British Ecological Society

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Source: *Journal of Ecology*, Vol. 2, No. 2 (Jun., 1914), pp. 98-109

Published by: [British Ecological Society](#)

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98 *Direct effects of Rainfall on Hygrophilous Vegetation*

the intake of root-absorbed, salt-containing water by the intake of leaf-absorbed, salt-free water is the most important effect of rainfall on hygrophilous vegetation.

6. Hydathodes, dripping points and other supposedly adaptational structures in hygrophilous foliage fail to perform the functions which have been attributed to them, and are poorly represented in the Jamaican rain-forest.

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THE DESERT LABORATORY,
TUCSON, ARIZONA.

VEGETATION OF THE WYE GORGE AT SYMONDS YAT

By ELEONORA ARMITAGE

(*With Plate XV and one Figure in the Text*)

INTRODUCTION

The remarkably rich oak-beech association (*Quercus-fagetum*) of the wooded Carboniferous Limestone gorge of the Wye, where this river forms for a short distance the boundary between the counties of Herefordshire and Gloucestershire, and the very distinctive grouping of vegetation which is found in this area, appear to have hitherto escaped the attention of British ecologists, though considerable work has been done on the vegetation of the Carboniferous Limestone in other parts of England—see Tansley (**2**, pp. 49, 146—161) and the literature there

cited, also Moss (1). The richness of the vegetation here may be judged from the facts that nearly all the forest trees and shrubs of the British flora are represented, that the species of vascular plants number about 700, and that of mosses and hepatics there are about 270 species.

The southern portion of Herefordshire which is here dealt with, together with the adjoining part of West Gloucestershire, enjoys a mild equable climate, with no great extremes of temperature, and with a moderate rainfall averaging about 70 cm.—as to the latter it may be noted that South Herefordshire represents an isolated area with a mean rainfall of 60—75 cm. surrounded on all sides by a rainfall of 75—90 cm. The gorge through which the Wye runs (Fig. 13) is on the edge of the Forest of Dean coalfield, our area lying to the north-west of that dealt with recently in this JOURNAL by Tansley and Adamson (3), and the river flows between lofty cliffs of Carboniferous Limestone, of which rock the adjacent wooded

FIG. 13. Map of the Wye Gorge; for further description see Text.

hills—Great and Little Doward (H.¹) and Symonds Yat (W.G.¹)—are composed. The Yat Rock itself is situated in 2° 38' W. and 51° 50·5' N., and the area with which this paper is concerned is about 4 km. (2·5 miles) in length and 0·8 km. (0·5 mile) in width on either side of the river. In addition to the Carboniferous Limestone there is on the W.G. side some Coal Measure Sandstone on the higher parts, and on the H. side a tract of Old Red Sandstone and Conglomerate—the former covers the greater part of Herefordshire. The Wye has deepened the gorge by at least 60 m. since the advent of man in this locality, for there are caves on

¹ “H.” and “W.G.” are used here, and elsewhere in this paper, as contractions for Herefordshire and West Gloucestershire, corresponding respectively to vice-counties 36 and 34 of Watson’s *Topographical Botany*.

Great Doward at that height above the present bed of the river which were hyaena dens and contained bones of bison, mammoth, Irish deer, etc., and were also visited by the cave-bear and cave-lion, while Palaeolithic man left his chipped flints there. The influence of glaciation in the Wye valley is shown by the presence of erratic blocks, some of which occur in the area under consideration.

The accompanying map (Fig. 13) shows the windings of the river and the configuration of the gorge. On the H. side Great Doward (nearly 200 m. high) and Little Doward (210 m.) rise steeply from the river (river-bed about 75 m. above sea-level) with a narrow strip of alluvial meadow here and there—elsewhere the rocky woodland runs right down to the water's edge. The portion of Great Doward facing the river is thickly clothed with woodland to the summit; Little Doward is mostly enclosed as a deer park. On the W.G. side the rocky hill rises directly from the river reaching an elevation of 140 m. at Symonds Yat, and is covered with woodland belonging to the Crown lands of the Forest of Dean.

The soil consists of limestone detritus and is very rocky, and the hills are dry as is natural in a limestone area. On the W.G. side there are only two small streams descending the cliffs and entering the Wye; one of these, the Whippington Brook, rises high up in the High Meadow Woods and runs underground for a considerable distance, emerging again a few hundred metres above the river. On the H. side there is a small bog on the top of an outstanding cliff; this drains over the cliff to the meadow below and has made a tufaceous deposit called the Dropping Well, with a small marsh at its foot whence a streamlet drains into the Wye. The woodland soil is a mild humus. The bold white limestone cliffs, 10 to 30 m. high, which jut out from the hillsides along the course of the river, with very steep wooded slopes between, contribute to form the strikingly picturesque scenery of the gorge; the cliffs themselves are crowned by ancient yews (*Taxus baccata*) and are festooned with ivy (*Hedera Helix*).

THE PLANT ASSOCIATIONS

In the detailed descriptions of the plant associations which follow, the vascular plants will first be considered and then the bryophytes, the latter forming so important a constituent of the vegetation as to require separate treatment; the lichens, though they have been but little investigated, seem to be relatively unimportant. As the plants on both sides of the gorge are practically identical, the lists may be taken as applying to both; in those cases where plants have been found only on one side the fact is indicated by "H." and "W.G." The physical conditions are more diversified on the Doward (H.) side than on that of Symonds Yat (W.G.), hence the plant lists are divided according to the following distinct habitats:—(1) the Great Quarry; (2) limestone wall-tops; (3) summits of cliffs; (4) upper wood above the cliffs; (5) lower wood and screes; (6) bog; (7) Dropping Well Marsh.

General Remarks on the Associations

A notable feature is the co-dominance of oak (*Quercus* spp.) and beech (*Fagus sylvatica*) on the steep slopes of the woods; another is the great rarity of ash (*Fraxinus excelsior*) which is a common constituent of other limestone formations.

As to the oaks, both *Quercus Robur* and *Q. sessiliflora* grow in these woods and have doubtless done so for a long period, as large specimens of the hybrid form *Q. Robur* var. *intermedia* Don are known; it is not possible now to ascertain the original proportion of species before human interference—*Q. sessiliflora* is now the less abundant form, but may be seen clinging to the cliff tops in true “primeval” fashion¹. The Forest area has gone through many vicissitudes both of ownership and of disafforesting and reafforesting, besides the ordinary felling and regeneration. Of the present Crown possessions of over 18,000 acres (7200 hectares) more than 15,000 are woodland, with 4000 acres of land adjoining which is nearly all woodland, so that the Forest of Dean is still—unlike some so-called “forests” in Britain—a forest of trees in the literal sense.

From what has been said regarding the moderate rainfall and the dry substratum, it is not surprising to find that there is a more or less marked tendency to xerophily among the woodland plants—in this connexion *Helleborus foetidus*, *Daphne Laureola*, *Convallaria majalis* and *Scolopendrium vulgare* may be mentioned. Among early-flowering bulbous and rhizomatous herbs are found *Galanthus nivalis*, *Allium ursinum*, *Scilla non-scripta*, *Ranunculus Ficaria* and *Anemone nemorosa*. Saprophytes and parasites are well represented on the humus under the

¹ Great quantities of timber were used for iron smelting, which has been carried on from pre-Roman days, before the coal was discovered—the latter has only been worked for about 700 years. *Q. Robur* was extensively planted for naval use, as owing to its spreading habit and gnarled growth with numerous “crooks” and “knees” it was the kind of timber specially prized by ship-builders. Early in the 19th century there was a great replanting of *Q. Robur*, and the last important fall of naval timber took place in 1853. Some large trees which survived this fall are still standing at Parkend.

It is interesting to note that the straight direction of the branches of *Q. sessiliflora* is due to the fact that the terminal bud of the year’s shoot is much more fully developed than the three or four others which cluster round it; hence in the succeeding spring it takes the lead and thus continues the direction of the previous year’s axis of growth. In *Q. Robur* the terminal bud is very often smaller and less developed than those which surround it; one or more of these therefore takes the lead in producing shoots in the following spring, and their direction forms an angle with that of the last year’s shoot. Where the tree is not vigorous enough to develop more than one such shoot, we get the zigzag branches associated with ancient oaks (Purchas and Ley, *Flora of Herefordshire*, p. 263).

The giant of the Forest is the “Newland Oak,” one of the largest trees in England and probably nearly 1000 years old. Measured around its warped and twisted trunk set with projecting burrs, at 1.5 m. from the ground its girth is over 13 m., while what remains of the bole, which is quite hollow, reaches about 4 m. in height. It is crowned by about a dozen stag-headed branches still alive and bearing their annual crop of leaves. Among other great trees are the “Three Brothers” in Russell’s Wood, sessile oaks with tall great stems; an oak near Parkend is about 6 m. round at 1.5 m. from the ground; “Jack o’ the Yat” is about 7 m. round.

The tallest tree in the Wye Gorge is the great English Elm (*Ulmus campestris*) near the Dropping Well at Doward, about 3.6 m. round and 40 m. high. In the High Meadow Woods just opposite, where larch (*Larix europaea*) has been a good deal planted, there are some fine specimens of this tree. One has a girth of 3 m. at 1.5 m. from the ground and a height of 30 m., while others close by reach a still greater height; there are also some fine oaks here with beech undergrowth. On the eastern side of the Forest, near Flaxley, there are old Spanish chestnut (*Castanea vesca*) woods, with oak (*Quercus* spp.) mixed. Near the Speech House there are very large old hollies (*Ilex Aquifolium*). The modern planting includes Scots pine (*Pinus sylvestris*) and spruce fir (*Picea excelsa*).

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trees—*Monotropa hypopitys*, *Neottia Nidus-avis*, *Melampyrum pratense* and *Lathraea squamaria*.

Detailed Observations on the Associations¹

(1) *The Great Quarry*, with its high vertical reddish-grey face directed eastwards, includes much broken hillocky ground. It was formerly quarried for lime and latterly for road-metal, and is now partly overgrown with a scrub of shrubs and bushes :—

Betula alba	d	Salix caprea	o	Rosa canina	o
Crataegus monogyna	f	S. cinerea	o	Cornus sanguinea	o
Viburnum Lantana	f	Rubus spp.	o	Fraxinus excelsior	o

The ground is covered by a rough stony turf plentifully sprinkled with a large number of flowering plants and mosses (the latter will be dealt with later). The grasses are

Brachypodium sylvaticum	d	Arrhenatherum elatius	f	Briza media	o
Deschampsia caespitosa	sd	Melica nutans	f	Festuca rigida	o
Agropyron repens	sd	Dactylis glomerata	o	F. ovina	o

Other plants growing scattered among the grass (**f** or **o** except where otherwise marked) are

Reseda luteola		Angelica sylvestris		Primula vulgaris	
Viola hirta		Chaerophyllum temulum		Blackstonia perfoliata	
V. sylvestris		Daucus Carota		Centaureum umbellatum	
Polygala vulgaris		Galium Mollugo		Gentiana amarella	r
Arenaria serpyllifolia		Scabiosa arvensis		Cynoglossum officinale	
Linum catharticum		Eupatorium cannabinum		Lithospermum officinale	
Hypericum perforatum		Solidago Virgaurea		Euphrasia Rostkoviana	
H. montanum		Erigeron acris		Rhinanthus Crista-Galli	
Medicago lupulina		Inula squarrosa		Origanum vulgare	
Trifolium pratense		Achillea Millefolium		O. vulgare var. alba	
T. procumbens		Tussilago Farfara		Thymus Serpyllum	
Lotus corniculatus		Senecio Jacobaea		Prunella vulgaris	
Vicia hirsuta		Carlina vulgaris		Bartsia Odontites	
V. sepium		Picris hieracioides		Teucrium Scorodonia	
Lathyrus pratensis		Hieracium sciaphilum		Juncus articulatus	
Fragaria vesca		Leontodon nudicaule		Carex flacca	
Poterium Sanguisorba		Lactuca muralis		Ophrys apifera	r
Pimpinella Saxifraga		Campanula rotundifolia		O. muscifera	r

These are also met with on the Symonds Yat side, and the following occur in similar open rocky places :—

Arabis hirsuta	a	Senecio erucifolius	o	Potentilla argentea	r
Helianthemum Chamaecistus	a	Veronica officinalis	o	Scabiosa Columbaria	r
Serratula tinctoria	f	Verbena officinalis	o	Plantago Coronopus	r
Cardamine impatiens	o	Thymus Chamaedrys	o	Deschampsia flexuosa	r
Erophila verna	o	Rumex Acetosella	o	Avena pubescens	r
Trifolium medium	o	Aira caryophyllaea	o	Sieglingia decumbens	r
Anthyllis vulneraria	o	A. praecox	o	Hutchinsia petraea	vr
Cotyledon Umbilicus	o	Melica montana	o	Koehleria gracilis var. britteniana (H.)	vr
Myosotis versicolor	o	Ornithopus perpusillus	o	Glyceria distans (H.)	vr
		Hippocrepis comosa	r		

¹ Nomenclature of *London Catalogue of British Plants*, 10th Ed. 1908. Signs used : **d**=dominant, **sd**=subdominant, **a**=abundant, **f**=frequent, **o**=occasional, **r**=rare, **vr**=very rare.

(2) *Limestone Wall-tops* :—

Cerastium triviale	f	Hieracium Pilosella	f	Polypodium vulgare	f
Arenaria serpyllifolia	f	Veronica arvensis	f	Geranium columbinum	o
Geranium lucidum	f	Asplenium ruta-muraria	f	Saxifraga tridactylites	vr
Trifolium dubium	f				

(3) *Summits of Cliffs*. The vegetation on these dry sun-exposed rocks may be gauged by the lists taken from one cliff-top on each side of the gorge.

(a) Doward side, about 6 square metres :—

Trees and Shrubs		Herbaceous Plants	
*Taxus baccata	*Tilia platyphyllos ¹	(f or o unless otherwise stated)	
Betula alba	T. cordata ¹	Helianthemum Cha-	Serratula tinctoria
B. tomentosa	Hedera Helix	maecistus	Taraxacum officinale
*Quercus sessiliflora	Ilex Aquifolium	Geranium sanguineum	Origanum vulgare
*Fagus sylvatica	Cornus sanguinea	Pimpinella Saxifraga	Thymus Serpyllum
*Prunus spinosa	*Viburnum Lantana	Spiraea Filipen-	Carex flacca
*Rosa canina	*Fraxinus excelsior	dula	C. digitata
*Pyrus terminalis	*Ligustrum vulgare	Scabiosa succisa	C. humilis (H.)
*P. Aria		Solidago Virgaurea	vr

(b) Top of Symonds Yat :—

Trees and Shrubs		Herbaceous Plants	
All those marked * in above list, and 5 more		Erophila verna	Cotyledon Umbilicus
Euonymus europaeus	Crataegus monogyna	Hutchinsia petraea	Erigeron acre
Rhamnus catharticus	Corylus Avellana	Helianthemum Cha-	Festuca rigida
Rubus sp.		maecistus	

(4) *Upper Wood*. On some of the higher parts of the hill the Carboniferous Limestone has been denuded away and the surface is a broken detritus of Old Red Sandstone and Conglomerate.

Trees forming Canopy		Herbs growing in deep shade		Melampyrum pratense	
Quercus spp (mostly		Brachypodium sylvaticum	d	Stachys officinalis	
Q. Robur)	d	Solidago Virgaurea	f	Teucrium Scorodonia	
		Serratula tinctoria	f	Listera ovata	
Undergrowth of Trees and		Euphorbia amygdaloides	f	Helleborine latifolia	
Shrubs		Monotropa Hypopitys	o	Orchis maculata	
Fagus sylvatica	sd	Lathraea squamaria	o	Habenaria virescens	
Corylus Avellana	sd	Neottia Nidus-avis	o	Carex digitata	
Acer campestre	sd	Carex montana	o	C. pilulifera	
Prunus spinosa	f	C. sylvatica	o	Poa nemoralis	
Pyrus Aria	f	Blechnum Spicant	o	Bromus giganteus	
Crataegus monogyna	f	Pteris aquilina (poor)	o	Athyrium Filix-foemina	
Cornus sanguinea	f	Pyrola minor	vr	Polystichum aculeatum	
Viburnum Lantana	f			P. angulare	
Ligustrum vulgare	f	Herbs in more open places		Lastrea Filix-mas	
Cytisus scoparius	o	(f or o unless otherwise stated)		L. aristata	
Ulex Gallii	o	Polygala vulgaris		Hieracium lasiophyllum	
Calluna vulgaris	o	Hypericum Androsaemum		and var. planifolium	r
Pyrus rupicola	r	Lathyrus montanus		H. pachyphyllum	r
P. cordata (H.)	vr	Rubia peregrina		H. stenolepis	r
		Veronica montana		Cephalanthera longifolia	r
				C. grandiflora	r

¹ The following note is extracted from the *Life of C. C. Babington*, p. 184, date Sept. 10, 1856. "Lingwood, Purchas and I went above on a long range of lofty cliffs on the Great Doward, where we saw *Tilia parviflora* and *T. grandiflora* growing side by side out of the clefts of the rocks, and each apparently equally quite wild."

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(5a) *Lower Wood and Screes below the Cliffs, facing south-east.*

		Herbaceous Plants			
Trees forming Canopy		(o unless otherwise stated)		Hieracium pellucidum	
				H. boreale	
				Lysimachia nemorum	
Fagus sylvatica	d	Mercurialis perennis	d	Atropa Belladonna	
		Scolopendrium vulgare	d	Digitalis purpurea	
Undergrowth of Trees and Shrubs		Anemone nemorosa	sd	Lamium Galeobdolon	
		Ranunculus Ficaria	sd	Galanthus nivalis	
		Asperula odorata	sd	Convallaria majalis	
Fagus sylvatica	sd	Allium ursinum	sd	Scilla non-scripta	
Acer campestre	f	Ranunculus Auricomus		Paris quadrifolia	
Cornus sanguinea	f	Helleborus foetidus		Arum maculatum	
Rubus spp.	f	Aquilegia vulgaris		Hordeum europaeum	r
Hedera Helix	f	Cardamine impatiens		Lomaria Spicant	
Prunus avium	o	Hypericum hirsutum		Polygonatum multiflorum	
Euonymus europaeus	o	Oxalis Acetosella		(W.G.)	r
Lonicera Periclymenum	o	Agrimonia eupatoria		Bromus ramosus	
Ribes Grossularia	o	Circaea lutetiana		Asplenium trichomanes	
Daphne Laureola	o	Sanicula europaea		(on shady rocks)	
		Dipsacus sylvestris		A. Adiantum-nigrum	r
		D. pilosus		Ceterach officinarum (rocks)	r

(5b) *Scrub Association, Symonds Yat.* Before leaving the subject of the lower woodland flora of the Wye Gorge, mention should be made of the plant associations found on the steep slope between the Yat and the river on the W.G. side, where there are no forest trees but only a thick scrub, the aspect being north-west. Beech (*Fagus sylvatica*) is dominant here; *Corylus*, *Cornus* and *Betula* subdominant; with occasional *Pyrus Aria*, *Acer*, *Viburnum Lantana*, *Prunus spinosa*, *Crataegus*, *Rosa* spp., *Rubus* spp., *Ligustrum* and *Clematis Vitalba*; *Fraxinus* and *Euonymus* are rare, while above on the cliffs the rare *Pyrus latifolia* is found.

The herbs, in great part, are those listed under (5a), but the following, though mostly occurring on both sides of the river, are more abundant and conspicuous on the Symonds Yat slopes (a unless otherwise stated):—

Vicia sepium	Deschampsia caespitosa	Helleborine atroviridis	r
Inula squarrosa	Melica montana	Cephalanthera longifolia	r
Senecio erucifolius	M. nutans (=M. uniflora)	Cynoglossum montanum	
Luzula Forsteri	Milium effusum	(W.G.)	vr
L. pilosa	Epilobium angustifolium	Festuca elatior	vr
L. Forsteri x L. pilosa	Erica cinerea (W.G.)	F. sylvatica (W.G.)	vr
(=L. Borreri)	Vaccinium Myrtillus	Brachypodium pinnatum	
L. sylvatica	(W.G.)	(W.G.)	vr
L. multiflora	Verbena officinalis	Hordeum europaeum	vr
Carex digitata			

It is to be feared that all the *Cystopteris fragilis*, *Polypodium Dryopteris* and *P. calcareum*, once plentiful in these woods, have been dug up and that the rarer orchids are likely to share a similar fate.

(6) *Bog.* The little bog on Doward, situated on the summit of a cliff and fed by a small stream from the hill above, shows an interesting vegetation. There is a thinly scattered scrub above the swampy surface in which the dominant plants

are *Betula* and *Alnus*, with occasional *Quercus*, *Fagus*, *Pyrus Aria*, *Ligustrum* and *Viburnum Lantana*, also *Rhamnus Frangula* **r**, and *Viburnum Opulus* **vr**. The herbaceous plants are the following (the sedges and grasses form the greater part of the herbage, the other plants are mostly **o**) :—

Eriophorum latifolium	d	Other plants growing in and around the bog and the streamlet	Mentha aquatica
Phragmites communis	f		Stachys officinalis
Molinia caerulea and var. major	f		Juncus articulatus
Eriophorum angustifolium	o		Triglochin palustre
Carex echinata	o	Rubia peregrina	Pteris aquilina
C. Goodenowii	o	Scabiosa succisa	Equisetum maximum
C. flacca	o	Eupatorium cannabinum	E. palustre
C. pendula	o	Solidago Virgaurea	Chara vulgaris (in streamlet)
C. flava	o	Centaurea nigra	
	o	Calluna vulgaris	

(7) *The Dropping Well Marsh*. This is situated immediately below the bog, at the foot of the cliff. The continual drip of the water over the cliff has caused a considerable accumulation of tufaceous deposit which has broken away into irregular rocky masses; beyond this is the marsh which blends into the narrow strip of alluvial meadowland bordering the river, the water ultimately draining into the river through a short brook. The following grow in and around the marsh :—

Trees and Shrubs (all o)	Herbaceous plants (f or o unless otherwise stated)		
Ulmus campestris	Juncus inflexus	d	Angelica sylvestris
U. montana	J. effusus	d	Eupatorium cannabinum
Fraxinus excelsior	Carex pendula	sd	Pulicaria dysenterica
Fagus sylvatica	Phragmites communis	sd	Senecio aquaticus
Taxus baccata	Holcus lanatus		Cnicus palustris
Alnus glutinosa	Glyceria fluitans		Lysimachia Nummularia
Corylus Avellana	Iris Pseudacorus		Myosotis scorpioides
Sambucus nigra	Caltha palustris		Scrophularia aquatica
Rosa spp.	Geranium Robertianum		Veronica Beccabunga
Rubus spp.	Fragaria vesca		Mentha aquatica
Clematis Vitalba	Potentilla reptans		Lycopus europaeus
	Epilobium parviflorum		Stachys palustris
	Apium nodiflorum		Polygonum Persicaria
			Rumex crispus
			Urtica dioica

The pastures and the river bank vegetation are not dealt with.

BRYOPHYTA OF THE WYE GORGE AT SYMONDS YAT¹

The Bryophyta of the Wye Gorge in the woodlands and on the rocks both of Symonds Yat (W.G.) and of the Great and Little Doward Hills (H.) are so numerous and of such importance among the plant population that they can only be adequately dealt with apart from the Phanerogams. Here they can be treated with greater detail and the various associations can be more clearly defined and enumerated. Exceedingly little attention has been paid hitherto to the Ecology of

¹ The names and order of the Musci are those of the *Census Catalogue of British Mosses*, 1907; and of Hepaticae, the *Census Catalogue of British Hepatics*, 1913.

the British bryophytes. In order that the mosses and hepatics can be easily correlated with the phanerogams in each ecological group, the same topographical divisions are adopted; they are amplified where necessary, and the river moss-flora is included.

The richness of the bryophyte flora in this very restricted area may be realised from the following statistics. Of Musci growing on the Doward Hills there are 229 species and varieties; on the Symonds Yat side from the Coldwell Rocks to the Monmouthshire boundary about 170, including about 20 not found on the right bank of the Wye. Of Hepaticae, 19 species and varieties on the Dowards, and 36 on Symonds Yat, both totalling 38 different forms. The relative dryness of soil and climate militates against a large development of Hepaticae, but these have not yet been worked out so thoroughly as the Musci, so that additions to the lists are likely.

The lists naturally include a large number of woodland species which are developed here in great luxuriance, many of them being rare species, while an unusually large proportion are found fruiting, the rarer examples of this being indicated by “c. fr.” (*cum fructu*) after the name. The woodland Bryophyta are not separated according to tree or ground habitat, as many species vary greatly in this respect, but this is indicated where it is of importance. The rock species are next in dominance and are found both on the steep sides of the cliffs and on exposed rock surfaces and also upon the larger and smaller rock masses which have become detached and have rolled to the lower portions of the woods.

1. **The Great Quarry** (Doward) and other open rocky ground and exposed rocks, both limestone and conglomerate, on Symonds Yat, Buckstone and the Dowards.

Musci:—*Ditrichum flexicaule* f, *Cynodontium Bruntoni* (c. fr., congl.) o, *Dicranella varia* r, *Dicranum fuscescens* (congl.) r, var. *falcifolium* (congl., W.G.) vr, *Fissidens decipiens* (c. fr.) f, *F. taxifolius* a, *Grimmia apocarpa* a, *G. orbicularis* vr, *G. trichophylla* (congl., c. fr.) o, *G. montana* vr, *Racomitrium heterostichum* (congl.) o, var. *alopecurum* (congl.) r, *R. fasciculare* (congl.) r, *Hedwigia ciliata* (congl., H.) r, *Phascum curvicolle* (H.) r, *Pottia recta* r, *P. Starkeana* (H.) vr, *Tortula rigida* (H.) vr, *T. ambigua* (H.) o, *T. aloides* f, *T. Vahlana* (H.) vr, *T. muralis* var. *rupestris* f, *T. subulata* o, *T. mutica* (H., quarry) r, *T. intermedia* (c. fr.) f, *T. ruralis* (H.) r, *Barbula lurida* o, *B. rubella* f, *B. tophacea* o, *B. fallax* a, var. *brevifolia* o, *B. recurvifolia* vr, *B. rigidula* a, *B. vinealis* (H.) r, *B. gracilis* (H.) vr, *Weisia microstoma* (H.) r, *W. crispata* (H.) r, *W. viridula* a, *Trichostomum crispulum* (c. fr.) a, *T. mutabile* o, *T. nitidum* o, *Pleurochaete squarrosa* vr, *Encalypta vulgaris* o, *E. streptocarpa* (H.) a, *Orthotrichum anomalum* var. *saxatile* vr, *O. cupulatum* r, *Funaria calcarea* r, *Bryum pallens* o, *Neckera crispa* var. *falcata* (W.G.) vr, *Pterogonium gracile* (H., congl.) vr, *Cylindrothecium concinnum* (W.G.) r, *Camptothecium sericeum* a, *C. lutescens* (c. fr.) f, *Brachythecium velutinum* var. *condensatum* (H.) vr, *B. plumosum* (H.) vr, *B. purum* (c. fr.) a, *Hypnum stellatum* o, var. *protensum* (c. fr.) o, *H. molluscum* f, *H. cuspidatum* (c. fr.) o, *H. Schreberi* r, *Hylocomium squarrosum* f.

Hepaticae:—*Lunularia cruciata* (rocky bank, W.G.) r, *Frullania Tamarisci* (rocks) r.

2. **Limestone wall-tops**, on both sides of the river.

Musci:—*Polytrichum piliferum* f, *Grimmia pulvinata* a, *Ptychomitrium polyphyllum* r, *Pottia lanceolata* r, *Tortula muralis* a, *Barbula rigidula* f, *B. Hornschuchiana* vr, *B. revoluta* a, *B. convoluta* a, var. *Sardoa* (H.) vr, *B. unguiculata* a, *Encalypta vulgaris* a, *E. streptocarpa* a, *Bryum pendulum* (H.) vr, *B. inclinatum* r, *B. caespiticium* f, *B. capillare* a, *B. murale* (H.) r, *Eurhynchium murale* o.

3. A. **Cliff-tops.** Two characteristic areas were studied in detail.

(a) Limestone point on Great Doward.

Musci:—*Ditrichum flexicaule* var. *densum* (H.) **vr**, *Grimmia apocarpa* (particularly xerophilous form with very long hair-points), *G. pulvinata*, *Tortula intermedia*, *Trichostomum mutabile*, *Bryum provinciale* (c. fr.) **vr**, *Camptothecium sericeum*, *Hypnum stellatum* var. *protensum*, *H. cupressiforme*, *H. molluscum*.

Hepaticae:—*Metzgeria conjugata*, *Plagiochila asplenoides*, *Madotheca laevigata*, *M. platyphylla*, *Lejeunea cavifolia*.

(b) Summit of the Yat Rock.

Musci:—*Fissidens decipiens*, *Tortula muralis*, *T. intermedia*, *Barbula sinuosa*, *Trichostomum nitidum*, *Pleurochaete squarrosa*, *Encalypta vulgaris*, *Orthotrichum anomalum* var. *saxatile*, *O. cupulatum*, *Funaria calcarea*, *B. argenteum*, *Camptothecium sericeum*.

Hepaticae:—*Madotheca platyphylla*.

3. B. **Steep shady limestone rocks** (Doward and Symonds Yat).

Musci:—*Seligeria Doniana* (H.) **vr**, *S. pusilla* (H.) **vr**, *S. acutifolia* var. *longisetia* (H.) **vr**, *S. recurvata* **r**, *Fissidens pusillus* (c. fr.) **r**, *Weisia calcarea* (W.G., fruit rare) **f**, *W. tenuis* (W.G.) **v**, *W. rupestris* (W.G.) **r**, *W. verticillata* (c. fr.) **o**, *Zygodon viridissimus* var. *rupestris* **vr**, *Z. Stirtoni* **r**, *Bryum pyriforme* (H., c. fr.) **vr**, *Neckera crispa* (c. fr.) **f**, *N. complanata* (H., c. fr.) **f**, *Porotrichum alopecurum* (c. fr.) **f**, *Anomodon longifolius* (W.G.) **vr**, *A. viticulosus* (c. fr.) **a**, *Heterocladium heteropterum* var. *fallax* (H.) **vr**, *Orthothecium intricatum* **r**, *Eurhynchium tenellum* (c. fr.) **a**, *E. circinatum* **r**, *Amblystegium Sprucei* **vr**, *A. confervoides* (W.G.) **vr**, *A. compactum* (W.G.) **vr**, *Hypnum chrysophyllum* **r**.

Hepaticae:—*Metzgeria conjugata* **f**, *M. pubescens* **o**, *Scapania aspera* (W.G.) **r**, *Madotheca laevigata* **f**, *M. platyphylla* **o**, *Cololejeunea calcarea* (W.G.) **r**, *C. Rossettiana* **r**, *Lejeunea cavifolia* **o**, var. *heterophylla* (H.) **r**, *Marchesia Mackaii* **o**, *Frullania dilatata* **f**, *F. tamarisci* **o**.

4. **Upper Woods** (partly on limestone, with some Old Red Sandstone in H., and in W.G. some coal-measure sands).

Musci:—*Sphagnum cuspidatum* (in one spot on damp sand, Great Doward, H.) **vr**, *Tetraphis pellucida* (sandstone rocks, H.) **o**, fruiting on stumps (W.G.), *Atrichum undulatum* **a**, var. *minus* **o**, *Polytrichum aloides* **f**, *P. juniperinum* **o**, *P. formosum* **o**, *Pleuroidium subulatum* **o**, *Dicranella heteromalla* (sandstone) **f**, *D. Schreberi* (c. fr., W.G.) **r**, *Dicranoweisia cirrhata* **vr**, *Campylopus flexuosus* **o**, var. *paradoxus* (H.) **vr**, *C. fragilis* (H.) **o**, *C. pyriformis* (c. fr.) **f** (the *Campylopus* spp. only on sandstone and conglomerate), *Dicranum scoparium* **o**, *D. majus* **r**, *Leucobryum glaucum* **o**, *Fissidens exilis* (W.G.) **r**, *F. viridulus* **o**, *F. incurvus* **r**, *F. bryoides* **o**, *Leptodontium flexifolium* (W.G.) **r**, *Weisia mucronata* **vr**, *Funaria ericetorum* **r**, *Aulacomnion androgynum* (W.G.) **r**, *Bartramia pomiformis* (H.) **r**, *Webera nutans* **r**, *Bryum rubens* **vr**, *Mnium undulatum* **f**, *Eurhynchium myosuroides* **f**, *Hypnum cupressiforme* **a**, var. *resupinatum* **o**, var. *filiforme* **f**, var. *minus* (H.) **r**, *H. Patientiae* **o**, *Hylocomium splendens* **o**, *H. loreum* **r**, *H. squarrosum* (fr. rare, W.G.) **o**.

5. **Lower Woods on Limestone, with detached rocks** (Doward and Symonds Yat).

Musci:—*Polytrichum nanum* (W.G.) **r**, *P. juniperinum* **o**, *Dicranella rufescens* (W.G.) **r**, *Tortula marginata* (c. fr.) **r**, *T. laevipila* (on *Ulmus*, H.) **o**, *T. papillosa* (on *Ulmus*, H.) **r**, *Barbula cylindrica* **o**, *Trichostomum tortuosum* (c. fr.) **f**, *T. tenuirostre* (W.G.) **vr**, *Zygodon viridissimus* (on *Ulmus*, H.) **r**, *Orthotrichum tenellum* (on *Ulmus*, H.) **vr**, *O. Lyellii* **o**, *O. diaphanum* **f**, *O. affine* **o**, *Bryum roseum* **vr**, *Mnium rostratum* (c. fr.) **o**, *M. hornum* **a**, *M. stellare* **o**, *Leucodon sciuroides* (trees) **f**, *Homalia trichomanoides* **o**, *Thuidium tamariscinum* (c. fr.) **a**, *T. recognitum* (W.G.) **r**, *T. Philiberti* Limpr.¹ (W.G.) **r**, *Brachythecium glareosum* (fruit rare) **f**, *B. rutabulum* **a**, *B. populeum* **f**, *B. velutinum* **f**, *Eurhynchium piliferum* (fruit very rare, W.G.) **f**, *E. crassinervium*

¹ Not to be confounded with the mountain plant which is *T. Philiberti* var. *pseudo-Tamarisci* Ryan and Hagen (see Dixon, *Journ. Bot.*, June 1913).

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(c. fr.) **f**, *E. praelongum* **a**, var. *Stokesii* **o**, *E. Swartzii* (fr. rare) **a**, *E. abbreviatum* (c. fr.) **o**, *E. pumilum* **r**, *E. striatum* (c. fr.) **a**, *E. striatulum* (fr. rare) **o**, *E. confertum* **f**, *Plagiothecium depressum* (on rocks) **o**, *P. elegans* **r**, *P. denticulatum* **a**, *P. sylvaticum* (c. fr., W.G.) **r**, *Amblystegium serpens* **a**, *Hypnum hispidulum* var. *Somerfeltii* (c. fr.) **f**, *Hylocomium brevirostre* **o**, *H. triquetrum* (fr. rare, W.G.) **a**.

Woodland Hepaticae:—*Riccia sorocarpa* (open spot, Little Doward, H.) **r**, *Reboulia hemisphaerica* (steep slope, W.G.) **r**, *Aneura major* (earth in wood, W.G.) **vr**, *Metzgeria furcata* (on trees) **f**, *Pellia epiphylla* (c. fr., damp soil, W.G.) **r**, *P. Fabbroniana* (damp spots) **o**, forma *furcigera* (steep slope, W.G.) **o**, *Fossombronia pusilla* (damp spot, W.G.) **vr**, *Alicularia scalaris* (sandstone, W.G.) **r**, *Haplozia crenulata* (sandstone, W.G.) **r**, *Lophozia turbinata* **a**, *L. badensis* (W.G.) **r**, *Plagiochila asplenoides* **a**, var. *major* **o**, var. *minor* (H.) **r**, *Lophocolea cuspidata* (logs, W.G.) **o**, *L. heterophylla* (logs, W.G.) **o**, *Cephalozia bicuspidata* **o**, *C. media* (W.G.) **r**, *Calypogeia fissa* (sandstone, W.G.) **r**, *C. arguta* (sandstone, W.G.) **r**, *Trichocolea tomentella* (W.G.) **r**, *Diplophyllum albicans* (c. fr.) **o**, *Scapania nemorosa* (sandstone, W.G.) **r**, *Radula complanata* (trees, W.G.) **o**, *Frullania tamarisci* (trees) **r**, *F. dilatata* (trees) **o**.

6. Doward bog.

Musci:—*Fissidens adiantoides* (c. fr., H.), *Bryum pseudotriquetrum* (H.), *B. bimum* (H.), *Hypnum stellatum*, *H. commutatum* (H.), *H. falcatum* var. *virescens* (H.).

7 a. Dropping Well, Doward (tufaceous rock).

Musci:—*Tortula marginata*, *Barbula spadicea*, *Weisia calcarea*, *W. verticillata* (c. fr.), *Amblystegium filicinum* (c. fr.), *Hypnum commutatum* (c. fr.).

Hepaticae:—*Pellia Fabbroniana* and forma *furcigera*, *Haplozia atrovirens* var. *sphaerocarpoidea* (c. fr., also on damp rocks, W.G.).

7 b. Marsh below the Dropping Well.

Musci:—*Funaria fascicularis* **r**, *Climacium dendroides* **vr**, *Eurhynchium speciosum* **vr**, *Amblystegium varium* **vr**, *A. fluviatile* **vr**, *Hypnum cuspidatum* **f**.

8. **Brookside** (W.G.). The interesting features of the moss-flora here are *Rhacomitrium aciculare*, *Pterygophyllum lucens* (c. fr.), and *Eurhynchium Teesdalei*.

9. The River Banks.

Musci:—*Pleuroidium axillare* (H.) **r**, *Dichodontium pellucidum* **o**, *Pottia truncatula* (H.) **o**, *Tortula subulata* **o**, var. *subinermis* (on willows, W.G.) **r**, *T. mutica* (c. fr., H.) **o**, *Barbula lurida* **f**, *B. Nicholsoni* (W.G.) **r**, *B. sinuosa* (H.) **r**, *Orthotrichum affine* **o**, var. *rivale* (on willows, H.) **o**, *O. rivulare* (H.) **o**, *O. Sprucei* (H.) **r**, *Philonotis fontana* (H.) **r**, *Webera annotina* (W.G.) **r**, *W. carnea* **o**, *W. albicans* **o**, *Bryum Donianum* (H.) **r**, *B. turbinatum* (H.) **vr**, *Mnium cuspidatum* **r**, *M. serratum* (c. fr.) **r**, *M. riparium* (H.) **vr**, *M. punctatum* **o**, *Leskea polycarpa* **f**, *Brachythecium rivulare* **o**.

10. Stones in River.

Musci:—*Fissidens crassipes* **o**, *Grimmia apocarpa* var. *rivularis* (H.) **r**, *Cinclidotus fontinaloides* **o**, *Fontinalis antipyretica* **f**, *Brachythecium caespitosum* **vr**, *Eurhynchium rusciforme* **o**, *Amblystegium fluviatile* **r**, *Hypnum riparium* (c. fr., H.) **o**, *H. palustre* **o**.

LITERATURE REFERRED TO

- (1) **Moss, C. E.** "The Vegetation of the Peak District." London (Cambridge University Press), 1913.
- (2) **Tansley, A. G.** "Types of British Vegetation." London (Cambridge University Press), 1911.
- (3) **Tansley, A. G., and Adamson, R. S.** "Reconnaissance in the Cotteswolds and the Forest of Dean." This JOURNAL, 1, 1913, pp. 81—89.

Phot.

Phot. 1. Wye Gorge, looking down the river.

Mary Lavie

Phot.

Phot. 2. Wye Gorge, view from river, showing the fine elms in the meadow which reach as high as the oaks on the cliff-top, the tallest elm being about 40 m. high; the dropping-well (see Text) is shown on the right.

Mary Lavie

ARMITAGE—VEGETATION OF THE WYE GORGE (see pp. 98—109).

SOURCES OF RECORDS

I. *Phanerogams and Ferns*.—Purchas and Ley, "Flora of Herefordshire," 1889, and subsequent additions; Watkins, "Florula of the Doward Hills," *Trans. Woolhope Club*, 1881; Herbarium E. Armitage, Vice-counties 34 and 36.

II. *Bryophyta*. (1) *Musci*.—Ley, "Moss Flora of the Doward Hills," *Journ. Bot.*, 1891; Herbarium E. Armitage; additional records by C. H. Binstead, H. N. Dixon, and H. H. Knight. (2) *Hepaticae*.—Herbarium E. Armitage; additional records by H. H. Knight.

(N.B.—The Flora of Gloucestershire is not yet published.)

ON NATIONAL AND INTERNATIONAL PROTECTION
OF NATURE¹

BY PROFESSOR H. CONWENTZ

(*With Plates XVI—XVIII and four Figures in the Text*)

I have been requested by Dr Forrer, President of the International Conference, to discuss, primarily, the methods of national protection of nature which have long prevailed in Germany.

CENTRAL INSTITUTE IN BERLIN

In 1906 the Prussian Ministry of Education founded a Central Institute for the Care of Natural Monuments (*Staatliche Stelle für Naturdenkmalpflege in Preussen*), which is at present located in the Old Botanical Museum in Berlin (Fig. 14). This Institute contains seven main rooms, among which there are a library and a hall (Plate XVII) for public lectures and other large meetings, conducted with the aid of lantern slides. Besides the Director of the Institute, there are three Chief Assistants, of whom two are naturalists and one a lawyer; there are also two librarians and two clerks. The Institute disposes of the funds provided by the Prussian Budget and receives, besides, further contributions.

LOCAL COMMITTEES IN PRUSSIA

In order to help the Central Office, committees for the care of natural monuments have been formed in the different provinces, and also in several government districts, land districts and territories. It is intentional that no stereotyped form of society has been inspired, because there already exist countless societies, and a general weariness of this form of activity prevails. In the committees, the various spheres of interest are represented by delegates. To these belong, for instance, representatives of the universities, of the royal government, of the agricultural department and of those of forestry and schools, of the provincial self-administration, of the large towns, of the museums and societies of natural history, of the

¹ An address delivered to the Berne International Conference for the Protection of Nature, November 18, 1913.