

ADDRESS OF THE PRESIDENT

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AN ECOLOGICAL RECONNAISSANCE OF DARTMOOR.

(Read at Barnstaple, 21st June, 1938.)

WHEN I looked down the lists of names of Presidents who have occupied this chair I realized very clearly the honour you have done me by electing me your President for the coming year, and I tender you my sincere thanks. Further, when I considered the subjects chosen for their Addresses by the majority of my predecessors it is not too much to say that I almost despaired of finding a subject that I was qualified to speak upon and that should at the same time merit inclusion amongst the learned Addresses you have had on previous similar occasions.

In electing to choose a botanical subject I shall probably not disappoint your expectations, and I shall be dealing with a subject with which I feel more or less conversant, and one to which I have devoted a good deal of time. By a coincidence, at the previous meeting of the Association held at Barnstaple in 1917 the President's Address dealt also with botanical matters.

I am aware that in restricting myself to the ecology of Dartmoor I shall fail to command the sympathy of the majority of botanists taking an interest in the flora of the county, but there is a feature of botanical science equally important with the naming and cataloguing of plants growing in a given district and that is the relationship of a plant to its surroundings. As we wander over Dartmoor we see some portions in June a glorious mass of bog asphodel; some parts almost entirely heather-clad; here a great expanse of rush; and in some swampy places an extensive growth of bog myrtle. At one time the bulrush was frequent on the moor, to-day it is a very infrequent member of the moorland flora. Why all this should be so is one of the questions ecology sets itself.

Territorially, Dartmoor is a very elusive name. With some writers it indicates the portion defined by the Perambulation of 1240. Others include the Dartmoor commons surrounding the forest proper, while yet others would extend

its boundaries more or less indefinitely. For the purpose of this reconnaissance it will be limited to the central granite district and the surrounding aureole of metamorphic rocks. No precise boundary can be usefully drawn. Within the confines of this delimitation is a moorland expanse whose varied surface should satisfy the most exacting ecological botanist, and one that is more especially the home of ericetal and cryptogamic plants in Devon. The authors of the *Flora Devoniensis* rightly say that "to the botanist it is, perhaps, the most interesting portion of the county." However, in spite of its superior attractions as a collecting ground for the botanist the remark may be ventured that it has been more neglected than any of the lowland areas. Possibly for this neglect contributory causes are the difficulty attending pedestrianism in a rough and mountainous country, the uncertain climatic conditions, and, a by no means negligible factor, the absence of arresting phanerogamic plants; for Dartmoor is more especially the cryptogamic botanist's happy hunting ground, a hunting ground that has been to a great extent left unexplored. I venture to hope that the present imperfect review of the ecology of the moor will stimulate someone more qualified than myself to give the subject the attention it deserves.

For the ecologist Dartmoor is a composite district wherein he may find the ecologist's true moor, wet and dry heath, woodland, siliceous grassland, rock and boulder communities, aquatic associations, and modifications of all of them.

Plant hunting on Dartmoor is not quite the recreative pastime it usually is when pursued in the lowlands. Many of the plants most worth finding may be missed by a few feet. The rare orchid *Malaxis paludosa*, for instance, is said to grow on Dartmoor, yet in spite of tiring search it has never found a place in my vasculum, and I agree unreservedly with Bentham and Hooker that although it is found sparingly over the greater part of Britain it is always difficult to find. It is a plant of arctic Europe, and one would naturally like to know definitely that it still lingers as a member of Dartmoor's vestigial arctic flora. Another relic of this select arctic flora remaining on Dartmoor is *Sagina subulata*. *Empetrum nigrum*, a plant characteristic of arctic Europe, and growing plentifully in Greenland and on the moors of north-eastern Yorkshire, is quite infrequent on Dartmoor, and is a plant that might easily be overlooked. *Vaccinium Vitis-Idæa* also is an arctic plant, rare even on the northern moors of Britain but said to occur on Dartmoor. A near relative and a boreale plant also, *Vaccinium Oxycoccus*, grows sparingly on the moor but might easily be passed unnoticed. Quite recently, that is within the last few years, *Claytonia sibirica*, a

plant at home in Siberia and North America, has been found in one or two places on the moor. The easy explanation of its presence would be that it is a garden escape, but enquiry fails to elicit its presence in any garden near its present habitats. These plants are mentioned to show that the vascular flora of the moor is still worth considerable attention.

One feature of plant life on Dartmoor still awaits investigation, and perhaps it is the most fascinating of all the problems the moor presents for unravelling. It is the past history of plant life on the moor. To an uncritical inquirer the plant community of a certain district seems to be a stable assemblage, little likely to change as the years pass. This is far from being the case. The edaphic features of a territory like Dartmoor are subject to climatic changes and it is a difficult matter to arrive at a reasonable estimate of what the conditions on Dartmoor may have been in the geological past, and what connection the present flora may have with a flora that existed on the moor far nearer glacial times. With altitudes reaching at the present time some 2000 feet one would expect to find a fair proportion of sub-alpine plants in the flora of the moor, but such plants are extremely rare, and when one tries to construct an alpine flora from the present assemblage of plants the result is far from encouraging. The geologists of the Geological Survey in their Memoir on Dartmoor flatly say "the flora includes no northern forms even on the highest hills." This is by far too sweeping an assertion, as on the moor at the present time may be found such northern species as *Empetrum nigrum*, *Eriophorum vaginatum*, *Vaccinium Oxycoccus*, *Sagina subulata*, *Galium saxatile*, *Lycopodium Selago*, and amongst mosses the dominant *Racomitrium lanuginosum*. But it must be admitted that alpine species such as may be found on the mountains of North Wales and Scotland of three to four thousand feet are conspicuously absent from the Dartmoor flora. If we try to connect the present flora of the moor with what may be regarded as the flora of a glacial district, the Pennine, the moors of North-east Yorkshire and some of the continental moors, the results are more encouraging. We are conclusively told that "the question of the former climatic changes which have taken place on Dartmoor is a difficult one, for there is an entire absence of striated rocks or arctic fossils such as would prove conclusively what Dartmoor was like during the glacial period." When botanising among the mountains of North Wales I have been accustomed to look for evidence of glacial action such as striæ and the smoothing of rock surfaces by the passage of glaciers, so that I am quite conversant with the principal features of ice action. In all my rambles about Dartmoor I have never seen anything that would suggest a glacial occupation of the

moor, but in some places there are features that strongly indicate morainic action, and if one accepts the conventional statement that the ice sheet came no further south than about Bristol it will be a safe assumption to regard Dartmoor as having been at one period of its history a sub-glacial district and the flora of that period as having been a more or less arctic one.

In reviewing the moorland flora, however, it should be remembered that no intensive examination of it has so far been made to help one to make a correct estimate. The most one can do is to compare it with other moorland districts that are said to have a sub-arctic facies.

So far, no pollen examination of the peat beds of Dartmoor has been made similar to those of Dr. Rastrick and Dr. Godwin of the peat on the northern Pennines, which have yielded such rich results. In fact the peat beds of Dartmoor, so far as plants are concerned, remain an unexplored territory. If a thorough examination of them were made, such as has been made in other districts doubtless many species would be revealed as having existed in former times which have now disappeared from the moor. On the Pennine moors remains of plants have been found in beds of peat which suggest an entirely different condition of vegetation.

Greenland is a country generally supposed to afford a picture of the vegetation of Britain in post-glacial times. Professor A. C. Seward, F.R.S., writing of the flora of Greenland says, "Greenland as it is enables us to picture the British Isles in the grip of the Ice Age at a time separated from the present by a comparatively short interval as geologists reckon time. We know that the flora of Britain, as also that of northern Europe generally, was much richer in Arctic forms than it is now. To give one example: from thin layers of peaty material in a gravel pit close to Cambridge several Arctic species have been identified. Professor Ostenfield believes that a small proportion of the present flora survived the "great ordeal of the Ice Age." "When the British Isles were as Greenland is now, there must have been sheltered places which served as refuges for the hardier members of the pre-glacial vegetation."

This being so we can reasonably push back the flora of Dartmoor as far as the close of the last Ice Age. *Azalea procumbens* (*Loiseleuria*), one of the last survivors of an arctic flora, has been reported from Dartmoor, but requires confirmation. It has been scheduled by ecologists as belonging to the "snow-patch" group of plants, and occurs in Britain in Perthshire (Blair Athol) at about 3000 feet on patches whence snow had recently melted. With some 400 species of vascular plants in the rigorous climate of Greenland at the

present time, palæo-botanists are disposed to regard many species of plants as quite able to survive the rigours of a waning glacial epoch. The following may be regarded as a provisional list of Greenland plants to be found on Dartmoor at the present time, but intensive search would almost certainly add to it additional species. *Empetrum nigrum*, *Vaccinium Vitis-Idæa*, *Oxycoccus palustris*, *Thymus Serpyllum*, *Pinguicula vulgaris*, *Lycopodium Selago*, *Eriophorum vaginatum*, *E. angustifolium*, *Calluna vulgaris*, *Sagina subulata*, *Potamogeton* (spp.), *Campanula rotundifolia*, ("The familiar and always attractive hare-bell seems to be as much at home on the hills of Greenland as it is in England"—Professor Seward), *Cystopteris fragilis*. This list does not include cryptogamic plants common to both Dartmoor and Greenland, nor yet grasses; it is merely given to indicate the relation that exists between the flora of Dartmoor and that of an arctic region. Curiously enough the ling and the heaths so abundant on Dartmoor are said to be absent from Greenland. Professor Seward says, "There is much heathland but the heather and ling we associate with heath moors are absent; their place is taken by *Cassiope tetragona*"

The flora of a moorland district, in Great Britain as elsewhere, is not a stable feature of the landscape when measured by the efflux of long periods. It varies by the appearance and disappearance of certain species. The climate may alter in some particular, to the advantage of one species or the disadvantage of another, and even in recent years several species have appeared on Dartmoor that seem to be not only maintaining themselves but spreading from one place to another on the moor. *Erica ciliaris* and *Erica vagans* have both been found on Dartmoor since the publication of the *Flora Devoniensis*; at least they are not mentioned in it. And other moors have the same tale. The arctic sedge, *Carex pauciflora*, seems to have disappeared from the moors of North-East Yorkshire within comparatively recent times. *Typha latifolia* seems to be disappearing entirely from Dartmoor, as also *Cladium Mariscus*. *Campanula rotundifolia*, so plentiful in arctic Greenland and on some of the hills in Worcestershire, is more or less of a rarity on Dartmoor and may be a disappearing species; Dr. W. Watson speaking of heath associations in Somerset, says of this plant, "The infrequency of *Campanula rotundifolia* is very noticeable to an observer accustomed to northern heaths, in fact it is almost confined to calcareous districts in Somerset, though not necessarily to calcareous soil." *Matricaria suaveolens* on the other hand is becoming a weed of the moor. It has followed the footsteps of man and is now established as a moorland plant in the vicinity of his homesteads. *Polygonum*

Sachalinense has found its way right on to the moor, above Princetown, and a lowland plant, *Serratula tinctoria*, was seen on rock ledges of Fur and Great Mis Tors, the seed doubtless conveyed there by westerly winds; but the habitat was obviously an unfavourable one for it disappeared in the course of a few years. In moorland waters are *Elodea canadensis* and *Mimulus Langsdorffii*, both comparatively recent arrivals and now flourishing luxuriantly. It will be seen from these instances that the flora of Dartmoor has by no means achieved a state of equilibrium but is always in a condition of debit and credit. Professor Eugenius Warming in his great work on the ecology of plants refers to the "unceasing change of vegetation all the world over", and points out that a plant is rare because (a) it is an immigrant that has just reached the district in question or (b) because it is a "relic" plant, that is to say a relic of a former but now suppressed vegetation. He further remarks, "the extensive migration that took place after the Glacial Epoch has perhaps left its traces in many supposed relic plants which have maintained themselves here and there but now occur only sporadically in small numbers and are gradually dying out. The localities where they have survived are those agreeing most closely with the conditions that prevailed in the Tundra Epoch, namely cold, wet moors. It is very difficult to prove of a species that it is a relic plant or even to show this with reasonable probability, and in many cases this character has been ascribed on insufficient grounds to species that are perhaps recent immigrants."

The edaphic features of Dartmoor, in common with other moors of Great Britain, are changing year by year. The late Mr. G. French of Postbridge told me that in his boyhood he knew Broad Down Marsh as an open piece of water partly overgrown with bulrushes. When I visited it one wet autumn some years ago it was possible to cross it in almost any direction, and the bulrushes were practically extinct. In the course of time by changing edaphic conditions this piece of what was originally fen may pass through the intermediate conditions of wet and dry heath until it reaches a more or less stable condition of grassland.

The upland moors of England have been more exhaustively studied perhaps than any other natural feature of vegetation; in Great Britain, the Pennine range in particular has had the attention of such well-known ecologists as Dr. F. J. Lewis and Dr. C. E. Moss, and the moors are regarded as typical examples of English upland moorland. Hence I have found it convenient to compare the Dartmoor district with them. Their elevation is much the same as Dartmoor. In both districts the peat varies in depth from a few inches to several

feet, but on Dartmoor it overlies granite, and not shales and sandstones as in the Pennines. In both districts retrogression of the peat seems to be taking place, as well on the Lancashire as on the Yorkshire moors. On Dartmoor it may be seen in progress on Great Kneeset and Cut Hill. The "peat hags" on Great Kneeset tell a tale of moorland degeneration. Water channels cutting right down to the granite floor have divided the peat into peat "hags" that eventually become washed away during winter storms. As to the age of the peat little can be said conclusively. F. Elgee's remarks on the age of the Yorkshire moorland peat may well apply to Dartmoor peat. "Since the deepest layers began to form, thousands of years or only a few centuries may have elapsed. If the lower layers could be shown to contain the remains of arctic plants then the peat would date back to the close of the Ice Age, but until this has been determined we have no clue to the antiquity of the deposits except by vaguely asserting that they are post glacial." Documentary evidence appears to exist with regard to one of the large Yorkshire "mosses" that would make it upward of one thousand years old.

The plant associations recognised on the Pennines are (1) Sphagnum Moor, (2) Cotton Grass Moor, (3) Scirpus Moor, (4) Bilberry Moor, (5) Heather Moor. These associations are said to form a series showing a decreasing soil water content. The ecological associations represented on Dartmoor are very similar and may be broadly grouped as Heath, Heather Moor, Moor, Aquatic, Woodland, and minor associations of Scirpus, Juncus, and Eriophorum. These broad units of classification would be subdivided by an enthusiastic ecologist into many associations, as for instance the *Eriophorum vaginatum* association, of which a conspicuously good example exists near Cowsic Head, this association being distinguished from the *Eriophorum angustifolium* association which also occurs in many parts of the upland plateau. The delimitation of these units is by no means rigidly defined as they frequently merge one into another without any apparent physical boundary. They are however useful definitions for the field botanist and unless too closely sub-divided are quite natural sub-divisions.

With respect to the western heaths of Great Britain Professor Tansley says, "on the Devonian sandstones and grits of Exmoor and on the granite of Dartmoor extensive heaths are developed, but in both regions local patches of the true moor formation occur on deep peat. *Ulex Gallii* is abundant and forms a beautiful feature, as on most of the western heaths." Heather moor is widespread over Dartmoor. Dr. W. Watson in his paper on the Bryophytes and Lichens

of moorlands includes as heather moor a district which he studied near Widecombe-in-the-moor, mainly granite fringed by Devonian slates. Some forty-five species of flowering plants are given in his list as typical of the association. The list agrees very closely with that given for heather moor in Tansley's *Types of British Vegetation*. True *Calluna* moor is developed on Dartmoor and varies much in altitude. Heather moor passes over into moorland on the higher tracts of Dartmoor where the deep peat occurs, and in the lower parts, where there is no peat, grass heath occurs, characterised by *Nardus stricta*, *Deschampsia flexuosa*, *Holcus lanatus*, *Agrostis vulgaris*, *Festuca ovina*, *Anthoxanthum odoratum* and in wetter ground *Molinia coerulea*, *Euphrasia officinalis*, dwarfed *Blechnum Spicant*, *Linum catharticum*, *Teucrium Scorodonia* and *Thymus Serpyllum* may also be present. In wet places *Molinia coerulea* may form extensive molinieta, as between Nun's Cross and Childe's Tomb. Other plants characteristic of damp places are *Viola palustris*, *Hypericum elodes*, *Hydrocotyle vulgaris*, *Drosera rotundifolia*, and *Anagallis tenella*. The Sphagnum association is generally distributed on Dartmoor though it would appear that Dartmoor does not possess those extensive areas of Sphagnum which may be seen on some of the northern moors; nor does Sphagnum appear to be the chief producer of Dartmoor peat. In his *Types of British Vegetation*, Professor Tansley says "*Sphagnum* peat is rare in the upland Pennine moors," and from my own limited knowledge of Dartmoor peat I should say the same of Dartmoor peat, though it still awaits a careful examination. On some northern moors species of *Eriophorum* seem to be the main producers of peat, and it may be so on Dartmoor as some peat I have examined seems to be filled with *Eriophorum* sheaths.

In small standing pools, such as those on Standon Hill, *Sphagnum plumosum* is often dominant. *Sphagnum recurvum* is said to be the dominant species in some places but as the various species and varieties have not been worked out ecologically on Dartmoor no useful statement can be made. *S. plumosum* var. *plumulosum* is often in profusion in swampy ponds, as under High Willays (2039 feet), and in permanently boggy places this seems to be the principal form. Associated with the *Sphagnum* may be *Hypericum elodes*, *Viola palustris*, *Erica Tetralix*, *Eriophorum angustifolium*, *Juncus bufonius*, *Oxycoccus quadripetala* very rarely, and among Bryophytes *Philonotis fontana*. *Eriophorum angustifolium* seems to be the species principally concerned with cotton grass moors on Dartmoor but *E. vaginatum* in places (e.g. Cowsic Head) produces pure associations; generally speaking, however, it is much the rarer species on Dartmoor, and so Dr. Watson



PRIMITIVE WOODLAND, WISTMANS WOOD, DARTMOOR.

Photo by G. T. Harris.



HEATHER MOOR, LANGSTONE MOOR, DARTMOOR.

Photo by G. T. Harris.

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PLATE II



JUNCETUM, WATERN TOR, DARTMOOR.

Photo by G. T. Harris.



WET MOOR, CRANMERE, DARTMOOR.

Photo by G. T. Harris.

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found it in the neighbourhood of Widecombe. On the Pennines Smith and Moss found a general mixture of the two species.

The Dartmoor heather moors are fairly rich in number of species the more dominant being *Potentilla erecta*, *Calluna vulgaris* (abundant), *Erica Tetralix* (abundant), *E. cinerea* (abundant) *Rumex Acetosella* (frequent), *Ulex Gallii* (abundant in the lower parts), *Vaccinium Myrtillus* (plentiful), *Anagallis tenella*, *Eriophorum angustifolium*, *E. vaginatum*, *Pteris aquilina*, *Blechnum Spicant*. *Erica vagans* and *E. ciliaris* both occur but are very rare. *Carex binervis* and *Carex præcox* are the two most frequent moorland sedges.

Junceta are very frequent on the moor where patches of wet peaty ground occur. They are especially well developed at the head of the West Okement and below Cranmere Pool; in fact wherever a shallow depression occurs and water collects junceta are sure to form, *Juncus communis* probably being the dominant species. Floristically they are rather poor, the following being the principal species: *Drosera rotundifolia*, *Narthecium ossifragum*, *Ranunculus Flammula*, *Hydrocotyle vulgaris*, *Schœnus nigricans*, *Montia fontana*, *Cnicus palustris*, *Galium palustre* var. *Witheringii*, *Juncus lamprocarpus* and among Bryophytes *Leucobryum glaucum*.

Vaccinium Myrtillus is widespread on Dartmoor as it is on the Pennine moors and on the moors of North-east Yorkshire, and ecologists recognise three different associations depending on the peat and water content. The "vaccinium ridges" of Smith and Moss seem to occur on Dartmoor as well as on more northern moors, and in some places, as on the steep banks of the Tavy above Watern Oke, it grows in a most luxuriant manner, almost forming a miniature wood, the plants being over three feet in height and thickly associated.

Typically dry heath is developed on Black Down near Okehampton and on Great Nodden, which are on Carboniferous Grit. They are treeless areas dominated largely by *Calluna vulgaris* and *Ulex Gallii*. Other plants are *Vaccinium Myrtillus* (dwarf), *Galium saxatile*, *Teucrium Scorodonia*, *Blechnum Spicant*, *Potentilla erecta*, *Rumex Acetosella*, *Luzula campestris*, *Carex caryophylla*, *Erica Tetralix*.

Dr. W. R. G. Atkins, F.R.S., of the Plymouth Biological Laboratory, gives the acidity of the Dartmoor peaty soil as P H⁴ to P H¹ but on the metamorphic fringe, as at High Down near Lydford distinctly calcareous conditions may be met with, and calcicole species such as *Viola lactea*, *Blackstonia perfoliata*, and *Ceterach officinarum* may be met with. In places where old mine buildings have become ruinous and the mortar has gradually become incorporated with the adjoining soil, calcicole species will gradually make their

appearance. At Meldon in the vicinity of some ruined buildings *Ceterach officinarum* grows luxuriously on the ground and several calcicole Bryophytes, also the calcareous-loving mollusc *Helicogena aspera*, which a short distance away, on the granite, entirely disappears.

In lowland parts of the moor where the peat is comparatively shallow, *Ulex Gallii* often occurs in extensive tracts and seems more addicted to forming pure societies than does its relative *U. europæus*. On the siliceous grass of Whit Tor is a striking instance of a former society that originally covered the whole slope with a thick growth. The plants themselves are all dead but the round mounds of soil that gradually accumulated under them during their lifetime remain, covering the hillside thickly with grass grown hillocks. *Ulex Gallii* seems an attractive plant to *Cuscuta Epithimum*, for while it is rarely seen on *Ulex europæus* on Dartmoor, this parasite often covers *U. Gallii* thickly. One summer at Nodden Gate a considerable extent of *Ulex Gallii* was completely covered with *Cuscuta Epithimum*, and from the distance the rose-coloured corollas gave the patch a very striking appearance.

Pteris aquilina, that "pestilent weed" of the agriculturist, the travelling geophyte of the botanist, forms extensive societies in some of the well-drained areas of the moor, a conspicuous example being the slope of Homerton Hill, where it rises from the West Okement above Meldon.

Fen and marsh formation would scarcely be looked for upon Dartmoor but it is possible that in some places, Broad Down mire for instance, fen may have existed in the past. By progressive desiccation fen may pass over into moor and heathland. Fen is usually regarded as having telluric water, alkaline in reaction, but it has been pointed out that "the fen formation passes over into the moor formation by the gradual growth of plants above the reach of the alkaline ground water, and the consequent accumulation of peat poorer in mineral salts, so that moor plants begin to supplant fen plants" (Tansley). Marsh formation exists in several places on the fringe of the moor at about 1200 feet, for instance above Throwleigh, where is a piece of marsh containing *Alnus rotundifolia*, *Salix* (spp.), *Caltha palustris*, *Phragmites communis*, *Myrica Gale* (abundant), *Potamogeton* (spp.), *Lychnis Flos-cuculi*, *Spiræa Ulmaria*, *Mentha* (spp.), *Scrophularia aquatica*. *Typha latifolia* is now rare on the moor. *Cladium Mariscus* has been recorded for the moor but it is doubtful if it now exists on it. These plants indicate that marsh formations may at one time have existed in places. Undoubtedly the tale the plant formations of the moor have to tell is one of gradual dessication.

It has been repeatedly said that at one time Dartmoor

PLATE III



PRIMITIVE WOODLAND. WISTMANS WOOD, DARTMOOR.

Photo by G. T. Harris.



WET MOOR, TAW MARSH, DARTMOOR.

Photo by G. T. Harris.

was more or less covered with trees, but there is no ecological evidence to confirm this statement. Mr. F. Elgee says, when writing of the moors of north-east Yorkshire and the popular belief that they were at one time tree-covered, "It must be admitted that they contain no evidence of ever having been covered with forests or even woods. I think there can be little doubt that the higher wind-swept moors were never clothed with arboreal vegetation. Of course this does not exclude the presence of occasional trees or scrub, for that such can grow on the open moor has been pointed out." (*The Moorlands of North Eastern Yorkshire.*) Lewis and Moss when writing of the Pennine moors say, "There is no evidence in this region to warrant the conclusion that the whole of the extensive elevated tracts now occupied by cotton-grass moors were formerly covered by continuous forests, though it appears highly probable that woodland existed on the less exposed tracts." All this applies with equal force to Dartmoor. The popular assumption with regard to Dartmoor woodland is that the trees were felled by the tanners for fuel. On the Yorkshire moors the belief was that the mediæval iron smelters were responsible for the destruction of the trees. The term "forest" has been the cause here as elsewhere of the belief in Dartmoor's previous woodland. At the same time the wood frequently found in the Dartmoor peat indicates that at one time trees may have been more or less numerous in sheltered positions. As on the Yorkshire moors, so on Dartmoor the deep peat bogs contain ample evidence of former trees where are now only deep and extensive peat deposits. In his *Perambulation of Dartmoor* Rowe mentions that near Princetown twenty cart loads of wood were obtained without any trouble, and from a peat bog near Postbridge I myself have obtained birch remains and hazel nuts from a considerable depth in the peat, and also from peat in Taw Marsh. On the moors in the north of England the tale is the same. The peat beds contain evidence of the destruction of trees (principally birch as on Dartmoor) by the gradual accumulation of peat.

The woodland actually existing on Dartmoor at the present time is the notorious Wistmans Wood, Piles Wood, and Black Tor Copse. A small patch of woodland on a steep slope of the moor under Sourton Tors is of some interest to the ecologist. It conforms very closely to the dry oak wood association of Tansley (*Quercetum Roburis et sessiliflora*). The wood is on Carboniferous Grit and being situated on a very steep slope the drainage is exceptionally good. It is principally composed of pedunculate oak (*Quercus pedunculata*) but there is also a fair quantity of sessile oak (*Quercus sessili-*

flora) and numbers of hybrids. From one tree pedunculate, sessile and hybrid fruit were obtained. Ash (*Fraxinus excelsior*) was also present in minor quantity. The wood has a shrub layer of *Cratægus monogyna*, *Prunus spinosa*, *Rubus* (spp.), *Corylus Avellana*, and *Ulex europæus*. The ground flora is principally *Scilla non-scripta*, *Mercurialis perennis*, *Teucrium Scorodonia*, *Blechnum Spicant*, *Vaccinium Myrtillus*, *Lonicera Periclymenum*, *Origanum vulgare*, *Sanicula europæa*, and other species, but owing to lack of time a complete list was not made. The profusion of hybrid oak was very remarkable. Probably the extremely steep slope of the ground and the presence of thorny shrubs helped to preserve the wood from much trespass by grazing animals.

The sessile oak on Dartmoor seems to follow the metamorphic aureole around from Okehampton and adheres pretty closely to it, for, if one examines the oaks north of Okehampton towards Jacobstowe, they seem to be all pedunculate. As far as I have examined the oak trees on and around Dartmoor they are a mixture of pedunculate, sessile and hybrids, with a preponderance of the pedunculate. This is not in accordance with the views of most writers on ecology, who definitely state that *Quercus sessiliflora* is the primitive oak of England. Dr. C. E. Moss says, "On siliceous soils the typical woodland association is dominated by *Quercus sessiliflora*." This species is also stated to be the dominant oak on the Pennines. The "woods of sessile oak" spoken of by some ecologists as occurring in some parts of Devon I have nowhere seen, certainly not in East Devon, where they are specifically said to occur on the Upper Greensand.

From an ecological point of view Wistmans Wood is the most interesting wood on Dartmoor. It consists of an assemblage of trees occupying a rocky slope on the West Dart at an altitude of about 1250 feet. The trees are all dwarf and contorted in shape and grow amongst a mass of granite boulders, the debris of Longaford Tor rising above them. The wood is a piece of "elfin woodland" such as can be matched in any country where the edaphic conditions are severe. Professor A. C. Seward says of the trees in Greenland, "In the region of Disko Island the only representatives of trees are the dwarf shrubby willows and birch," and Dr. Sten Bergman in his journey through Kamschatka describes alder thickets as "the curse of Kamschatka, through which it is possible to creep if you have nothing to carry, but which otherwise you must cut your way through." Warming's description of elfin woodland might quite well have been written of Wistman's Wood and Black Tor Copse, for he says, "An erect stem is not developed, the stems creep under ground, descend slopes, and are clothed with

moss and other plants. This elfin scrub is a xerophytic type of vegetation which is well able to withstand on the one hand rapid transpiration, intense sunlight, and cutting cold winds, and on the other hand the exceeding moisture of a wet soil, frequent and dense mists and falls of rain and snow." Hence it will be seen that such patches of woodland on Dartmoor conform in character and conditions to a type well-known and widespread. Two instances may be given illustrating the influence of edaphic conditions on a plant. On Dartmoor *Salix repens* forms low creeping plants scarcely observable unless the fluffy catkins are present, and yet on Woodbury Common in the same county this species is a bush of some size. Again, within a short distance of Cranmere Pool, on the sour humus of the extensive peat beds is a small mountain ash (*Pyrus Aucuparia*) a few inches in height, leading a solitary and very precarious existence, while only three miles away in the sheltered ravine through which the Rattlebrook flows is probably the finest individual on Dartmoor of the same species, with a stem 54 inches in circumference. A long and painstaking examination of the scrub oak of Wistmans Wood and Black Tor Copse established the fact that although *Quercus sessiliflora* was present the majority of trees were *pedunculata* with a considerable sprinkling of hybrids.

The vegetation covering the trees and boulders of both woods is essentially of woodland type. The most conspicuous feature is the luxuriant growth of *Juncoides sylvatica*. Depending from the branches of the trees are great masses of *Antitrichia curtispindula* bearing a plentiful supply of capsules. Mr. H. N. Dixon in his *Student's Handbook of British Mosses*, says, "This plant grows nowhere perhaps more finely in our islands than in Wistmans Wood, where it clothes the limbs of old and stunted oaks with large masses, hanging down to the length of a foot and producing fruit in abundance." Another sub-alpine bryophyte plentiful in the wood is *Hylacomium loreum*. The dominant flora of the trees and boulders in the wood includes *Corydalis sylvaticum*, *Vaccinium Myrtillus*, *Digitalis purpurea*, *Stellaria Holostea*, *Geranium Robertianum*, *Oxalis Acetosella*, *Ulex europæus*, *Sedum anglicum*, *Hedera Helix*, *Salix aurita*, *Lonicera Periclymenum*, *Teucrium Scorodonia*, *Galium saxatile*, *Corylus Avellana*, *Rumex Acetosella*, *Anthoxanthum odoratum*, *Holcus lanatus*, both the filmy ferns, *Hymenophyllum tunbridgense* and *H. peltatum*, besides *Lastrea Filix-mas*, *Athyrium Filix-fœmina*, *Pteris aquilina*, *Polypodium vulgare*, and a fairly long list of bryophytes.

The amount of humus collected on the branches of the trees and on the surfaces of the boulders is quite remarkable.

On one tree branch sufficient humus had accumulated to allow of the growth of quite a sizeable mountain ash, and on one boulder a depth of two inches of rich humus was observed.

As the edge of the wood is reached *Rhacomitrium lanuginosum* replaces on the granite blocks the bryophytes found nearer the interior of the wood.

The above is by no means a complete list of the species occurring in the woods of Wistmans and Black Tor Copse, the lichens and hepatics being totally omitted. Considerable woodland of a normal type exists in the sheltered valleys of the West Okement about the Isle of Rocks, the West Cleave on the East Okement, the Becka Falls and other such sheltered places, which may be regarded as semi-natural woodland, the ground flora approaching very closely to that of lowland woods. In some places *Rhinanthus Crista-galli* is abundant. *Osmunda regalis* still lingers in obscure spots in spite of the depredations of collectors, and *Polypodium Phegopteris* sometimes occurs as a pure society, clothing extensive areas in sheltered gullies. In some of the woodlands on the lower parts of the moor (Spitchwick for instance) *Melittis Melissophyllum* is quite a remarkable sight in the luxuriance of its growth. Birch must have been comparatively frequent on Dartmoor in the past if one may judge from the frequency of the remains found in the peat deposits, but at the present time it is rarely seen except in some of the lower parts of the moor, as about Yarner and Trendlebear Down, where it forms the well-known association of oak-birch-heath.

Cytisus scoparius is not uncommon in several parts of the moor, as for instances along the banks of the Cherry Brook in the neighbourhood of the old powder mills, and *Rhamnus Frangula* occurs in woodland on the lower slopes of the moor. That "undisputed alien", *Acer Pseudo-platanus*, is planted round farm-steads, presumably as a wind screen. It is now thoroughly at home all over the lower parts of the moor. In fact T. R. Archer Briggs (*Flora of Plymouth*) considered that it was indigenous in the Tavy Valley. It now spreads naturally by means of its winged seeds. On the Pennines it grows at an altitude of 1100 feet, and on Dartmoor at 1200 to 1500 feet.

Spiræa salicifolia has established itself (or been established) in several places, but may be excluded from the flora of the moor.

Juniiperus communis, so frequent on northern moors, appears to be quite absent from Dartmoor. I myself have never seen it on the moor, nor can I find any published record of its having been found there. At first sight this might be thought a striking omission from the moorland flora, especially

as the plant occurs in neighbouring counties, but one has to remember that the juniper is very largely a calcicole plant, and the acid soil of Dartmoor would be inimical to its growth there. Even so, with the present incomplete knowledge of the Dartmoor flora the plant may be existant in some obscure spot.

The aquatic formations of Dartmoor are the rivers and streams flowing off its surface, the mill leats traversing the moor for considerable distances, bog pools, which are not numerous, and the reservoirs supplying water to the large towns near the moors. Dartmoor, unlike similar moors in other parts of the country and in mountainous regions, is practically wanting in small tarns and moor pools with Blanket vegetation. In the quickly flowing streams the flora seems to consist principally of bryophytes and algæ; flowering plants are comparatively rare. *Ranunculus aquatilis*, species of *Potamogeton*, and *Anacharis Alsinastrum* are plentiful in the slowly moving waters of the mine leats. *Menyanthes trifoliata* is occasionally seen in semi-boggy waters. *Ranunculus Lenormandi* is frequent also in the same localities. *Alisma Plantago* occurs in marshy places. The moss *Fontinalis antipyretica* is abundant in some of the old mine leats, and *Hypnum ochraceum* is a prominent feature of the submerged rocks in the Rattlebrook and other rivers of the moor, with the blackish tufts of *Rhacomitrium aciculare*. In clear still pools that occupy the granite basins by the sides of the Teign and Taw the alga *Batrachospermum moniliforme* grows most luxuriantly.

Around the fringe of small moorland ponds, such as may be found on the summit of Standon Hill, a semi-aquatic flora is usually found. *Hippuris vulgaris* has been reported from the moor but requires confirmation. *Viola palustris*, *Hypericum elodes*, *Scutellaria minor*, *Pinguicula lusitanica*, *Hydrocotyle vulgaris*, *Drosera rotundifolia*, *Pedicularis palustris*, and *Anagallis tenella* are all frequent on the moor in wet boggy places usually being accompanied by a dense growth of *Sphagnum plumosum* var. *plumulosum*. *Comarum palustre* has been recorded from the moor, but I myself have never seen it there. In some parts of the moor (Okehampton Hamlets for instance) where springs break through and run down a slope, a luxuriant growth of *Montia fontana* appears, accompanied by *Stellaria uliginosa*, *Poa fluitans*, *Ranunculus hederaceus*, and *Hydrocotyle vulgaris*.

The cryptogamic flora of Dartmoor far exceeds the phanerogamic in number of species, and has attracted the attention of several competent botanists; the lichens, mosses and hepatics have been the subjects of papers and reports by Dr. W. Watson, the late Edward Parfitt, and many who have

collected desultorily on the moor. The number of species of cryptogams given in the *Perambulation of Dartmoor* (660 species) is quite inadequate, the true number being probably more than double the total given there. The algae alone would reach the total given for the entire cryptogamic flora. The species of the Desmidiaceæ collected on the moor by myself total some four hundred, with a few varieties, and I have no reason to regard this as a complete total. The mosses, hepatics and lichens are spread generally over the entire moor, on peaty ground, in the bogs and on rock surfaces. The siliceous-loving species of the genus *Grimmia* are numerous. Some species of mosses make a more dominant feature than others. *Polytrichum commune* often grows luxuriantly in damp peaty spots, though it must be remarked here that when of luxuriant growth *P. juniperum* is often collected for it by unwary botanists. *Rhacomitrium lanuginosum* is, *par excellence*, the moss of the upland area where it forms remarkable tussocks quite unlike the growth of the same species when growing on rock surfaces in the lowland quarters of the moor. *Ceratodon purpureus* is one of the mosses that lends local colour to the moor, occurring in large patches of claret colour. *Campylopus atrovirens* on the other hand attracts attention by the black patches it makes amongst the greener species. *Leucobryum glaucum* is not infrequent in damp places that dry out occasionally. *Splachnum ampullaceum* is a species that seems addicted to places where moor cattle have gathered and left their dung. It grows in profusion on the summit of Standon Hill and around Chat Tor, and as it usually fruits abundantly it forms a very attractive feature in moorland vegetation. *Dicranella squarrosa* occurs profusely in damp shady gullies, as in those of such botanical interest, that run up Standon Hill from the middle of Tavy Cleave. Here it grows luxuriantly, but seems to be always barren. *Bryum roseum* occurs on shady banks in the lower parts of the moor. The fruit is extremely rare and has only been found in three or four places in Britain, according to H. N. Dixon (*Student's Handbook of British Mosses*). On a bank near Lydford one autumn I was fortunate enough to collect some dozen or more fruiting stems, some of them bearing several setæ. *Schistostega osmundacea* was first found in Britain on the northern confines of the moor and is a granite loving species. Although said to be rare generally, it is abundant all over Dartmoor in the rocky crevices of tors and in rabbit burrows. It usually prefers situations facing west or north-west, and a crevice with a plentiful growth of this moss is a very beautiful sight owing to the light reflected by the cells of the protonema. It is uncommon in fruit. At one station on Dartmoor I was fortunate in discovering the gemmæ,

that had only previously been known from North America. These are easily detachable from the plant when it is brushed by a rabbit; adherence to the fur is an obvious method of distribution. *Polytrichum alpinum* occurs rarely on the moor, as at White Horse Hill. The *Sphagnaceæ*, as one would expect, are abundant on the moor, but little that is useful can be said as to the species and varieties owing to the exasperating way in which authorities have multiplied species, varieties, forms and sub-forms. The variety *plumosum* of *Sphagnum cuspidatum* is, as H. N. Dixon says, "a very beautiful form when growing, but it is almost impossible to preserve its delicate feathery appearance when dried." It seems to choose small boggy pools on the higher parts of the moor, and in a small pool near Lints Tor I have seen it growing so luxuriantly that its extremely tenuous stems gave the surface of the pool the appearance of being covered with blanket algæ. *Andræa Rothii* with numerous varieties is one of the features of the rock surfaces.

The fresh-water algæ of Dartmoor may be safely estimated at some thousand species and varieties. The desmid flora alone is extraordinarily rich, some of the bogs yielding two hundred species and over fifty varieties. The total census of species and varieties for the British Isles being 623 species, Dartmoor with 280 species and about 90 varieties must be considered an extremely rich district. One genus (*Tetmemorus*) has the whole of its species represented, and *Euastrum*, most of whose species are amongst the rarest of British desmids, has 67 per cent. of the species occurring on the moor. Professor G. S. West, who collected desmids on Dartmoor describes a bog near Haytor as one of the richest in species he ever collected from, and a bog at the foot of Rippon Tor gave me species of algæ seen in no other bog. It contained *Mougeotia gelatinosa*, one of the rarest species of algæ found in the British Isles. Dr. O. Borge of Stockholm gives its distribution as Finland, Sweden, and Great Britain. Another rare algæ, *Palmodictyon viride*, also occurs in this bog. Dartmoor is one of the three localities in the British Isles in which *Hydrurus foetidus* is known. It is usually found attached to stones in the beds of mountain streams in central Europe and the arctic regions. It seems to have been first found in Britain in the Walkham river by John Ralfs, and in the Meavy by W. S. Hore. Lyngbe states that the odour is so offensive that only an algologist can stand it.

The cryptogamic flora of the moor is especially rich in lichens and has had the attention of Dr. W. Watson, E. Parfitt, Dr. Crombie, and several other well-known lichenologists. Species of *Cladonia* are particularly frequent and *Racodium rupestre* in places covers the entire face of the

granite blocks. The following species are only a few of those that may be found on the surfaces of the tors and granite blocks: *Bæomyces rufus*, *Stereocaulon coralloides*, *Cladonia pyxidata*, *Usnea barbata* (in woods), *Alectoria bicolor*, *Ramalina fastigiata*, *Parmelia saxatilis*, *P. ompholodes*, *Umbilicaria pustulata*, *Lecidea contigua*, *L. geographica*, *L. solediza*.

The diatom flora of Dartmoor bears no comparison with the desmid flora in number of species, though this may be due in some measure to the intensive collecting of the desmids compared with that of the diatoms. The yield of individual stations in number of species is about seventy, which has to be compared with about 230 species of desmids practically from the same stations. As a general statement it may be said that the diatom flora mainly exists in the lower parts of the moor. The peat deposits round Cranmere and the Rattlebrook were collected over with practically negative results, the only species being the typically moorland diatoms, *Frustulia saxonica* and *Tabellaria flocculosa*. In the lower parts of the moor the streams and waters show quite a different state of affairs. They are often packed with diatom growth. One autumn a small watercourse near Postbridge had a dense mat-like growth of diatoms that harboured a congested population of aquatic larvæ. This formed an attractive feeding ground for ducks, which were wading up the stream ravenously consuming the felt-like growth. What have been termed irrorated rocks, that is more or less vertical rock surfaces down which a thin film of water trickles, seem to have quite a prolific diatom population, such rocks in Tavy Cleave and on the East Okement yielding about forty species and varieties. The arctic species *Cocconeis flexella* was obtained from a dripping rock surface on the East Okement.

The sub-fossil diatom flora as contained in some of the Dartmoor peat beds might yield interesting results if examined. A peat bed in the lower part of Taw Marsh had a narrow belt of diatom valves of species that now appear to be extinct on the moor. A pool near Okehampton is of some interest, though it is not actually on the moor. It contained some thirty species of *Navicula* in great profusion and appears to be the parallel of what some algologists have termed "Melosira lakes". Another striking instance of the density of diatom growth was noticed near Sheepstor where a bog on an inclined surface with slowly running water passing through it contained a prodigious population of *Eunotia pectinalis* var. *undulata*. From observed instances like these it is easy to realise the formation of diatom beds found in some parts.

A remarkable similarity exists between the diatom flora of Dartmoor at the present time and that of some geological

beds. Quite recently a sample of diatomaceous earth of Triassic age was sent to me from a deposit in Westmorland and the resemblance to a gathering that could be made to-day on Dartmoor was quite startling. It contained some fifty species, all, with two exceptions, being found to-day in general gatherings on and round Dartmoor.

The casual wanderer on Dartmoor little realises the part cryptogams play in lending colour to the moor. The rivers and streams especially owe to the mosses and algæ adherent to their stones a considerable part of their beauty. The alga *Schizochlamys gelatinosa* often coats the stones in the beds of small streams with a vivid emerald green colour, and the moss *Hypnum ochraceum* gives a beautiful ochraceous colour to the bed of the Rattlebrook and similar small rivers. The Doe stream owes a great deal of its charm to the presence of the hepatic *Scapania dentata*, which thickly covers the stones in its bed with a claret colour. The Sphagna dominate some parts of the moor with their varied colours, ranging from ruby to golden yellow. *Ceratodon purpureus* provides large expanses of brilliant colour here and there on the moor. *Trentepohlia aurea* in some places provides a gorgeous expanse of golden colour, notably in old mine adits. *Campylopus atro-virens* asserts itself, when growing in considerable patches, by its funereal colour.

Zygonium ericetorum, one of the *Conjugatæ*, clothes bare expanses of peat on the higher parts of the moor with claret colour that changes to green in damp weather. The purple or claret colour is due to the development of phycoporphyrin. The sheets of algal filaments spread over the surface of the peat gradually lose their green colour in dry weather, develop phycoporphyrin, and become hard and horny. When such a sheet is stripped from the ground, the peat or soil underneath is seen to be quite damp, so that the roots of any plants underneath the algal sheet are protected from complete evaporation.

In bringing this very inadequate survey of the vegetation of Dartmoor to a close I would plead for a more thorough examination of its flora, both floristically and ecologically. It is a district that should appeal most forcibly to specialists in the various groups of plant life, and at the risk of repeating myself I may say again that Dartmoor still awaits the attention of systematic and intensive study. I do not wish it to be thought that this paper pretends to be in any way an exposition of the ecology of Dartmoor as ecology is understood by its professors at the present time; only team work could produce such a review, and even if such were produced I very much question if the result would be a sympathetic review of the moor's floral life.