

*Higher rainfall, Western Snowdonia* (Snowdon section). In the Snowdon section it is possible to compare directly a number of sheepwalks on basic (pumice tuff and dolerite) and acidic (rhyolite) terrains. No statistical difference in grazing intensity exists between such terrains (basic terrains, mean of four walks, 1.39; acidic terrains, mean of eight walks, 1.21 ewe units per acre). Under the prevailing high rainfall conditions, the properties of soils derived from different parent rocks tend to merge, though vegetational differences persist<sup>1</sup>. Here, therefore, climatic factors are of paramount importance, and vegetational differences appear to have little influence on sheep grazing intensity.

The general conclusions that emerge from this study are:

(1) For the Snowdonia region as a whole, though environmentally complex, climatic factors, in particular rainfall, are the major influence determining livestock productivity estimated in terms of the number of stock per acre. These conclusions are similar to those of Phillips<sup>2</sup>, who has considered productivity in terms of estimated dead-weight.

(2) Within the lower-rainfall Conway Valley area, geological and physiographical complexity affecting soil and vegetation have, however, an important bearing on livestock productivity, so that over a major part of Snowdonia, where precipitation is less than 70–80 in. mean annual rainfall, the basic igneous and volcanic terrains are of first importance to its livestock economy. Locally, even at higher rainfalls, these terrains are important grazing foci.

(3) The arctic-alpine element in the flora of Snowdonia is found mainly on these basic rocks. It is of interest to the problem of the conservation of this flora that it survives locally in the face of considerable grazing pressure. This needs detailed investigation.

(4) Environmental variations in an area like Snowdonia are of an extreme and complex kind. They are available within a single compact region and can provide a fruitful field of inquiry into fundamental ecological problems and also into animal productivity and health in relation to environment<sup>4</sup>.

I am indebted to the Agricultural Research Council for financial help, and to Prof. R. Alun Roberts for his encouragement and facilities placed at my disposal. Part of the work outlined here was carried out at the School of Agriculture, Cambridge, and thanks are also due to Sir Frank Engledow for the facilities provided there for part of this investigation. A more detailed account of this work will appear elsewhere. A statistical appraisal of the results has already been given<sup>4</sup>.

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<sup>1</sup> Phillips, R., Davies, J. L., and Brown, E. H., *J. Dairy Res.*, **10**, 129 (1949).

<sup>2</sup> Phillips, R., and Brown, E. H., *J. Agric. Sci.*, **40**, 341 (1950).

<sup>3</sup> Phillips, R., *J. Agric. Sci.*, **43**, 432 (1953).

<sup>4</sup> Hughes, R. E., "The Ecology of Some Snowdonian Sheepwalks", European Grassland Conference, Paris, 1954 (mimeographed, available for circulation on request).

<sup>5</sup> Watson, J. A. S., and Moore, J. A., "Agriculture: The Science and Practice of British Farming", 795 (1949) (gives stock equivalents).

<sup>6</sup> Boulet, L. J., thesis, University of Wales (1939).

<sup>7</sup> Hunter, R. F., *J. Brit. Grassland Soc.*, **9**, 195 (1954).

<sup>8</sup> Hughes, R. E., Report of the 5th International Grassland Congress, Netherlands, 1949, p. 154.

<sup>9</sup> Hughes, R. E., and Lindley, D. V., *Nature*, **175**, 806 (1955).

### Wild White Clover in Natural Mountain Grassland

IN the course of ecological investigations from Bangor, it has been found that there is a considerable number of outcrops of soft base-rich rocks distributed throughout Snowdonia which have a marked effect on the natural vegetation. The cliffs and crevices harbour an Arctic-Alpine flora and have been well described. On the slopes, however, there is an extremely different distinctive vegetation, a grassland scarcely distinguishable from lowland base rich grassland, about which little is known<sup>1</sup>.

Cwm Llefrith, which is situated between Moel Hebog and Moel yr Ogor in South Caernarvonshire, is being investigated. This is related to a more general study of mountain grasslands by R. E. Hughes, preliminary details of which are given in the preceding communication. The upper reaches of this Cwm carry a very rich pasture in which wild white clover features prominently, though at 1,600–1,800 ft. in a rainfall of 100 in. The soil is a well-drained brown-earth type with a good crumb structure and very little undecayed organic matter, similar to those described in East Snowdonia by Hughes<sup>2</sup>, the underlying rock being a magnesium-rich soft volcanic ash.

In pastoral Snowdonia, Cwm Llefrith is outstanding for the record of its productivity (Cwm Llefrith means milky cwm). Summer milk production used to be a prominent feature of its economy to the close of the past century. Every autumn about three tons of salted butter was taken from a single farm and sold at the slate-quarrying district of Blaenau Festiniog for winter use. Now under sheep, its carrying capacity is about two ewes to the acre, a capacity well above that of the surrounding districts. Hughes<sup>1</sup> reports a similar state of affairs elsewhere in Snowdonia. The basis of this remarkable productivity at such a high altitude seems to a great extent to be due to the abundance of wild white clover and the fertility of the accompanying sward.

From preliminary transplant experiments, a distinctive ecological race of wild white clover seems to have been differentiated, characterized by small size but extreme persistence, adapted to upland conditions of grazing and climate. Such a race is capable of enduring successfully the rigour of climatic conditions at high altitudes while lowland races are not. At the same time, it is likely that the mountain race shows some adaptation to low base content and low pH, since the soil in Cwm Llefrith, while it approaches that of lowland soil, is by no means identical with it.

The implications of such a situation are far-reaching in the economics of the reclamation and improvement of hill regions at the present state of our national economy, and make investigations on the ecology and genetics of wild white clover paramount in such regions.

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March 23.

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<sup>1</sup> Hughes, R. E., "The Ecology of some Snowdonian Sheepwalks", European Grassland Conference, Paris, 1954 (mimeographed).

<sup>2</sup> Hughes, R. E., *J. Ecol.*, **37**, 306 (1949).