26
9	0	0	0	0	4	17	9	5	26	10	0	0
10	13	23	13	43	133	83	24	18	26	11	9	25
11	2	4	1	8	15	10	4	3	8	1	2	4
12	8	15	10	27	39	13	6	12	16	19	38	35
13	2	5	2	14	17	8	7	5	7	3	5	7
14	0	0	1	9	29	19	7	4	5	1	2	6
15	0	0	0	23	67	78	37	7	21	10	6	5
16	0	2	2	14	25	36	13	5	6	4	6	10
17	7	30	15	30	89	50	9	12	10	5	8	10
18	0	0	0	5	13	10	12	16	46	19	0	0
19	0	0	0	0	4	6	6	3	0	1	0	0
20	34	57	12	16	29	34	33	72	134	71	76	89
21	8	11	3	5	13	6	0	12	12	4	3	15
22	2	3	2	0	5	13	6	3	14	12	4	5
23	10	0	0	0	2	4	3	4	16	18	26	22
24	0	2	0	3	8	16	8	10	14	8	3	4
25	0	0	0	2	18	23	16	7	19	20	6	8
26	0	0	1	0	7	12	6	0	3	5	7	4
27	0	3	2	4	22	32	18	5	24	19	16	2
28	0	2	1	6	18	27	26	9	26	24	12	5
29	0	0	0	2	16	29	29	10	28	15	8	3
30	2	6	5	8	27	33	24	15	24	16	18	13
31	1	5	4	7	16	20	20	9	17	9	14	16
32	0	0	0	2	4	6	5	1	6	5	0	0
33	0	4	3	2	5	6	3	3	12	2	5	4
34	0	6	2	7	17	8	4	6	4	3	2	4
35	0	0	0	0	6	7	2	1	0	3	1	2
36	0	0	0	0	3	6	2	5	7	5	7	0
37	0	2	1	4	8	13	12	15	9	2	5	1
38	14	26	15	30	88	87	61	40	82	56	48	24
39	9	14	6	16	50	41	43	24	33	28	36	29
40	200	400	200	500	1200	1100	700	500	1000	600	600	600

TABLE 6

Hirsel..Barnacarry Group..Lwes Years..1957-1960

Monthly Averages

Month	Jan.	Feb.	Mch.	Apl.	May	Jun.
Samples	2	4	2	5	12	11
No.1	11.5	12.5	21.0	14.6	9.1	11.7
2	2.5	2.0	3.5	4.0	3.6	1.6
3	10.5	11.75	13.0	11.6	10.3	9.0
4		5.25	5.0	8.0	7.9	6.0
5	1.0	1.25	0	0	0.1	0
6	4.0	4.5	3.0	3.0	2.1	2.9
7	3.5	3.0	1.5	0.8	0.5	0.1
8	5.0	4.75	2.5	0.6	0	0.1
9	0	0	0	0	0.3	1.5
10	6.5	5.75	6.5	8.6	11.1	7.5
11	1.0	1.0	0.5	1.6	1.3	0.9
12	4.0	3.75	5.0	5.4	3.2	1.2
13	1.0	1.25	1.0	2.8	1.4	0.7
14	0	0	0.5	1.8	2.4	1.7
15	0	0	0	4.6	5.6	7.1
16	0	0.5	1.0	2.8	2.1	3.3
17	3.5	7.5	7.5	6.0	7.4	4.5
18	0	0	0	1.0	1.1	0.9
19	0	0	0	0	0.3	0.5
20	17.0	19.25	6.0	3.2	2.4	3.1
21	4.0	2.75	1.5	1.0	1.1	0.5
22	1.0	0.75	1.0	0	0.4	1.2
23	5.0	0	0	0	0.2	0.4
24	0	0.5	0	0.6	0.7	1.5
25	0	0	0	0.4	1.5	2.1
26	0	0	0.5	0	0.6	1.1
27	0	0.75	1.0	0.8	1.8	2.9
28	0	0.5	0.5	1.2	1.5	2.5
29	0	0	0	0.4	1.3	2.6
30	1.0	1.5	2.5	1.6	2.2	3.0
31	0.5	1.25	2.0	1.4	1.3	1.7
32	0	0	0	0.4	0.3	0.5
33	0	1.0	1.5	0.4	0.4	0.5
34	0	1.5	1.0	1.4	1.4	0.7
35	0	0	0	0	0.5	0.6
36	0	0	0	0	0.2	0.5
37	0	0.5	0.5	0.8	0.7	1.2
38	7.0	6.5	7.5	6.0	7.3	7.9
39	4.5	3.5	3.0	3.2	4.2	3.7
40	100.0	100.0	100.0	100.0	99.8	99.4

TABLE 6 CONTD.

Hirsel..Barnacarry Group..Lwes Years..1957-1960

Monthly Averages

Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	7	5	10	6	6	6
No.1	17.3	12.6	13.7	12.8	11.5	13.3
2	3.7	3.8	3.5	1.1	2.7	1.8
3	6.6	6.0	6.2	6.5	8.2	6.9
4	5.1	6.6	6.7	4.8	4.2	5.5
5	0	0	0	0	0.8	1.3
6	1.4	2.6	3.4	4.1	5.5	5.3
7	0.7	0.2	1.0	0.7	2.2	2.9
8	0.1	0	0	1.7	2.9	4.3
9	1.3	1.0	2.6	1.7	0	0
10	3.4	3.6	2.6	1.8	1.5	4.2
11	0.6	0.6	0.8	0.2	0.3	0.7
12	0.9	2.4	1.6	3.1	6.3	5.9
13	1.0	1.0	0.7	0.5	0.8	1.2
14	1.0	0.8	0.5	0.2	0.3	1.0
15	5.3	1.4	2.1	1.7	1.0	0.8
16	1.9	1.0	0.6	0.7	1.0	1.7
17	1.3	2.4	1.0	0.8	1.3	1.7
18	1.7	3.2	4.6	3.1	0	0
19	0.9	0.6	0	0.2	0	0
20	4.7	14.4	13.4	11.9	12.7	14.8
21	0	2.4	1.2	0.7	0.5	2.5
22	0.9	0.6	1.4	2.0	0.7	0.8
23	0.4	0.8	1.6	3.0	4.3	3.7
24	1.1	2.0	1.4	1.3	0.5	0.7
25	2.3	1.4	1.9	3.3	1.0	1.3
26	0.9	0	0.3	0.8	1.1	0.7
27	2.6	1.0	2.4	3.2	2.7	0.3
28	3.7	1.8	2.6	4.0	2.0	0.8
29	4.1	2.0	2.8	2.5	1.3	0.5
30	3.4	3.0	2.4	2.7	3.0	2.2
31	2.9	1.8	1.7	1.5	2.7	2.7
32	0.7	0.2	0.6	0.8	0	0
33	0.4	0.6	1.2	0.3	0.7	0.7
34	0.6	1.2	0.4	0.5	0.3	0.7
35	0.3	0.2	0	0.5	0.2	0.3
36	0.3	1.0	0.7	0.8	1.2	0
37	1.7	3.0	0.9	0.3	0.8	0.2
38	8.7	8.0	8.2	9.3	8.0	4.0
39	6.1	4.8	3.3	4.7	6.0	4.7
40	100.0	100.0	100.0	99.8	101.2	98.1

TABLE 7

Hirsel..Barnacarry Group..Lambs Year..1957

Average Counts per Month

Month	May	Jun.	Jul..	Aug.	Sep.	Oct.
Samples	8	4	2	4	4	5
No.1	11.0	14.5	16.5	15.0	11.25	13.6
2	5.4	3.25	5.0	4.25	5.5	2.6
3	9.5	10.75	13.5	10.25	11.25	8.6
4	10.5	12.50	10.5	6.50	2.25	3.0
5	0	0	0	0	0.25	0
6	0.5	0.25	0	0.5	2.0	4.4
7	0.1	0	0	0.5	0.25	0
8	0	0	0	0	0.5	0.8
9	0.4	1.50	0.5	1.25	0.75	2.0
10	9.7	9.25	7.0	3.50	2.75	1.2
11	2.4	2.0	1.5	1.25	0.5	0.6
12	3.5	4.25	4.0	4.75	3.25	2.0
13	0	0	0	0.50	0	0.2
14	1.2	0.75	0	0.25	0	0
15	6.7	3.75	4.0	0.75	0.5	0.6
16	0	0	0	0	0.25	0.2
17	5.1	8.25	2.0	2.50	1.25	0.8
18	2.4	2.0	4.0	4.25	7.0	5.6
19	0.4	1.25	1.5	1.50	1.5	2.0
20	4.3	1.25	3.0	3.0	8.0	10.6
21	1.0	0.5	1.0	0.25	1.0	0.8
22	0.4	0.5	0	0.75	0.5	1.0
23	0.9	0.25	1.5	0	0.5	1.8
24	0.5	0	0	0	0	1.4
25	2.4	2.5	2.0	2.75	3.75	5.0
26	0	0	0	0	0	0.2
27	2.1	3.0	4.5	6.25	5.0	4.6
28	1.6	3.25	2.5	4.25	3.5	4.2
29	0.4	1.0	1.5	2.75	3.5	1.8
30	1.2	2.0	2.5	2.0	2.5	2.0
31	0.4	0.75	1.5	0.75	1.25	0.8
32	0.3	0.75	0	0.5	0.25	1.0
33	0	0.5	1.5	0	0.5	0.6
34	0	0	0	0.5	0.25	0.4
35	0.3	0.75	0	0	0.25	0.2
36	0.3	0.75	1.0	1.50	1.0	1.4
37	0	0	0	0	0	0
38	8.6	5.5	3.5	13.5	9.75	7.0
39	6.6	2.5	4.0	4.0	7.5	7.0
40	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 8

Hirsel..Barnacarry Group..Lambs Year..1958

Average Counts per Month

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	2	2	2	2	2	2
No.1	5.5	12.0	15.0	14.0	13.0	17.0
2	5.0	4.0	5.5	4.5	2.5	5.0
3	7.5	10.5	11.0	11.0	12.0	10.0
4	6.0	10.5	12.0	7.0	4.5	3.0
5	0	0	0	0	0.5	0
6	0.5	0.5	0	0.5	1.5	0.5
7	0.5	1.0	0	0	0	0
8	0.5	0	0	0	0	0.5
9	0.5	1.5	1.5	1.5	1.5	3.0
10	9.5	7.5	6.0	3.5	5.0	1.5
11	3.0	2.0	1.5	0.5	0	0
12	2.5	3.5	3.0	3.5	4.5	5.5
13	1.0	0	0	0	0.5	0
14	1.5	1.0	0	1.0	0	0
15	5.5	4.0	3.0	1.5	1.5	1.0
16	1.0	0.5	0.5	0	0	0
17	13.0	5.5	6.5	1.0	1.5	1.5
18	2.0	3.5	3.5	4.5	5.5	4.0
19	0.5	1.5	1.5	3.5	2.5	1.5
20	7.5	1.0	1.0	5.0	5.5	5.0
21	1.0	1.0	0.5	0.5	1.0	2.0
22	1.0	0	0	1.5	0.5	1.0
23	1.5	0.5	1.0	1.0	2.5	1.5
24	0	0	0	0	0.5	1.0
25	2.5	2.5	1.5	4.5	4.5	6.5
26	0	0	0	0	0	0
27	3.5	4.5	4.0	4.0	3.0	5.0
28	3.5	8.0	4.5	3.5	5.0	4.5
29	2.0	2.0	1.0	1.5	3.5	5.5
30	1.5	2.5	3.0	3.0	3.5	3.0
31	1.5	1.5	1.0	0.5	1.0	1.0
32	0.5	0.5	0.5	1.0	1.0	1.5
33	0	1.5	1.0	2.0	1.5	0
34	1.0	1.5	0	0	0	1.5
35	0.5	0	0	0.5	0.5	0.5
36	0	0.5	0.5	0.5	1.0	2.5
37	0	0	0	0	0	0
38	1.5	2.5	4.5	9.0	6.5	2.0
39	5.5	1.0	5.5	4.5	2.5	2.0
40	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 9

Hirsel..Barnacarry Group..Lambs Year..1959

Average Counts per Month

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	3	2	3	3	3	3
No.1	11.0	12.0	17.0	14.6	18.0	13.3
2	3.3	4.0	3.6	5.3	4.0	2.6
3	11.3	11.5	6.0	9.3	10.6	7.6
4	6.3	9.0	7.3	5.6	3.6	3.0
5	0	0	0.3	0	0.3	0
6	1.0	0	0	0.3	1.0	1.6
7	0.6	0	0.3	0.3	0	0.3
8	0	0	0	0	0	0.3
9	1.0	0.5	0.6	1.0	1.6	1.6
10	7.6	5.0	7.0	4.6	2.6	2.3
11	1.3	1.5	1.0	0.6	0.3	0
12	1.6	2.0	3.3	3.0	2.6	4.3
13	0	1.0	0.6	0	1.0	0
14	1.0	0.5	0	0.6	0	0
15	5.6	5.0	2.6	1.3	1.0	0
16	0	0.5	0.6	0.6	0	0.6
17	7.0	7.5	7.3	2.6	1.3	1.0
18	1.6	3.0	2.6	2.6	6.3	5.3
19	0.6	1.0	1.0	2.3	2.0	2.6
20	5.6	1.0	1.3	5.6	6.3	13.3
21	0.6	0.5	0.3	0.3	0.6	1.0
22	0.6	0	0.6	1.0	0.3	0.6
23	1.0	1.5	0	0.6	1.3	0.6
24	0	0	0	0	1.0	1.0
25	1.3	2.5	3.3	3.6	3.6	6.3
26	0	0	0	0	0	0
27	2.3	3.5	5.0	6.0	2.6	4.3
28	2.0	2.0	6.3	2.0	4.0	3.6
29	1.0	1.5	1.3	0.6	1.6	4.6
30	1.6	2.0	1.6	3.3	1.3	3.0
31	0.6	1.0	0.3	0.6	1.0	1.0
32	0	0.5	0.6	0.3	0.6	1.0
33	0.3	1.0	0	1.3	1.0	0.6
34	0.6	0	0.3	0	0	0
35	0.3	0.5	0.3	0.3	0.3	0
36	0.3	0.5	0.6	1.3	0.6	0.6
37	0	0	0	0	0	0.3
38	14.0	10.0	9.3	11.6	14.3	5.0
39	6.0	5.5	6.6	5.6	2.3	5.6
40	98.9	100.0	98.2	98.6	98.9	98.8

TABLE 10

Hirsel..Barnacarry Group..Lambs Years.1957-1959

Monthly Totals

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	13	8	7	9	9	10
No.1	132	106	114	132	125	142
2	63	29	32	42	39	31
3	125	87	67	91	101	86
4	115	89	67	57	29	30
5	0	0	1	0	3	0
6	8	2	0	4	14	28
7	4	2	1	3	1	1
8	1	0	0	0	2	6
9	7	10	6	11	11	21
10	120	67	47	35	29	16
11	29	15	9	7	3	3
12	38	28	24	35	30	34
13	2	2	2	2	4	1
14	16	6	0	5	0	0
15	82	33	22	10	8	5
16	2	2	3	2	1	3
17	88	59	38	20	12	10
18	28	21	23	34	58	52
19	6	10	9	20	17	21
20	66	9	12	39	62	103
21	12	5	4	3	8	11
22	7	2	2	9	4	9
23	13	5	5	4	11	14
24	4	0	0	0	4	12
25	28	20	17	31	35	57
26	0	0	0	0	0	1
27	31	28	32	51	34	46
28	26	33	34	30	36	41
29	10	11	9	16	26	34
30	18	17	16	24	21	25
31	8	8	6	6	10	9
32	3	5	3	5	5	11
33	1	7	5	8	8	5
34	4	3	1	2	1	5
35	4	4	1	2	3	2
36	3	5	5	11	8	14
37	0	0	0	0	0	1
38	114	47	44	107	95	54
39	82	23	39	42	42	56
40	1300	800	700	900	900	1.000

TABLE 11

Hirsel..Barnacarry Group..Lambs Years.,1957-1959

Monthly Averages

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	13	8	7	9	9	10
No.1	10.2	13.3	16.3	14.7	13.9	14.2
2	4.6	3.6	4.6	4.7	4.3	3.1
3	9.6	10.9	9.6	10.1	11.2	8.6
4	8.8	11.1	9.6	6.3	3.2	3.0
5	0	0	0.1	0	0.3	0
6	0.6	0.3	0	0.4	1.6	2.8
7	0.3	0.3	0.1	0.3	0.1	0.1
8	0.1	0	0	0	0.2	0.6
9	0.5	1.2	0.9	1.2	1.2	2.1
10	9.2	8.4	6.7	3.9	3.2	1.6
11	2.2	1.9	1.3	0.8	0.3	0.3
12	2.9	3.5	3.4	3.9	3.3	3.4
13	0.2	0.3	0.3	0.2	0.5	0.1
14	1.2	0.8	0	0.6	0	0
15	6.3	4.1	3.1	1.1	0.9	0.5
16	0.2	0.3	0.4	0.2	0.1	0.3
17	6.8	7.4	5.4	2.2	1.3	1.0
18	2.2	2.6	3.3	3.8	6.4	5.2
19	0.5	1.2	1.3	2.2	1.9	2.1
20	5.1	1.1	1.7	4.3	6.9	10.3
21	0.9	0.6	0.6	0.3	0.9	1.1
22	0.5	0.2	0.3	1.0	0.5	0.9
23	1.0	0.6	0.7	0.4	1.2	1.4
24	0.3	0	0	0	0.5	1.2
25	2.2	2.5	2.4	3.4	3.9	5.7
26	0	0	0	0	0	0.1
27	2.4	3.5	4.6	5.7	3.8	4.6
28	2.0	4.1	4.9	3.3	4.0	4.1
29	0.8	1.3	1.3	1.7	2.9	3.4
30	1.4	2.1	2.3	2.7	2.3	2.5
31	0.6	1.0	0.9	0.6	1.1	0.9
32	0.2	0.6	0.4	0.6	0.6	1.1
33	0.1	0.9	0.7	0.9	0.9	0.5
34	0.3	0.4	0.1	0.2	0.1	0.5
35	0.3	0.5	0.1	0.2	0.3	0.2
36	0.2	0.6	0.7	1.2	0.9	1.4
37	0	0	0	0	0	0.1
38	8.8	5.9	6.3	11.9	10.6	5.4
39	6.3	2.9	5.6	4.7	4.7	5.6
40	99.8	100.0	100.0	99.7	100.0	100.0

TABLE 12

Hirsel..Low End Group..Lwes Year..1957

Average Counts per Month

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	3	2	2	2	2	2	2	3
No.1	11.6	15.5	17.5	12.5	12.0	15.0	11.0	12.6
2	3.6	6.0	2.0	4.5	3.5	3.0	6.5	2.0
3	10.0	5.5	5.0	4.0	6.5	8.0	5.0	7.0
4	11.3	5.0	4.0	4.5	6.0	3.5	6.0	5.3
5	0.3	0	0	0	0	0	1.0	1.3
6	3.6	2.5	3.0	5.0	2.5	4.0	3.0	6.3
7	0.6	0	0.5	0.5	1.5	3.5	3.0	3.3
8	1.0	0	0.5	0	0.5	1.0	3.5	4.3
9	0	0	0.5	0.5	6.0	1.5	0	0
10	7.6	6.0	3.5	4.0	2.5	3.5	1.5	4.6
11	2.0	1.5	1.0	0.5	1.0	0	1.5	1.3
12	3.0	3.5	1.5	0.5	3.5	5.5	5.0	3.6
13	1.3	2.0	2.0	1.0	1.0	3.0	3.0	1.3
14	2.0	1.0	0.5	1.5	0.5	1.0	2.0	1.0
15	6.3	9.0	5.5	4.0	0.5	0.5	1.5	0.3
16	2.6	1.5	1.5	1.0	0.5	1.0	0	0
17	6.0	4.0	2.5	3.0	1.0	2.5	2.0	5.0
18	0.6	1.0	2.0	2.5	4.0	3.0	2.0	0
19	0	0.5	1.5	1.5	2.5	3.5	0	0
20	6.0	2.0	5.5	12.0	16.5	12.5	16.5	18.3
21	2.0	2.0	1.5	2.0	1.5	1.5	0	2.3
22	1.0	3.0	1.0	0	2.5	2.5	2.5	0.6
23	0	0	0	0.5	0	0	1.0	1.6
24	0	1.0	0.5	0	0	0.5	1.5	0.6
25	0.3	0	1.5	0	3.5	3.0	3.5	0.3
26	0.6	0.5	0.5	0	0	0	0	0
27	1.3	6.0	2.5	4.5	2.0	0	1.5	0
28	1.0	2.5	3.0	8.0	4.5	2.0	0	0
29	2.0	2.5	5.5	3.0	3.5	4.5	1.0	0.3
30	2.6	3.0	5.5	4.5	4.0	2.0	1.5	1.6
31	1.3	2.0	1.5	0.5	0.5	1.0	1.0	1.3
32	0	0.5	1.5	1.5	0.5	0	0	0
33	0.6	2.5	1.0	0	1.5	0.5	0.5	0.3
34	0.3	0.5	0	0	0	1.5	0.5	0.6
35	2.0	4.0	1.5	0	0	0	0	0
36	0	0	1.5	3.0	2.5	0.5	0	0
37	0	0	0	0	0	0	0	0
38	2.3	0.5	7.0	5.5	1.0	3.0	9.0	9.3
39	2.3	1.0	4.5	3.5	1.0	2.0	2.5	2.6
40	99.0	100.0	100.0	100.0	100.0	100.0	100.0	98.9

TABLE 13

Hirsel..Low End Group..Ewes Year..1958

Average Counts per Month

Month	Jan.	Feb.	Mch.	Apl.	May.	Jun.
Samples	0	1	2	2	0	3
No.1		15	17.5	15.0		12.6
2		2	4.0	3.0		2.3
3		10	6.0	9.0		5.6
4		5	6.5	8.0		6.6
5		2	0	0		0.3
6		4	3.0	5.0		0.3
7		4	4.0	1.0		0
8		5	5.0	1.0		0.3
9		0	0	0		0.3
10		9	9.0	5.5		7.0
11		3	1.5	2.5		1.3
12		4	4.0	5.0		1.3
13		1	2.5	3.0		1.0
14		2	1.5	0.5		1.0
15		0	0	3.5		5.3
16		0	0.5	1.0		1.0
17		5	5.5	3.0		5.6
18		0	0	1.0		0.6
19		0	0	0		0.3
20		21	10.5	5.5		5.3
21		2	5.0	3.5		0.3
22		2	1.0	1.5		2.3
23		1	0	0.5		0
24		0	0	0		0.6
25		0	0	0.5		0.6
26		0	0	0		0.3
27		0	1.0	1.0		2.6
28		0	0	0		2.3
29		0	0	1.0		5.0
30		0	4.5	4.5		7.0
31		0	1.5	1.0		2.0
32		0	0	0		0.6
33		0	0	2.5		1.6
34		0	1.5	2.0		1.6
35		0	1.0	0.5		0.6
36		0	0	0		0.3
37		0	0	0		0
38		1	3.0	9.0		7.6
39		2	0.5	0		5.0
40		100	100.0	100.0		98.6

TABLE 13 CONTD.

Hirsel..Low End Group..Lwes Year..1958

Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	0	3	3	4	2	2
No.1		14.6	13.0	11.75	13.0	12.5
2		2.6	6.6	3.75	5.0	4.5
3		8.3	6.0	5.75	10.5	9.0
4		5.0	4.3	4.25	8.0	7.5
5		0	0.3	0	0	1.0
6		0.6	3.0	4.25	6.5	7.5
7		0.6	1.0	1.75	3.0	2.5
8		0	1.3	1.25	4.0	4.5
9		0.6	1.3	2.00	0	0
10		5.0	4.0	1.75	2.0	5.0
11		1.0	0.6	0.50	0.5	1.5
12		2.6	2.0	2.25	4.0	4.0
13		0.6	1.3	0.75	2.0	1.5
14		2.6	1.3	2.00	1.0	1.5
15		4.3	1.0	0.25	0	0.5
16		1.0	0.3	0.75	0	1.0
17		3.3	2.0	2.75	1.5	3.0
18		2.3	1.3	3.00	1.0	0
19		0.3	0.6	2.00	0	0
20		16.3	12.0	8.25	10.5	15.5
21		1.0	1.6	0.75	1.0	1.5
22		0.6	0	1.25	1.5	1.5
23		0.3	0.6	1.00	1.0	2.5
24		0.6	0	0	1.0	0
25		3.3	2.3	1.75	1.5	0.5
26		0	0	0	0	0
27		4.6	5.0	6.50	0.5	0
28		3.0	5.6	2.75	0	0
29		5.0	3.3	3.25	0	1.0
30		3.6	3.6	4.25	4.5	1.5
31		0.6	1.6	2.75	1.0	1.5
32		0.3	1.6	0	0	0
33		0	0.6	1.00	0	0
34		0	0	1.25	0.5	0
35		1.0	0.6	0.25	0	0
36		0.3	1.0	1.50	0	0
37		0	0	0	0	0
38		2.6	7.3	7.25	8.5	4.5
39		0.3	1.0	5.50	8.5	2.5
40		98.7	98.9	100.00	100.0	100.0

TABLE 14

Hirsel..Low End Group..Lwes Year..1959

Average Counts per Month

Month	Jan.	Feb.	Mch.	Apl.	May	Jun.
Samples	2	1	4	4	3	3
No.1	12.0	10	23.00	15.50	13.3	11.0
2	1.5	1	2.50	5.25	3.6	2.6
3	8.5	9	13.50	5.25	8.3	7.6
4	5.5	5	5.75	5.75	5.6	7.0
5	1.0	0	0.75	0.75	0	0
6	5.0	5	2.25	2.25	3.3	3.3
7	3.0	1	0.75	1.25	1.3	1.0
8	5.0	8	2.00	1.50	1.3	0.6
9	0	0	0	0	0	0
10	9.0	4	7.50	6.75	6.6	10.0
11	3.0	0	0.75	0.25	1.6	1.0
12	5.0	6	2.25	5.25	3.6	1.6
13	2.0	1	0.50	1.50	0.6	1.0
14	1.0	0	0.50	1.75	2.3	0
15	0	0	0	1.50	4.3	4.0
16	0	0	1.50	3.25	1.3	1.3
17	3.5	3	7.50	11.00	6.6	6.6
18	0	0	0	0	0.3	1.0
19	0	0	0	0	0	0.3
20	19.0	22	13.75	12.00	6.3	4.0
21	4.0	4	0.75	0.50	0.3	1.0
22	2.0	0	0.75	1.00	1.3	2.0
23	2.0	1	1.00	1.25	1.0	0
24	0	0	0.75	0	0	0.3
25	0	0	0	0.50	0.3	1.3
26	0	0	0	0.25	1.3	1.3
27	0	0	1.00	0.75	0.6	3.6
28	0	0	0	0.50	0.6	2.0
29	0	0	0	0.25	3.0	5.3
30	2.0	3	2.75	3.00	6.3	5.3
31	1.0	4	1.00	1.25	1.3	1.6
32	0	0	0	0	0	0.3
33	1.0	0	0	0.25	1.3	1.6
34	0	0	2.00	2.00	1.6	0.6
35	0	0	0.25	0.75	0.6	2.6
36	0	0	0	0.25	0.3	0.3
37	0	0	0	0	0	0
38	1.5	6	2.50	2.50	4.6	3.0
39	2.5	2	2.50	4.25	3.3	3.0
40	100.0	100	100.00	100.00	97.9	99.0

TABLE 14 CONTD.

Hirsel..Low End Group..Ewes Year..1959

Average Counts per Month

Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	2	2	3	2	0	2
No.1	15.5	14.0	14.0	10.0		13.0
2	4.0	4.0	2.6	4.5		2.5
3	5.0	3.0	7.0	7.5		13.0
4	6.0	3.5	3.0	9.0		5.0
5	0	0	0.6	0		1.0
6	2.0	3.5	1.3	5.0		5.0
7	1.0	1.0	1.0	2.0		6.0
8	0.5	1.0	0.6	1.5		6.0
9	1.0	0.5	1.6	2.0		0
10	5.5	3.0	4.6	1.0		7.0
11	1.5	0	0.3	0.5		1.5
12	2.0	2.0	1.3	3.5		3.5
13	0.5	1.0	0.6	5.5		3.0
14	1.5	0.5	0.6	1.0		0.5
15	6.0	1.0	1.3	1.0		0.5
16	0	2.0	0.3	0.5		0
17	2.5	2.0	4.0	1.0		3.0
18	2.0	2.0	2.0	2.0		0
19	1.0	1.0	0.6	0.5		0
20	8.5	7.5	12.6	12.5		14.0
21	0.5	2.5	0.6	2.5		1.5
22	1.5	4.0	2.3	2.0		1.5
23	0	0.5	0.6	0.5		1.0
24	0.5	0	0	1.0		1.0
25	1.5	4.0	2.6	2.5		0
26	1.0	1.0	1.0	0		0
27	6.0	3.5	7.3	4.0		0.5
28	2.0	8.5	4.6	2.5		0
29	3.0	4.0	2.6	0.5		0
30	3.0	3.5	5.3	4.5		2.5
31	1.0	1.0	2.6	1.0		1.0
32	0.5	0	0.6	0		0
33	0.5	1.5	0	1.0		1.5
34	1.0	0	1.0	0		0.5
35	1.6	3.5	1.0	1.0		0
36	0	1.0	0.6	2.5		0
37	0	0	0	0		0
38	7.0	6.0	3.6	3.5		3.0
39	3.5	3.0	2.3	2.5		1.5
40	100.0	100.0	98.5	100.0		100.0

TABLE 15

Hirsel..Low End Group..Ewes Year 1960

Average Counts per Month

Month	Jan.	Feb.	Mch.	Apl.	May	Jun.
Samples	2	1	2	2	1	2
No.1	8.5	11	13.5	16.5	14	13.0
2	3.5	3	4.5	5.0	5	2.0
3	9.5	12	12.0	10.0	7	6.0
4	7.0	6	6.5	8.0	6	8.5
5	1.5	3	2.5	0	0	0.5
6	3.0	5	9.0	7.0	5	8.0
7	5.0	3	4.0	2.0	0	0.5
8	7.5	3	5.0	4.5	2	0
9	0	0	0	0	0	0
10	5.0	7	7.5	8.0	8	5.5
11	0.5	2	0	2.5	1	2.0
12	1.5	3	4.0	4.0	5	4.0
13	2.0	1	2.0	0.5	3	1.0
14	0.5	1	2.5	4.5	0	1.0
15	0	0	0	6.0	5	7.5
16	0	0	1.0	1.0	2	0
17	5.0	6	8.5	4.0	7	6.0
18	0	0	0	0.5	0	0.5
19	0	0	0	0	0	1.0
20	19.0	20	6.0	3.0	7	5.0
21	3.0	1	1.0	1.5	3	1.5
22	1.5	1	1.5	0	2	2.5
23	2.0	2	1.0	1.0	0	0
24	0	0	0	0	0	0.5
25	0	0	0	0.5	1	0.5
26	0	0	0	1.0	0	0.5
27	0	0	0	0.5	2	2.0
28	0	0	0	0	1	1.5
29	0	0	0	1.0	3	5.5
30	1.0	2	1.0	3.0	4	4.0
31	1.0	1	2.0	0.5	1	2.0
32	0	0	0	0	0	0.5
33	0.5	2	0	2.0	2	0
34	1.0	0	0.5	0	3	1.0
35	0	0	0	0	1	0.5
36	0	0	0	0	0	0.5
37	0	0	0	0	0	0
38	4.5	2	4.0	1.5	0	4.5
39	6.5	3	5.0	0.5	0	0.5
40	100.0	100	100.0	100.0	100	100.0

TABLE 16

Hirsel..Low End Group..Ewes Years..1957-1960

Monthly Totals

Month	Jan.	Feb.	Mch.	Apl.	May.	Jun.
Samples	4	3	8	8	7	10
No.1	41	36	154	125	89	128
2	10	6	27	37	27	31
3	36	31	90	59	62	63
4	25	16	49	55	57	68
5	5	5	8	3	1	2
6	16	14	33	33	26	32
7	16	8	19	11	6	4
8	25	16	28	17	9	3
9	0	0	0	0	0	1
10	28	20	63	54	51	78
11	7	5	6	11	12	14
12	13	13	25	39	25	24
13	8	3	11	13	9	12
14	3	3	10	17	13	7
15	0	0	0	25	37	61
16	0	0	9	17	14	11
17	17	19	58	58	45	57
18	0	0	0	3	3	8
19	0	0	0	0	0	5
20	76	63	88	65	44	42
21	14	7	15	12	10	11
22	7	3	8	7	9	24
23	8	4	6	8	3	0
24	0	0	3	0	0	6
25	0	0	0	4	3	8
26	0	0	0	3	6	7
27	0	0	6	6	10	35
28	0	0	0	2	6	21
29	0	0	0	5	18	47
30	6	5	22	27	31	51
31	4	5	11	8	9	19
32	0	0	0	0	0	5
33	3	2	0	10	8	15
34	2	0	12	12	9	10
35	0	0	3	4	9	19
36	0	0	0	1	1	3
37	0	0	0	0	0	0
38	12	9	24	31	21	42
39	18	7	12	18	17	26
40	400	300	800	800	700	1000

TABLE 16 CONTD.

Hirsel..Low End Group..Ewes Years..1957-1960

Monthly Totals

Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Samples	4	7	8	8	4	7
No.1	66	97	105	97	44	89
2	12	25	35	30	23	20
3	20	39	52	54	31	65
4	20	31	34	42	28	41
5	0	0	3	0	2	8
6	10	19	18	35	19	44
7	3	5	9	18	12	27
8	2	2	7	10	15	34
9	3	4	21	15	0	0
10	18	29	31	16	7	38
11	5	4	5	3	4	10
12	7	13	16	27	18	26
13	5	6	8	16	10	13
14	4	12	7	12	6	7
15	23	23	8	4	3	3
16	3	9	3	6	0	2
17	10	20	20	18	7	27
18	8	16	18	22	6	0
19	5	7	9	16	0	0
20	28	88	107	83	54	114
21	4	12	10	11	2	13
22	5	10	12	14	8	8
23	0	3	4	5	4	12
24	2	2	0	3	5	4
25	6	18	22	18	10	2
26	3	2	3	0	0	0
27	17	30	41	34	4	1
28	10	42	40	20	0	0
29	17	29	25	23	2	3
30	17	27	35	30	12	13
31	5	5	14	15	4	9
32	4	4	8	0	0	0
33	3	3	5	7	1	4
34	2	0	3	8	2	4
35	6	10	5	3	0	0
36	3	9	10	12	0	0
37	0	0	0	0	0	0
38	28	31	35	42	35	43
39	16	14	12	31	22	16
40	400	700	800	800	400	700

TABLE 17

Hirsel..Low End Group..Lwes Years..1957-1960

Monthly Averages

Month	Jan.	Feb.	Mch.	Apl.	May	Jun.
Samples	4	3	8	8	7	10
No.1	10.25	12.0	19.3	15.6	12.7	12.8
2	2.5	2.0	3.4	4.6	3.9	3.1
3	9.0	10.3	11.3	7.4	8.9	6.3
4	6.25	5.3	6.1	7.0	8.1	6.8
5	1.25	1.6	1.0	0.4	0.1	0.2
6	4.0	4.6	4.1	4.1	3.7	3.2
7	4.0	2.6	2.4	1.4	0.9	0.4
8	6.25	5.3	3.5	2.1	1.3	0.3
9	0	0	0	0	0	0.1
10	7.0	6.6	7.9	6.7	7.3	7.8
11	1.75	1.6	0.7	1.4	1.7	1.4
12	3.25	4.3	3.1	4.9	3.6	2.4
13	2.0	1.0	1.4	1.6	1.3	1.2
14	0.75	1.0	1.3	2.1	1.9	0.7
15	0	0	0	3.1	5.3	6.1
16	0	0	1.1	2.1	2.0	1.1
17	4.25	6.3	7.3	7.3	6.4	5.7
18	0	0	0	0.3	0.4	0.8
19	0	0	0	0	0	0.5
20	19.0	21.0	11.0	8.1	6.3	4.2
21	3.5	2.3	1.9	1.5	1.4	1.1
22	1.75	1.0	1.0	0.9	1.3	2.4
23	2.0	1.3	0.7	1.0	0.4	0
24	0	0	0.4	0	0	0.6
25	0	0	0	0.5	0.4	0.8
26	0	0	0	0.4	0.9	0.7
27	0	0	0.7	0.7	1.4	3.5
28	0	0	0	0.2	0.9	2.1
29	0	0	0	0.6	2.6	4.7
30	1.5	1.6	2.7	3.4	4.4	5.1
31	1.0	1.6	1.4	1.0	1.3	1.9
32	0	0	0	0	0	0.5
33	0.75	0.6	0	1.2	1.1	1.5
34	0.5	0	1.5	1.5	1.3	1.0
35	0	0	0.4	0.5	1.3	1.9
36	0	0	0	0.1	0.1	0.3
37	0	0	0	0	0	0
38	3.0	3.0	3.0	3.9	3.0	4.2
39	4.5	2.3	1.5	2.3	2.4	2.6
40	100.0	99.2	99.1	99.9	100.0	100.0

TABLE 17 CONTD.

Hirsel..Low Land Group..Lwes Years ..1957-1960

Monthly Averages

Month	Jul.	Aug..	Sep.	Oct.	Nov.	Dec.
Samples	4	7	8	8	4	7
No.1	16.5	13.9	13.0	12.1	11.0	12.7
2	3.0	3.6	4.4	3.7	5.75	1.9
3	5.0	5.6	6.5	6.7	7.75	9.3
4	5.0	4.4	4.3	5.3	7.0	5.9
5	0	0	0.4	0	0.5	1.1
6	2.5	2.7	2.3	4.4	4.75	6.3
7	1.75	0.7	1.1	2.3	3.0	3.9
8	0.5	0.3	0.9	1.2	3.75	4.9
9	0.75	0.6	2.6	1.9	0	0
10	4.5	4.1	3.9	2.0	1.75	5.4
11	1.25	0.6	0.6	0.4	1.0	1.4
12	1.75	1.9	2.0	3.4	4.5	3.7
13	1.25	0.9	1.0	2.0	2.5	1.9
14	1.0	1.7	0.9	1.5	1.5	1.0
15	5.75	3.3	1.0	0.5	0.75	0.4
16	0.75	1.3	0.4	0.7	0	0.3
17	2.5	2.9	2.5	2.3	1.75	3.9
18	2.0	2.3	2.3	2.7	1.5	0
19	1.25	1.0	1.1	2.0	0	0
20	7.0	12.6	13.4	10.4	13.5	16.3
21	1.0	1.7	1.3	1.4	0.5	1.9
22	1.25	1.4	1.5	1.7	2.0	1.1
23	0	0.4	0.5	0.6	1.0	1.7
24	0.5	0.3	0	0.4	1.25	0.6
25	1.5	2.6	2.7	2.3	2.5	0.3
26	0.75	0.3	0.4	0	0	0
27	4.25	4.3	5.0	4.3	1.0	0.1
28	2.5	6.0	5.0	2.5	0	0
29	4.25	4.1	3.1	2.9	0.5	0.4
30	4.25	3.9	4.4	3.7	3.0	1.9
31	1.25	0.7	1.7	1.9	1.0	1.3
32	1.0	0.6	1.0	0	0	0
33	0.75	0.4	0.6	0.9	0.25	0.6
34	0.5	0	0.4	1.0	0.5	0.6
35	1.5	1.4	0.6	0.4	0	0
36	0.75	1.3	1.3	1.5	0	0
37	0	0	0	0	0	0
38	7.0	4.4	4.4	5.3	8.75	6.1
39	4.0	2.0	1.5	3.9	5.5	2.3
40	100.0	100.2	100.0	100.2	100.0	99.2

TABLE 19

Hirsel..Low End Group..Lambs Year..1956

Average Counts per Month

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	3	4	3	3	3	2
No.1	12.3	13.50	19.6	15.0	12.0	15.0
2	3.6	5.00	3.0	4.6	4.3	3.5
3	7.0	7.25	6.6	6.3	5.3	6.0
4	9.3	7.500	7.0	6.0	7.0	5.0
5	0.3	0.25	0.6	0	0.3	0.5
6	3.3	2.25	2.0	2.6	2.6	4.5
7	1.0	0.50	0	0	1.0	1.5
8	0.6	0.25	0	0.3	0.3	2.0
9	0.6	0.75	0.3	1.0	1.6	2.0
10	5.3	5.00	6.0	5.0	4.3	3.5
11	1.6	1.50	1.0	0.3	1.3	1.0
12	4.3	4.50	3.0	6.0	4.0	4.5
13	1.3	3.50	1.6	2.0	2.3	3.0
14	1.6	1.50	1.3	1.3	1.3	1.5
15	5.3	3.50	4.6	2.6	0.6	0.5
16	1.3	1.00	1.6	0.6	0	1.0
17	4.6	6.50	5.0	2.0	1.3	1.0
18	0.3	1.00	1.0	2.6	2.0	2.5
19	0.3	0.75	1.3	2.3	1.6	3.0
20	4.6	3.50	2.6	3.0	4.0	11.0
21	0.6	0.50	0.6	2.6	3.6	1.5
22	0.6	0.25	1.0	2.3	2.3	1.0
23	0.6	0	0.6	0.3	1.6	1.0
24	0.6	0	0.6	0.6	0.6	0
25	1.0	2.75	2.3	2.3	2.6	3.5
26	1.0	0.50	0	0	0	0.5
27	1.6	3.00	4.3	5.3	6.6	4.5
28	1.0	2.00	2.3	3.3	4.6	4.5
29	2.0	3.50	3.6	3.6	3.3	1.5
30	3.6	5.25	5.0	6.0	4.6	2.0
31	3.0	1.75	1.6	1.3	3.6	2.0
32	0	0	0.6	1.0	0.6	0.5
33	0.6	1.00	1.0	1.3	1.0	0
34	1.0	1.25	0.6	1.0	1.0	1.5
35	2.3	1.75	1.0	1.6	2.3	1.0
36	0	0.75	0.6	0.6	1.6	1.5
37	0	0	0	0	0	0
38	6.6	3.00	4.0	2.0	0.6	1.0
39	4.0	3.25	1.0	0.3	1.0	0
40	93.6	100.00	98.8	98.9	98.6	100.0

TABLE 20

Hirsel..Low End Group. Lambs Year..1959

Average Counts per Month

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	3	4	3	3	4	4
No.1	13.6	15.5	17.6	15.0	14.75	13.0
2	4.0	4.75	4.0	3.6	5.5	4.75
3	8.6	8.25	4.3	2.6	4.5	7.25
4	7.6	7.0	8.0	6.0	5.0	6.0
5	0.3	0.5	0.3	0.3	0.5	0
6	4.0	1.75	3.0	2.3	1.5	2.5
7	0.6	0.25	0	0.6	0.25	1.75
8	0	0.5	0.3	0.6	0.5	0.25
9	0.6	0.25	0.6	0.6	1.0	2.0
10	7.0	6.25	7.0	6.3	2.25	2.25
11	3.0	2.25	2.3	0.6	1.0	0.5
12	3.6	3.5	3.3	3.0	4.75	3.0
13	3.6	2.5	2.0	2.3	2.5	2.75
14	1.3	1.75	1.0	1.6	1.5	0.5
15	3.3	3.0	1.6	1.6	1.25	1.0
16	1.0	1.25	0.3	0.3	0.5	0
17	6.6	6.25	4.6	1.3	0.75	1.0
18	1.3	1.25	1.6	3.0	2.75	2.0
19	0	0.75	0.6	1.3	2.25	1.5
20	5.0	2.75	3.6	3.3	5.5	9.25
21	1.0	1.0	1.3	1.6	1.75	1.0
22	0.3	0.75	1.6	1.0	1.25	1.5
23	0.3	0.25	0	1.0	1.0	0.5
24	0	0	0.6	0.6	0.75	0.25
25	1.3	3.5	0.6	4.0	5.75	3.25
26	0.3	0	0.6	0	0.25	0
27	1.3	3.0	3.0	6.3	5.5	5.75
28	1.3	2.0	1.6	5.6	5.25	3.0
29	3.0	1.75	3.6	3.3	4.25	2.75
30	6.6	5.25	3.6	4.3	4.0	5.25
31	2.0	2.0	2.0	3.6	2.5	1.25
32	0.3	0.75	0.6	1.6	1.0	0.75
33	0.3	0.75	1.3	1.3	0.5	0.5
34	0.3	1.25	2.0	1.0	0.75	0.25
35	1.6	1.25	1.6	3.0	1.75	1.0
36	0.3	1.25	1.3	1.6	1.25	1.0
37	0	0	0	0	0	0
38	1.6	4.25	6.0	1.0	3.0	7.0
39	2.0	0.75	1.3	1.6	1.0	3.75
40	97.8	100.0	98.6	97.6	100.0	100.0

TABLE 21

Hirsel..Low End Group..Lambs Years..1957-1959

Monthly Totals

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	8	8	7	6	8	7
No.1	104	116	124	90	109	98
2	33	39	26	25	41	30
3	63	62	40	27	39	45
4	61	58	48	36	42	40
5	2	3	4	1	3	1
6	28	16	19	15	17	22
7	6	3	1	2	6	12
8	3	3	1	3	5	6
9	6	4	3	5	10	16
10	52	45	45	34	25	17
11	17	15	9	3	8	6
12	30	32	25	27	35	25
13	19	24	15	13	20	21
14	13	13	9	9	12	7
15	34	26	23	13	8	7
16	11	9	7	3	3	2
17	46	51	31	10	7	8
18	7	9	10	17	20	19
19	2	6	7	11	16	13
20	33	25	20	19	36	65
21	7	6	7	13	19	9
22	6	4	10	10	15	9
23	5	1	2	4	9	6
24	2	0	5	4	6	1
25	10	25	12	19	33	25
26	5	2	3	0	2	1
27	12	24	27	35	49	34
28	9	16	15	27	41	25
29	19	21	25	21	27	17
30	39	42	30	31	35	27
31	20	15	13	15	28	12
32	1	3	6	8	8	4
33	4	7	10	8	6	4
34	6	10	10	6	8	5
35	14	12	12	14	17	6
36	2	8	7	7	11	9
37	0	0	0	0	0	0
38	41	29	31	9	16	30
39	28	16	8	6	8	16
40	800	800	700	600	800	700

TABLE 22

Hirsel..Low End Group..Lambs Years..1957-1959

Monthly Averages

Month	May	Jun.	Jul.	Aug.	Sep.	Oct.
Samples	8	8	7	6	8	7
No.1	13.0	14.5	17.7	15.0	12.6	14.0
2	4.1	4.9	3.7	4.2	5.1	4.3
3	7.9	7.7	5.9	4.5	4.9	6.4
4	7.6	7.3	6.9	6.0	5.2	5.7
5	0.2	0.4	0.6	0.1	0.4	0.1
6	3.4	2.0	2.7	2.5	2.1	3.1
7	0.7	0.4	0.1	0.3	0.7	1.7
8	0.4	0.4	0.1	0.5	0.6	0.9
9	0.7	0.5	0.4	0.8	1.2	2.3
10	6.5	5.6	6.4	5.7	3.1	2.4
11	2.1	1.9	1.3	0.5	1.0	0.9
12	3.7	4.0	3.6	4.5	4.4	3.6
13	2.4	3.0	2.1	2.2	2.5	3.0
14	1.6	1.6	1.3	1.5	1.5	1.0
15	4.3	3.2	3.3	2.2	1.0	1.0
16	1.4	1.1	1.0	0.5	0.4	0.3
17	5.8	6.4	4.4	1.7	0.9	1.1
18	0.9	1.1	1.4	2.8	2.5	2.7
19	0.2	0.8	1.0	1.8	2.0	1.9
20	4.1	3.1	2.9	3.2	4.5	9.3
21	0.9	0.8	1.0	2.2	2.4	1.3
22	0.8	0.5	1.4	1.7	1.9	1.3
23	0.6	0.1	0.3	0.7	1.1	0.9
24	0.2	0	0.7	0.7	0.7	0.1
25	1.2	3.1	1.7	3.2	4.1	3.6
26	0.6	0.3	0.4	0	0.3	0.1
27	2.0	3.0	3.9	5.8	6.1	4.9
28	1.1	3.0	2.1	4.5	5.1	3.6
29	1.4	2.6	3.6	3.5	3.4	2.4
30	4.9	5.3	4.3	5.2	4.4	3.9
31	2.5	1.9	1.9	2.5	3.5	1.7
32	0.1	0.4	0.9	1.3	1.0	0.6
33	0.5	0.9	1.4	1.3	0.7	0.6
34	0.7	1.3	1.4	1.0	1.0	0.7
35	1.8	1.5	1.7	2.3	2.1	0.9
36	0.2	1.0	1.0	1.3	1.4	1.3
37	0	0	0	0	0	0
38	3.1	3.6	4.3	1.5	2.0	4.3
39	3.5	2.0	2.3	1.0	1.0	2.3
40	99.1	100.2	101.1	100.2	98.8	100.2

Table 22

Crop damage

Monthly average

Years 1957-1959

TABLE 23

Comparison of the Yearly Averages of All Groups

1957

	Barnacarry		Low End	
	Ewes	Lambs	Ewes	Lambs
Number of Samples	20	27	18	5
Species				
F. rubra	11.4	13.0	13.3	13.6
F. ovina	2.9	4.4	3.8	5.0
A. stolonifera	9.0	10.2	6.6	6.4
D. flexuosa	5.7	7.6	6.0	4.0
D. caespitosa	0.3	0.0	0.4	0.2
J. effusus	2.8	1.4	3.9	3.2
J. articulatus	0.8	0.2	1.7	1.2
J. squarrosus	1.0	0.2	1.5	0.8
Luzula spp.	0.9	1.0	1.0	1.4
E. vaginatum	7.2	5.9	4.6	4.2
E. angustifolium	0.8	1.4	1.2	1.6
C. nigra	2.2	3.5	3.2	4.0
C. echinata	1.3	0.1	1.8	3.0
C. panicea	1.2	0.5	1.2	2.0
T. caespitosum	4.8	3.2	3.4	3.0
N. stricta	1.4	0.1	1.1	1.2
M. caerulea	3.3	3.5	3.5	3.2
P. pratensis	1.4	4.0	1.7	2.6
P. trivialis	0.4	1.3	1.1	1.0
C. vulgaris	7.6	5.3	11.3	2.6
E. tetralix	0.9	0.8	1.7	1.2
E. cinerea	0.7	0.6	1.6	1.8
V. myrtillus	1.4	0.8	0.4	0.8
V. oxycoccus	0.6	0.4	0.5	0.4
Galium spp.	2.1	3.1	1.4	2.6
U. europaeus	0.4	0.0	0.2	0.6
Trifolium spp.	2.1	3.9	2.1	3.4
Lotus spp.	1.7	3.1	2.4	3.0
P. erecta	1.8	1.6	2.6	2.0
Sphagnum agg.	2.8	1.9	3.0	3.8
Polytrichum agg.	2.1	0.8	1.2	3.4
Holcus spp.	0.4	0.5	0.4	0.8
C. cristatus	0.4	0.4	0.8	1.4
A. odoratum	0.6	0.2	0.4	1.4
D. glomerata	0.6	0.3	0.9	1.8
L. perenne	0.6	0.9	0.8	1.0
M. gale	0.6	0.0	0.0	0.0
Unclassified	9.3	8.4	4.8	3.8
Unknown	5.4	5.6	2.4	2.6
Total	100.9	100.0	99.9	100.0

TABLE 24

COMPARISON of the Yearly Averages of All Groups

1958

	Barnacarry		Low End	
	Ewes	Lambs	Ewes	Lambs
Number of Samples	24	12	22	18
Species				
F. rubra	14.4	12.8	13.4	14.5
F. ovina	2.3	4.4	3.9	4.1
A. stolonifera	8.4	10.3	7.4	6.5
D. flexuosa	6.4	7.2	5.9	7.1
D. caespitosa	0.2	0.1	0.3	0.3
J. effusus	3.1	0.6	3.5	2.8
J. articulatus	0.9	0.3	1.7	0.6
J. squarrosus	1.2	0.2	2.0	0.5
Luzula spp.	1.2	1.6	0.7	1.0
E. vaginatum	4.0	5.5	4.9	4.9
E. angustifolium	0.6	1.2	1.2	1.2
C. nigra	3.8	3.8	3.0	4.4
C. echinata	1.0	0.3	1.4	2.3
C. panicea	0.6	0.6	1.6	1.4
T. caespitosum	2.2	2.8	1.9	3.1
N. stricta	1.6	0.3	0.7	0.9
M. caerulea	3.7	4.8	3.4	3.7
P. pratensis	1.8	3.8	1.3	1.5
P. trivialis	0.2	1.8	0.6	1.4
C. vulgaris	8.9	4.1	10.9	4.4
E. tetralix	0.7	1.0	1.6	1.6
E. cinerea	1.1	0.7	1.2	1.2
V. myrtillus	1.4	1.3	0.7	0.7
V. oxycoccus	1.3	0.3	0.3	0.4
Galium spp.	1.7	3.7	1.4	2.4
U. europaeus	0.6	0.0	0.1	0.3
Trifolium spp.	2.0	4.0	3.1	4.2
Lotus spp.	2.4	4.8	2.0	2.8
P. erecta	1.8	2.6	2.6	3.1
Sphagnum agg.	1.9	2.8	4.1	4.6
Polytrichum agg.	1.8	1.1	1.6	2.2
Holcus spp.	0.4	0.8	0.4	0.4
C. cristatus	0.8	1.0	0.7	0.9
A. odoratum	1.0	0.7	0.9	1.1
D. glomerata	0.0	0.3	0.5	1.7
L. perenne	0.4	0.8	0.5	0.8
M. gale	1.3	0.0	0.0	0.0
Unclassified	8.2	4.3	6.1	3.0
Unknown	4.9	3.5	3.0	1.8
Total	100.2	100.2	100.5	99.8

TABLE 25

Comparison of the Yearly Averages of All Groups

1959

	Bavnacarry		Low End	
	Ewes	Lambs	Ewes	Lambs
Number of Samples	22	17	28	21
Species				
F. rubra	13.1	14.5	14.6	14.9
F. ovina	2.9	3.8	3.3	4.5
A. stolonifera	8.0	9.3	8.1	6.1
D. flexuosa	6.2	5.7	5.6	6.5
D. caespitosa	0.3	0.1	0.4	0.3
J. effusus	3.6	0.7	3.1	2.4
J. articulatus	1.3	0.3	1.6	0.6
J. squarrosus	1.3	0.1	2.1	0.4
Luzula spp.	0.7	1.1	0.4	0.9
E. vaginatum	5.8	5.2	6.3	5.1
E. angustifolium	0.9	0.8	0.9	1.4
C. nigra	3.6	2.9	3.1	3.6
C. echinata	0.8	0.4	1.3	2.6
C. panicea	1.5	0.4	1.0	1.3
T. caespitosum	3.5	2.5	1.9	2.0
N. stricta	1.7	0.4	1.2	1.6
M. caerulea	3.7	4.3	5.6	3.3
P. pratensis	1.5	3.7	0.8	2.0
P. trivialis	0.3	1.7	0.3	1.1
C. vulgaris	8.7	5.8	11.3	5.1
E. tetralix	1.5	0.6	1.3	1.3
E. cinerea	1.1	0.6	1.6	1.1
V. myrtillus	1.4	0.8	0.8	0.5
V. oxycoccus	1.1	0.4	0.3	0.4
Galium spp.	1.2	3.5	1.1	3.2
U. europaeus	0.6	0.0	0.6	1.2
Trifolium spp.	2.0	4.0	2.6	4.2
Lotus spp.	1.8	3.5	1.8	3.2
P. erecta	2.5	1.8	1.8	3.1
Sphagnum agg.	2.6	2.2	3.9	4.9
Polytrichum spp.	1.9	0.8	1.4	2.2
Holcus spp.	0.4	0.5	0.1	0.9
C. cristatus	0.7	0.7	0.8	0.8
A. odoratum	0.9	0.2	1.0	0.9
D. glomerata	0.3	0.3	1.0	1.7
L. perenne	0.5	0.7	0.4	1.1
M. gale	1.0	0.1	0.0	0.0
Unclassified	6.1	10.8	3.6	4.0
Unknown	3.4	5.3	2.9	1.8
Total	100.4	100.5	99.9	102.2

TABLE 26

Comparison of the Yearly Average of All Groups

1960

	Barnacarry Ewes	Low End Ewes
Number of Samples	10	10
Species		
F. rubra	11.2	12.8
F. ovina	3.9	3.8
A. stolonifera	8.4	9.4
D. flexuosa	6.6	7.2
D. caespitosa	0.3	1.2
J. effusus	4.2	6.4
J. articulatus	1.7	2.6
J. squarrosus	1.6	3.9
Luzula spp.	1.0	0.0
E. vaginatum	5.5	6.7
E. angustifolium	1.2	1.3
C. nigra	2.7	3.5
C. echinata	1.6	1.5
C. panicea	1.2	1.8
T. caespitosum	2.9	3.2
N. stricta	1.8	0.6
M. caerulea	4.1	6.0
P. pratensis	1.9	0.2
P. trivialis	0.1	0.2
C. vulgaris	10.2	9.3
E. tetralix	2.3	1.8
E. cinerea	0.7	1.4
V. myrtillus	1.3	1.0
V. oxycoccus	0.9	0.1
Galium spp.	1.1	0.3
U. europaeus	0.9	0.3
Trifolium spp.	1.5	0.7
Lotus spp.	2.6	0.4
P. erecta	0.6	1.6
Sphagnum agg.	3.3	2.4
Polytrichum agg.	1.1	1.3
Holcus spp.	0.3	0.1
C. cristatus	0.6	0.9
A. odoratum	0.7	0.8
D. glomerata	0.3	0.2
L. perenne	0.4	0.1
M. gale	0.7	0.0
Unclassified	5.6	3.1
Unknown	3.0	1.9
Total	100.0	100.0

TABLE 27

Comparison of Overall Averages for the Years 1957-60

	Barraggarry		Low End	
	Ewes	Lambs	Ewes	Lambs
Number of Samples	76	56	78	44
Species				
F. rubra	12.8	13.4	13.7	14.6
F. ovina	2.8	4.2	3.6	4.4
A. stolonifera	8.6	10.0	7.7	6.3
D. flexuosa	6.2	6.9	6.0	6.5
D. caespitosa	0.3	0.1	0.5	0.3
J. effusus	3.3	1.0	3.8	2.7
J. articulatus	1.1	0.2	1.8	0.7
J. squarrosus	1.2	0.2	2.2	0.5
Luzula spp.	0.9	1.2	0.6	1.0
E. vaginatum	5.5	5.6	5.6	5.0
E. angustifolium	0.8	1.2	1.1	1.3
C. nigra	3.1	3.4	3.2	4.0
C. echinata	1.1	0.2	1.5	2.6
C. panicea	1.1	0.5	1.3	1.4
T. caespitosum	3.3	2.9	2.4	2.5
N. stricta	1.6	0.2	0.9	0.8
M. caerulea	3.6	4.1	4.6	3.5
P. pratensis	1.6	3.9	1.1	1.9
P. trivialis	0.3	1.5	0.5	1.3
C. vulgaris	8.7	5.2	10.9	4.5
E. tetralix	1.2	0.8	1.6	1.4
E. cinerea	0.9	0.6	1.5	1.2
V. myrtillus	1.4	0.9	0.7	0.6
V. oxycoccus	1.0	0.4	0.3	0.4
Galium spp.	1.6	3.4	1.2	2.9
U. europaeus	0.6	0.0	0.3	0.3
Trifolium spp.	1.9	4.0	2.4	4.1
Lotus spp.	2.1	4.4	1.8	3.0
P. erecta	1.8	1.9	2.2	3.0
Sphagnum agg.	2.5	2.2	3.5	4.6
Polytrichum agg.	1.8	0.8	1.4	2.3
Holcus spp.	0.4	0.5	0.3	0.7
C. cristatus	0.6	0.6	0.8	0.9
A. odoratum	0.8	0.3	0.8	1.0
D. glomerata	0.3	0.3	0.8	1.7
L. perenne	0.5	0.8	0.5	1.0
M. gale	0.9	0.0	0.0	0.0
Unclassified	7.5	8.2	4.5	3.6
Unknown	4.3	5.1	2.7	1.7
Total	100.2	100.9	100.3	100.2