MOOR HOUSE FIELD STATION

REPORT

1965 - 1966

STAFF

M. Rawes (Officer in Charge)	Senior Experimental Officer
B. P. Springett	Scientific Officer
J. M. Nelson	Experimental Officer
D. Welch	Assistant Experimental Officer
T. Hodgson	Reserve Warden
R. B. Marsh	Scientific Assistant
D. Craig	Estate Worker
Mrs. M. Hodgson	Cook/Housekeeper
* Mrs. C. Norris	Shorthand/Typist
* Miss A. Peart	Domestic Assistant

* Part time.

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With the Compliments of

M. Rawes

I N T R O D U C T I O N

Dr. J. B. Cragg, Director of Merlewood Research Station, who was responsible for the scientific and administrative direction of Moor House, left the Nature Conservancy on 30th April 1966. Dr. M. W. Holdgate, Deputy Director (Research), has supervised the work of the Station since then. Mr. B. P. Springett, took up the vacant Scientific Officer (Zoology), post on 1st October 1965. He is based at Merlewood, but like Dr. Crisp before him, his research is centered at Moor House, where his duties include that of deputy to the Officer-in-Charge. Mr. D. Craig was appointed on 10th January 1966 to the Estate Worker post, vacant since the resignation of Mr. D. Snowdon on 19th November 1965. Assistance with the administration is given by Mrs. C. Norris, Shorthand/Typist, who has worked on a part-time basis since 16th May 1966.

The new laboratory, built with funds provided by the International Biological Programme (I.B.P.) has been in use since 1st July. The excellent facilities that this building provides have been well used, and during August and September the hostel accommodation was frequently inadequate to cater for the number of visiting research workers.

By its remoteness, Moor House held, for many years, considerable advantages for research. Increasing human pressure, however, has meant that this may no longer be the case in years to come. Trespass is not restricted to visitors on walking holidays, but from the Defence Ministry for military training, from skiers, from motor cyclists, from fishermen and sporting interests and from University and College departments. Moor House has benefitted from the interest in the area by Universities and it is unfortunate that so many geologists (six Universities are known to have had students working on the Reserve during the summer vacation) failed to seek permission to work on the Reserve. This is particularly regrettable as permission has never been refused, and it is felt that not only are useful contacts being lost but also the advantages of an exchange of information.

SCIENTIFIC RESEARCH

1. Climatology (J. M. Nelson & R. B. Marsh)

Routine observations continue. A Kipps solarimeter, together with a Kent integrator was installed late in the summer and will in time, provide information of energy input. Tests to overcome problems associated with electricity supply are still in progress.

ii. Vegetation

The influence of management on the grasslands of Moor House. (M. Rawes and D. Welch).

(a) Measurement of changes in vegetation and soil following the removal of grazing.

The Knock Fell grassland (2,450 ft. O.D.) site has been the subject of re-examination for botanical change and herbage production. Other investigations in this exclosure are reported later by Miss Latter, Mr. Springett and Mr. Howard. Botanically, the trends observed in 1962 (7 years after enclosure) have continued. With grasses, there has been a further increase in Deschampsia flexuosa, markedly in D. cespitosa and in Festuca rubra. The cover of Agrostis tenuis, has dropped, but this has also occurred in the control area. There has been a general reduction in flowering plant cover with the exception of Galium saxatile, which continues to increase rapidly. Bryophytes and lichens are less prevalent.

A comparison between 1962 and 1966 of the standing crop harvested within the exclosure in August shows that yield doubled in 1966. However the percentage of dead material in the cropped vegetation also increased although there was a decrease in the litter-stubble layer. Seasonal growth of herbage in this exclosure was nearly 2,000 kg/ha in 1966; a figure that compares favourably with production from any sward on the Reserve.

(b) The establishment of natural grassland communities.

Four exclosures were erected in 1955 56 on Knock Fell, Little Dun Fell, Hard Hill and Rough Sike. Most plants, many of them arctic-alpines and mountain species not otherwise found on the Reserve, were introduced in turves, in 1956 and 1957. Each year, a record has been kept of performance. Rough Sike has 113 stations whereas Little Dun Fell has only 16.

After heavy losses in the first year few losses have occurred since 1961. Some plants, such as Polygonum viviparum have increased rapidly in Rough Sike, and others such as the small willows, Salix reticulata and S. herbacea, have become firmly established.

(c) The productivity of grasslands in relation to sheep grazing.

32 sites, some investigated in previous years, have been studied this season. They represent the main vegetational types of the Reserve. On each, regular observations of sheep humber have been made, together with measurements of dung deposited (16 sites) and herbage production (7 sites). The relation between number of sheep present and the amount of dung left is good, and the type of sward is in some communities of greater significance than its location to utilisation by sheep. For instance, the number of sheep, and dung deposited, on Juncetum squarrosi is remarkably similar irrespective of whether the site is at 1,500 ft. O.D. or 2,450 ft. O.D. and also whether it is located in areas of high or low grazing pressure. Growth of herbage was measured by harvesting the standing crop in Feburary or March and also, after 5 months protection from grazing, in August or September. Yields varied from 540 kg/ha on Eriophoretum, (blanket bog burnt in 1960), to 1,550 kg/ha on Agrosto-Festucetum by the Tees at 1,700 ft. O.D.

(d) The establishment of high-level woodland.
(A. Carlisle, A. H. F. Brown, and E. J. White, Merlewood)

1. Species trials.

Wherever lodgepole pine (P. contorta) was planted it has grown well, both on blanket peat and on lead contaminated mine-spoil. Scots pine (P. sylvestris), is generally a poor performer, and in Green Hole trees of this species were badly damaged by frost and snow action. Other species in Green Hole were also damaged, and the birch (Betula spp) are now dying, leaving only Scots pine and rowan (Sorbus aucuparia). In the other exclosures, only 2% of the hybrid aspen (Populus tremula x tremuloides) survive and birch has almost disappeared.

2. Tree nutrition

Scots pine chlorosis on peat

Experimental data on lowland peat similar to blanket peat at Moor House shows that unlike Scots pine at Moor House, Scots pine at the lowland site does not exhibit potassium deficiency at an early age. However on wet sites in the lowland area there was evidence of nitrogen deficiency with reducing conditions in the rooting zone.

Lodgepole pine establishment and nutrition on peat at high elevation

The treatment differences in height increment in this experiment are now clear, and maximum height is associated with treatments of ground mineral phosphate and K_2SO_4, with a two-year delay in effect. Highly soluble nitrogen (NH_4NO_3) is giving poor height growth, and slow release nitrogen (urea formaldehyde) a little better growth. Foliar phosphate levels are beginning to fall even in the slowly soluble mineral phosphate treatments. Foliar nitrogen concentrations are similar in all treatments whether nitrogen was added or not. Potassium levels in the leaves are falling sharply and in some cases a deficiency may result if the rate of fall is maintained. Analysis of leaves for trace elements show that two blocks, nearer old lead workings than the others, have higher foliar concentrations of lead and zinc.

(e) Plant nutrition studies on peat (A. J. P. Gore, Merlewood)

Factors limiting plant growth on peat

1. The laboratory work is complete and the data now awaits analysis. This will be held up for a year until the author returns from Oak Ridge, U.S.A.

2. A publication dealing with the effects of waterlogging on two moorland plants has been accepted by the Journal of Ecology.

(f) Productivity of blanket peat vegetation (A.J. P. Gore, Merlewood)

Data from this experiment have been assembled and will be taken to Oak Ridge where it is hoped to use some of them in ecosystem modelling.

A publication on rain water chemistry has been prepared and will be submitted shortly to the Journal of Ecology.

(g) Reclamation of eroded peat areas. (A.J.P. Gore Merlewood).

The start to the new field experiment to establish Deschampsia flexuosa was delayed due to shortage of seed. Small plots were sown in 1965 and the remainder in 1966.

The treatments are:-

(1) peat dug + lime + N, P & K.
(2) peat not dug + lime + N, P & K.
(3) peat dug (control)
(4) peat not dug (control)

Digging the peat preparatory to sowing has been found previously to assist in seedling establishment. Nitrogen was applied as formalised casein.

Pilot plots, with Deschampsia flexuosa have been successfully established at Arnfield Moor, Longdendale, Manchester Corporation Waterworks. Mr. M. Godfrey of Manchester Corporation will be watching the progress of both the Moor House and Manchester plots, during the next year. He plans to embark on the next stage of development at Arnfield in 1967 by enclosing 5 acres of moorland for recolonization. He will be conducting controlled sheep grazing experiments in 1968. These trials may have widespread significance if other water authorities in the South Pennines follow the example of Manchester in dealing with their problems in erosion.

(h) Chemical changes during plant decomposition (S.E. Allen, Merlewood).

Sampling from plant litter laid out on Knock Fell continues and the material is being stored for analysis.

(i) Long-term investigation on effects of burning. (M. Rawes).

No further work on this project has been undertaken in the current year.

(j) The vegetation of Moor House. (D. Welch & M. Rawes)

During the year many additions have been made to the species lists and papers are now in preparation. A joint paper with Mr. A. Eddy, (British Museum (Natural History)) describing the vegetation of the Reserve, is in the final stages of preparation.

Assistance with naming specimens have been given by experts. Dr. C. West, for instance, visited the Reserve in July and with D. Welch, found on the limestone several rare species of Hieracia, twelve species of which are now known to occur here. The number of flowering plants exceeds 270.

Similarly, many more lichens, and a few more bryophytes have been found. It is interesting to note that among the lichens are eleven new county records, including one rarity Parmelia alpicola, found (1957) by Mr. T.D.V. Swinscow, on Little Dun Fell. Parmelia alpicola has not been recorded previously in England, but is now found to be common in this locality.

Visitors

(k) Autecology of Rubus chamaemorus (K. Taylor, Botany Department, University College, London).

In the field experiment, set up in July 1965 in the Bog Mine exclosure, R. chamaemorus produced viable seed which was allowed to overwinter in situ. The results in 1966 indicate that some germination and establishment can take place in the first year in the absence of sheep grazing. Cloudberry fruits sporadically, but where sheep have been excluded and fertilizers applied, fruiting is regular and heavy. The relationships between nutrient uptake and fruit production will be examined in 1967.

Insects collected by Mr. J.M. Nelson from Rubus flowers indicate that pollination during the main flowering period is likely to be achieved by Anacrostichus verralli (Dipt). The late flowers are probably pollinated by Pareple aestiva (Dipt).

(l) Measurements of production in certain species of Sphagna. (R.S. Clymo, Botany Department, Westfield College, London).

The main part of the study of Sphagna production has been completed.

III Fauna

(a) General collection of Diptera (J.M. Nelson).

The survey has continued for 4 years, but considerable gaps in knowledge remain, due in part to taxonomic difficulties.

In the sub-order, Nematocera, Bibionidae are well represented, there being about 50% of the known British species present. Only one, Bibio lepidus, is abundant. Chironomidae, Cecidomyiidae and Mycetophilidae are all abundant.

Climatic conditions are probably too extreme for most Brachycera, but Empididae (48 spp) and Dolichopodidae (18 spp) are well represented.

Of the Cyclorrhapha, Phoridae are abundant and 32 species of Syrphidae have been recorded. In the Acalypterae group, the most frequent are Borboridae, Sepsidae, Helomyzidae, Ephydridae and Cordyluridae. The Calypterae include probably the best represented family, the Muscidae. There have been 96 species recorded to date. Calliphoridae are few and Tachinidae very scarce.

(b) Surface-active invertebrates associated with Calluna dominated moorland and alluvial grassland. (J.M. Nelson).

Analysis of the data collected from moorland and grassland sites during a year show that the invertebrates caught in pit-fall detergent traps were, in total, of much the same numerical order. Diptera accounted for 64% of those trapped on the grassland and 80% on the moorland. Other numerically important groups were, on the grassland micro- Hymenoptera 12%, and Spiders and Hemiptera 9% each, on the moorland - Coleoptera 6%, Spiders 4% and micro-Hymenoptera 4%. In terms of biomass, however, Diptera and Coleoptera contributed about 90% of the grassland sample, whilst on the moorland Diptera alone comprised 82%, with Coleoptera and Opiliones being of less importance.

Continuous trapping throughout the year has proved, despite the limitation of the method, to be useful, in particular because the period of above-ground activity of some of the most abundant insects at Moor House is very short. Many of the groups trapped have not been studied previously on the Reserve, and as some are very abundant their role in the moorland ecosystem will have to be further investigated.

(c) Faunal survey of Knock Fell exclosure (B.P. Springett)

The fauna of the exclosure on Knock Fell (see IIa) is being compared with the fauna of the surrounding grassland. Pit-fall traps catch more animals outside the exclosure, but this way merely reflects a greater efficiency of the traps there. Spiders are more numerous inside the exclosure, probably because the large growth of vegetation affords more shelter then the close cropped grass outside.

Quantitative studies on the soil fauna show that within the exclosure there are more enchytraeid worms than outside, and there are certainly more Collembola inside (35,000/m^2) than outside (8,300/m^2). Similar data for the Acarina show that this group is more numerous outside (17,200/m^2, than inside (14,600/m^2). It may be significant that the Oribatide comprise 71.5% of the total mites within the exclosure, but 85.0% of the total mites outside.

Changes in the micro-climate associated with the exclosure are being studied using a thermograph, and the weekly records show that the micro-climate inside the fence has been much modified by the vegetation.

(d) Sheep production (M. Rawes & D. Welch)

Annual live weight increment has been followed for 3 years in two flocks, one grazing Moor House (April - Oct.) and the other Tynehead (year-round).

Within the flock grazing Moor House it has been possible to compare sheep from two parts of the Reserve, the western escarpment and an area adjoining the River Tees. The latter part of the Reserve, which is mainly blanket bog with marginal alluvial vegetation is lightly grazed overall, but gives individual live weight gains. In 1966 Gimmer hoggs from this area, weighed at clipping time were 8 lbs. heavier than those from the western escarpment.

50 sheep in these 2 flocks have been tagged and a record is kept of their weight and distribution. Provisional results show that some sheep remain in one locality for most of the season, but insufficient data is yet available on the subject of behaviour.

(e) Studies on Cercopidae. (J.B. Whittaker, Bureau of Animal Population, Oxford). (I.B.P.)

Population studies of Neophilaenus lineatus L. were begun in 1961 and have been continued each year since that date. I.B.P. have made available a travel grant this year, which has permitted two visits to Moor House to arrange for censuses to be made at fortnightly intervals during the season. These have been successfully carried out with the co-operation of Mr. M. Rawes and his staff. The population density on both areas studied has increased since last year, continuing the trend since 1965.

(f) Studies on stream fauna (D.T. Crisp, Freshwater Biological Association, Wareham) (I.B.P.)

Quantitative samples of the stream bottom fauna were taken from Rough Sike and Nether Hearth Sike. The data are still being analysed. At the time of sampling the bottom fauna in Rough Sike comprised 440 ± 130 animals/m^2 with a dry weight of 0.06 g. The corresponding values for Nether Hearth Sike were 640 ± 190 and 0.11 g. These values are likely to be too low to represent the annual mean values because they were taken around the time of year (June/July) when the population density and dry weight of the bottom fauna was likely to be minimal. At the same time of year the bottom fauna of a chalky mill stream with a mud bottom at East Stoke, Dorset, had a density of 13,000 ± 3,000 individuals/m^2 and a dry weight of 28 g/m^2.

Measurement of the mean daily distance of travel of the drift fauna in Rough Sike, was tested using the method of Waters (1965). Owing to very small stream discharges during the sampling period, no useful results were obtained.

(g) Studies on Molophilus ater (Tipulidae) (M.J. Hadley Zoology Department, Durham).

The three year study has now been completed and the results are being prepared in thesis form. The study on Molophilus ater (a small flightless crane-fly) has produced a detailed account of the biology and life-cycle of this important moorland species. The population aspect of the work is being continued as part of a study on Tipulidae sponsored by N.E.R.C. under the I.B.P. programme.

It has been shown that there is very little mortality throughout the greater part of the larval life of Molophilus (a period of 8 months) and that the major mortality appears to occur in the egg stage and in the adults which have a very short life span (1-2 days).

(h) Studies on ground living beetles in upland areas
(K.W.W. Houston, Zoology Department, Durham).

This study has been in progress for a year and attention has been concentrated on Staphylinidae and Carabidae. The study has been designed to give a general account of the distribution of these beetles at Moor House and to give quantitative measures of their abundance on certain vegetation types. Some species are predators and further investigations are being made into their food and feeding habits.

IV. Hydrology.

Visitors.

(a) The spatial distribution of storm rainfall
(D.G. Jamieson, Civil Engineering Department, Newcastle).

The harsh weather conditions of the Northern Pennines were ideal for testing new types of remote recording raingauges. The information supplied by these gauges has been utilized in the examination of rainfall patterns, on the Troutbeck catchment. Despite the formation of a complex series of lee waves to the east of the main Pennine ridge, the observed spatial distribution of rainfall on the catchment can be predicted with a fair degree of accuracy, if certain meteorological parameters are known. This investigation has now been completed.

(b) The propagation of floodwaves in natural channels
(R.B. Painter, Civil Engineering Department, Newcastle)

The comparison of the floodwave characteristics of Troutbeck with those from other catchments is in progress. Peat coverage and channel characteristics have proved of real significance and further research into these factors is being undertaken

(c) Water movement investigation in blanket peat.
(D.B. Smith, Wantage Research Laboratory, United Kingdom Atomic Energy Authority).

The investigation is to measure water movement in peat by use of tritium injected at different depths. Similar work has previously been done on a raised bog, in collaboration with the Hill Farming Research Organisation, and it is now desirable to establish the fate of the rainfall input on blanket bog. This will enable the results of the Conway and Millar run-off studies to be interpreted more fully. The site, near lower Valley Bog, has been fenced and the tracer injections will take place in October, 1966.

V. Soils.

(a) Soil physiology on Knock Fell (P. J. A. Howard Merlewood).

Soil respiration measurements are being made both inside and outside the Knock Fell exclosure (see IIa). Two methods are being employed, one measuring the evolution of CO_2 from the surface in the field, the other measuring the uptake of O_2 from soil cores in the laboratory.

The first method involves gravimetrically measuring CO_2 collected in metal cans, the results showing the amount of CO_2 evolved from the microflora and fauna, and from plant roots. Initial difficulties involving the evolution of CO_2 from the aerial parts of the vegetation inside the exclosure have been solved by lightly clipping the vegetation to 5-7 cm. and comparing the results with unclipped plots. The grazed limestone grassland presents no problem in this respect and clipping produced no difference to the measurements. It is hoped to continue the work, and also to study the Juncus areas on the peaty soils. The field results indicate that more CO_2 is evolved outside the fence than inside, pointing to a reduced activity in the soils within the exdosure.

The measurement of O_2 uptake in the laboratory involves cutting the cores until 7 cm, of mineral soil is left, and measuring the O_2 uptake of the whole core in a Dixon manometer. Each core is then divided into three layers, green vegetation, L/F material and mineral soil, and O_2 uptake for each section is measured.

(b) Soil morphology and genesis of the Moor House Nature Reserve. (M. Hornung, Geology Department Durham).

Analyses of the soil has included particle size (Bouyoos method), major element (X-ray spectrograph), trace element (X-ray and optical spectrograph), clay mineral (X-ray diffraction) and heavy mineral analysis on material from fine sand and silt fractions. The major element analyses are being recalculated using a computor programme worked out by Dr. G. Holland, of this Department. This is the first time that major element analyses of soils have been treated in this way.

A slope map of the western escarpment has been prepared and detailed studies of selected brown limestone soils have been made. The thesis which is now being written, will include a revised soil map of the Reserve.

VI. Microbiology.

(a) Fungi and bacteria associated with moorland sites (P. M. Latter and O. W. Heal, Merlewood).

The study on decomposing Juncus squarrosus leaves and a comparison of the microbiology of four of the Moor House soils have been completed and submitted for publication.

Using isolates from Roudsea Wood Nature Reserve (Lancashire), Moor House and Signy Island in the Antactic, the growth of fungi and bacteria in relation to temperature has been studied. The results show that tolerance to low temperature is related to the temperature of the habitat and that some cold intolerant fungi are absent from Moor House. Species which were isolated mainly in winter at Moor House (Mortierella, Mucor spp). showed good growth at 0-2°C compared with "summer" species (Penicillium, Trichoderma spp). Although the majority of bacteria isolated from Festuca-Agrostis grassland at Moor House grew best at 25°C., 31% of the strains had an optimum growth temperature below 25°C. The pattern of temperature tolerance of Moor House bacteria is very similar to that of bacteria from Macquarie Island in the Sub-Antarctic zone; the mean annual air temperatures are 5.1 and 4.4°C respectively. Part of this work is at press.

(b) Microbiology of grazed and ungrazed grassland (P. M. Latter and O. W. Heal, Merlewood).

A comparison is being made of the bacteria, fungi and protozoa in grazed and ungrazed areas of grassland on Knock Fell (see section IIa). Some differences are indicated but the pattern is not yet clear.

(c) Fauna-microflora relationships.

In collaboration with Mrs. J. A. Springett the predominant fungi and bacteria isolated from Moor House are being used in experiments to ascertain the food of moorland Enchytraeidae. A method has been developed for obtaining newly regenerated individuals of Cognettia sphagnetorum which are being used in growth experiments. Preliminary results indicate that some fungi can sustain growth of C. sphagnetorum.

Feeding studies on Moor House Nematoda have just begun in collaboration with Dr. W. B. Banage (Imperial College London).

VII. During the summer the following projects, financied by I.B.P., were undertaken by graduates or second year honours students. The work was supervised by Dr. J.C. Coulson (Durham) (a) Dr. O.W. Heal (b & c) and Mr. M. Rawes (d, e, & f). Full reports are contained in the Reserve Record.

(a) Study on the food of the Common Frog.
(Miss M. Parkes, Zoology Department, Durham).

This study was carried out during three months (July-September 1966) and was planned to give information concerning the food of the Common Frog (Rana temporaria) and also to give some information concerning the suitability of the frog for a detailed ecological study.

Stomach contents of 60 frogs were examined and the food reflected closely the available animals of the ground surface. In general, it appears that the Common Frog takes a wide range of invertebrates for food, but there is a marked selection for size in small individuals which is not found in larger specimens. There was some evidence that frogs fed more abundantly on animals associated with dung than would be expected by chance. Dung attracts many insects and it is possible that frogs learn to associate dung with a high concentration of potential food. Further study on this point is required.

(b) Initiation of an investigation in plant decomposition.
(M. Moseley, Liverpool College of Technology).

In connection with the I.B.P. microbiological studies of Dr. A.J. Holding (Edinburgh University) and Miss V.G. Collins (Freshwater Biological Association, Windermere) on the blanket bog, plant material was set out for future analysis. 100 samples each of Calluna stems, Calluna shoots and Eriophorum leaves have been laid down in the Calluna-Eriophorum-Sphagnum vegetation on Bog Hill. These samples, of known weight, will be examined annually to indicate the age of plant material in the surface layers of the profile, the rate of decomposition and the general morphological changes. The samples will also provide material of known age for microbiological sampling.

(c) Preliminary survey of invertebrate herbivores on blanket bog. (M. Mason, Zoology Dept. Oxford)

Little information on the invertebrate herbivores of blanket bog is available. The prevalence of these animals on Calluna, Eriophorum and Sphagnum during August and September was therefore studied.

Small numbers of Lepidoptera larvae were recorded and the study concentrated on Rhincola (Strophingia) ericae, a plant - sucking homopteran common on Calluna. R. ericae was confined largely to the green Calluna shoots, varying in number from 2 to 99 per gram. of shoot. Extraction by Tullgren funnel gave estimates of larval numbers of 1000 to 3000 /m^2 (about 0.02 - 0.05 g. dry weight /m^2.) No accurate estimates of adult numbers was obtained but a minimum of 220/m^2 were present, equivalent to 0.01 g. dry weight/m^2. These are feeding on a dry weight of about 140 g/m^2 of Calluna shoots.

(d) Morphology and age structure of Calluna vulgaris on Moor House. (J. Grace, Botany Dept. Sheffield).

Sites on Hard Hill (burnt and unburnt), Green Burn, Swindale Beck and Silverband were examined. Measurement of plant age, obtained by counting the rings of cut sections of the stem, were made at each site. It was found that the unburnt heather had an age range of 1 to 40 years, but that most plants on Hard Hill and Green Burn (representative of large areas of Calluneto-Eriophoretum on the Reserve), fell between the range of 16-25 years. On Silverband, where the heather is very sparse and the plants are small, the average age was about 8 years. A comparison was made between heather growing by natural drainage channels (a relatively dry habitat) and in Sphagnum (a wet habitat). The drier habitat supported plants of a higher average age, which had more flowers, greater shoot and live wood weight and more second year leaf.

(e) Initiation of experiments to establish the effect of sheep grazing and climate in limiting the altitude at which Calluna vulgaris grows at Moor House (Miss J. M. Millard, Botany Department, Newcastle).

The upper limit of Calluna on the Reserve is around 2,200ft. O.D., at which height it is sparse and depauperate. At these levels the place of Calluna in the blanket bog vegetation is often taken by Empetrum nigrum. Two sites, at 2,200 feet OD., on either side of the summit ridge, were selected, one by the Silverband track and the other at Troutbeck Head. At each place, two areas, one for subsequent enclosure, were marked out for the recording of 500 vertical point quadrats. The first analysis has been made, and charts and vegetation maps drawn.

(f) Standing crop production of Calluna vulgaris (T.B. Whiffin, Botany Department, Cambridge).

The above-ground dry weight of Calluna was obtained from near, or on, all the sites, except Swindale Beck, examined by Miss J. Millard and Mr. J. Grace, who had himself measured production at Green Burn.

Plants were divided into green shoots, live wood and dead wood, and each part weighed separately. The total dry weight (g/m^2) of *Calluna* varied on the east side of the summit ridge from 560 g. at 1,750 feet O.D. to 25 g. at 2,250 feet at Troutbeck Head. The weight of plants near the Silverband track was 17 g. in the 6 quadrats out of 40 that contained heather.

Publications.

Block, W.C. 1965. The life history of Platynothrus peltifer (Koch 1839) and Damaeus clavipes (Hermann 1804) (Acarina: Cryptostigmata) in soils of Pennine Moorland. Acarologia t VII Fasc. 4, 735-743.

Block, W.C. 1965. Distribution of soil mites (Acarina) on the Moor House National Nature Reserve, Westmorland, with notes on their numerical abundance. Pedobiologia 5, 244-251.

Block, W.C. 1966. The distribution of soil Acarina on eroding peat blanket bog. Pedobiologia 6, 27-34.

Block, W.C. 1966. Some characteristics of the Macfadyen high gradient extractor for soil micro-arthropods. Oikos 17, 1 - 9.

Clymo, R.S. 1965. Experiments on breakdown of Sphagnum in two bogs. J. Ecol. 53, 747-758.

Hale, W.G. 1966. Observations on the Collembola of the Moor House National Nature Reserve, Westmorland, U.K. Rev. Ecol. Biol. Sol. T. III, 1, 97-122.

Hale, W.G. 1966. A population study of moorland Collembola. Pedobiologia, 6, 65-99

Rawes, M. 1966. Productivity of upland grazings. North of England Soils Discussion Group, 2, 34-40.

Rawes, M. 1965. Residual effect of a manurial treatment in the northern Pennines. Scot. Agric. XLV 39-41.

Rawes, M. and Welch, D. 1966. Further studies on sheep grazing in the northern Pennines. J. Brit. Grassl. Soc., 21, 56-61.

Urquhart, C. 1966. An improved method of demonstrating the distribution of sulphides in peat soils. Nature, 211, 550.

Welch, D. 1965. A change in the upper altitudinal limit of Coleophora alticolella Zell (Lep). J. Anim. Ecol. 34, 725-729.

Welch, D. and Rawes, M. 1965. Herbage production of some Pennine grasslands. Oikos, 16, 39-47.

Welch, D. 1966. The reproductive capacity of Juncus squarrosus. New Phyt., 65, 77-86.

Welch, D. 1966. Biological Flora of the British Isles: Juncus squarrosus L. J. Ecol., 54, 535-548.

Other publications:

Newbould, P.J. 1966. Research and Education. 2. Studies at Moor House Field Station, Cumberland. Land and People, B.B.C. publication, 87-90,

Valentine, D.H. (ed.) 1965. The Natural History of Upper Teesdale. Newcastle-upon-Tyne, Northumberland and Durham Naturalists' Trust, 70 pp.

An eight page leaflet "Moor House Field Station and National Nature Reserve" was published locally.