theses, says Dr. Barrois, the conditions remind us somewhat of the *Dimetian* proposed by Dr. Hicks for Wales. It is evident, however, that he is more disposed to favour either of the other hypotheses.

Certain mica schists are largely developed in the southern plateau; they alternate with subordinate beds of fine-grained gneiss, amphibolites, chlorite schists, micaceous schists, and interstratified masses of diorites and "gneissites" of eruptive origin. These accessory rocks form, together with the mica schists into which they are injected, long parallel bands from one end to the other of the southern plateau. The "gneissites" include a complete assemblage of acid rocks, remarkable for their gneissic, ribboned, and glandular structure, rich in white mica, and in secondary feldspar, with "granulitic" quartz in elongated grains, in rounded drops, and in thin flakes. These include the rothe-gneiss, augen-gneiss, flaser-gneiss, stengel-gneiss, hälleflintas, and leptynites of the German geologists; as also the rhyolitic felsites, volcanic breccias, hälleflintas, and felsitic tuffs of the English geologists.

Is the injection of the "gneissites" contemporary with the mica schists, or should it be referred to a subsequent epoch? If we accept the first of these hypotheses, the stage so termed may be said to ally itself by its lithological characters to the *Arvonian* of Dr. Hicks. It would seem, however, that in making the (geological) sheets of Lorient and Chateaulin, Dr. Barrois and his coadjutors have adopted another view, by referring the characters of the "gneissites" or "granulites feuilletées" to their consolidation in special "encaissements" under suitable mechanical conditions of depth and pressure, and at an epoch different, but as yet undetermined, from that of the massive granulite of Pontivy.

The schists of Groix constitute a stage of micaceous schists, of chloritic and chloritoid schists, of carbonaceous schists, and of mica schists, especially remarkable for the abundance of the heavy minerals which they contain (staurolite, garnet, magnetite, &c.). The carbonaceous or graphitic schists sometimes referred to the Cambrian would appear to form the base of this stage. The boundary between it and the Cambrian is admitted to be obscure. If this stage, says Dr. Barrois, corresponds to the *Pebidian* of Wales, it is distinguished by its poverty in interstratified basic rocks, which are always of limited extent in Brittany.

Cambrian.—How far these greenish-gray satiny schists, with their beds of quartzite and veins of quartz, correspond to any British Cambrian beds, the author admits is uncertain. Moreover, we would observe that there is no mention here of any bed of conglomerate at the base of the Cambrian. Hence the evidence as to the antiquity of the presumably pre-Cambrian rocks fails in this important particular. The author estimates this stage (Phyllades of Douarnenez) at over 3000 metres. Above these are beds of schist and conglomerate in regular interstratification. The conglomerates are formed of little pebbles of quartz with about 1 per cent. of other stones. They are distinguished from the Silurian conglomerates by the smallness of their component parts, and by their inferior hardness. The equivalents of these beds in the north of the department are fossiliferous, and correspond to the *Paradoxides* beds of la Vega in the Asturias,[1] and to stage C of Barrande. Here then we have our first palæontological horizon in Brittany which would seem to be Menevian.

Silurian.—The lowest stage thus classified consists of red schists, variegated quartzites, and beds of quartzose conglomerate. This is succeeded by the famous "Grès Armoricain," which forms the most salient feature of Menez-Hom and the Black Mountains. It is characterised by *Scolithes*, *Bilobites*, *Lingulæ*, &c., and is the most constant of the fossiliferous beds of Finistère. Barrande's stage D is represented by the slates of Angers with *Calymene tristani*, &c. The three horizons of the third Silurian fauna are with difficulty traced on the north of the Black Mountains.

Devonian.—From a geognostic point of view the schists and quartzites of Plougastel, over 1000 metres in thickness, constitute the most important stage of this system, being largely developed in the roadstead of Brest and forming the northern crest of the Black Mountains. *Homalonotus* sp., *Rhynchonella puilloni*, and *Grammysia davidsoni*, are amongst the few fossils. Above these come beds recalling the Taunusian, Coblenzian, and Eifelian, for the most part fairly fossiliferous. As no higher ones are mentioned, we may presume that the Middle and Upper Devonian are absent.

[1] See *Geological Magazine*, 1883, p. 274.

Carboniferous.—The physical history of Brittany during this period was one of oscillation between terrestrial and marine conditions; it was a period of extensive eruptions and of great earth-movements. Hence a considerable portion of the sediments, especially towards the base, are of volcanic origin. The mass of the formation is comprised in what Dr. Barrois calls the "schists of Châteaulin," an alternation of schists, slates, and sandstones with *Spirifer striatus*, *Strophomena rhomboidalis*, *Phillipsia derbyensis*, and *Productus semireticulatus*: they also contain poor impressions of plants. In some respects this description reminds us of the Culm of Devonshire. This group rests unconformably on the various Devonian beds. The actual Coal-Measures form three small and distinct basins in Finistère of little economic value.

It is interesting to note that the volcanic phenomena in this region are referred to the Carboniferous rather than to the Devonian epoch, and this serves to recall the controversy as to the precise geological age of the rocks in the Brent Tor district—a doubt which is applicable to a large area of Palæozoic rocks lying to the north-west of Dartmoor. Since, in Brittany, the Carboniferous rocks are unconformable to the Devonian, whilst the intermediate deposits consist in many places of porphyritic tuffs, it is evident that the chief deposit of ashes and other volcanic material represent formations intermediate in respect of time. Why may they not in part be Middle and Upper Devonian? To the Carboniferous period also are referred the porphyroid granites of Rostrenan and other places, and the numerous veins of quartz porphyry, which are so apt to follow the synclinal folds of the sedimentary rocks, the prevailing direction being a little to the north of east. The eruptions, according to Dr. Barrois, must have commenced after the Devonian, and continued during the whole of the Lower Carboniferous. The most important development of quartz diorite, which follows the southern foot of the Black Mountains, he regards as posterior to the Devonian and anterior to the Carboniferous.

Lastly, Dr. Barrois speculates on the earth-movements that have helped to fashion the country of Finistère, which may be said to possess a radiate structure in consequence of the numerous flexures undergone by the rocks; the general orientation is east to west, but with a tendency to converge towards west. These directions correspond to axes of a complete series of synclinals and anticlinals. The eruptive rocks of the region have been affected at the same time as the sedimentary rocks, whose foldings they have followed; they made their appearance chiefly at two epochs, during the Archæan (*terrain primitif*) and during the Carboniferous, thus affording two periods of maximum eruptive force. The principal periods of flexing appear to have been five in number, and correspond in the main to the breaks in the great systems already detailed. The fifth and greatest flexure took place after the Upper Coal-Measures: it has left its mark on all the formations, and since that period Finistère has been in a condition of *terra firma*. W. H. H.

TEMPERATURE IN RELATION TO FISH.

THE influence of temperature exerts itself to such a marked degree upon the habits, food, reproduction, and migration of fish, that observations upon the subject are essential in determining the relations of certain forms to their surroundings. The National Fish-Culture Association have for some time past made investigations into the temperature of the ocean, not only at the surface, but also at the bottom, and the Council will shortly publish the results. In order to ascertain its effect upon fish maintained under artificial conditions, Mr. W. August Carter, of that body, has compiled the following statistics, showing the influence of temperature upon fish at the late South Kensington Aquarium, where the average depth of the tanks was 4½ feet. The statistics are derived from observations made daily during a period of three years by noting the temperature of the water in the tanks, and the death-rate prevalent at certain seasons of the year. By observing the degrees of temperature at which certain fish succumbed from time to time, Mr. Carter has drawn an average, showing the temperature adapted to various fish, and their capacity, in some instances, for withstanding extremes of heat and cold.

It must be borne in mind that the temperatures recorded are applicable only to fish in confinement, and living therefore under

unnatural conditions. The temperature registered on the death of the fish named exceeded the highest and lowest degrees given below, which are, as already stated, intended to indicate the temperature of water in which they can be maintained in aquaria.

Marine Fish.

Species.	Temp. ° Fahr. Highest	Lowest	Remarks.
Gurnard	62	49	Highly sensitive
Wrasse	55	50	,, ,,
Dogfish	71	45	Occasionally exist when in 38°
Mullet	70	35	Very hardy
Eels (Conger) ...	70	40	Occasionally at 30°
Bullhead	62	49	Thrives best at 55°
Skate...	70	45	
Sole	62	51	Thrives best at 56°
Flounder	70	35	
Plaice	70	35	
Bream	65	45	Thrives best at 58°
Bass	70	35	
Cod	70	35	Thrives best at 55°
Crayfish	60	45	Cannot exist in extremes
Blennie	58	43	

Fresh-water Fish.

Trout...	71	34	
Perch...	65	43	
Dace	60	44	Occasionally at 32°
Tench (Common)	65	45	
,, (Golden)..	68	45	
Roach	60	50	
Catfish	70	43	Occasionally at 38°
Eels	70	35	
Carp	70	35	
Gudgeon	55	43	
Pike	70	36	
Minnow	55	46	
Chub...	50	40	

It will thus be seen that the dogfish, mullet, conger, skate, flounder, bass, cod, trout, catfish, pike, and carp are extremely hardy, and can exist in both a high and low temperature, ranging from 34° to 71°. On the other hand, the gurnard, wrasse, bullhead, sole, bream, crayfish, blennie, perch, dace, tench, minnow, chub, roach, and gudgeon show themselves sensitive to extremes of temperature.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"On the Tubercular Swellings on the Roots of *Vicia Faba*." By H. Marshall Ward, Fellow of Christ's College, Cambridge, Professor of Botany in the Forestry School, Royal Indian College, Cooper's Hill.

In this paper the author gives a detailed account of his investigations, of which the following is a short abstract.

The curious tubercle-like swellings on the roots of *Vicia* and other Leguminosæ have long been a puzzle to botanists and agriculturists. They have even been described as normal structures by some observers. The general opinion, however, has been that they are not so. Erikssen and Woronin at one time thought they contained Bacteria; Kny and others ascribed them to a Myxomycete; Frank and others had also observed certain extremely minute hyphæ in their tissues; but no one had been able to discover the connexion between the tubercles and a fungus.

By special methods of culture and observations extending over some time, Prof. Marshall Ward has discovered that the tubercles of *Vicia Faba* contain a fungus of a very definite kind, and he exhibited preparations showing the structure of the tubercles and fungus, and the entrance of the infecting hypha into the root-hairs of the plant: this infecting hypha passes down the root-hair and across the cortex, and then breaks up into finer hyphæ, from the ends of which are budded extremely minute germ-like bodies, which Woronin mistook for Bacteria. They are not Bacteria, however, but present more resemblance to the buds discovered by Brefeld in the *Ustilagineæ*.

The author has succeeded in artificially infecting the roots of beans with the fungus, and finds that the minute infecting spores are to be met with in all kinds of soil, so that it is a matter of some difficulty to obtain roots which are not attacked by the fungus. This can be done by burning the soil, and by means of pure water-cultures.

The affinities of the fungus are with the *Ustilagineæ*, and the case is a very remarkable instance of symbiosis.

"On the Structure of the Mucilage Cells of *Blechnum occidentale*, L., and *Osmunda regalis*, L." By Tokutaro Ito, F.L.S., and Walter Gardiner, M.A. Communicated by Prof. M. Foster, Sec. R.S.

The growing point of many ferns is found to be covered with a slimy mucilage, which arises from hairs situated on the palæ and the leaves; this mucilaginous secretion serves a most important physiological function, in that it readily takes up and retains water, and thus keeps the young bud moist, and at the same time it prevents excessive transpiration. The authors investigated two cases of mucilaginous secretion, viz. *Blechnum occidentale*, L., and *Osmunda regalis*, L. They find that the mucilage arises from the protoplasm only, and not from the cell-wall, and that the whole process is distinctly intraprotoplasmic. They point out that the structure of mature mucilaginous gland is wonderfully like that of certain secretory animal cells recently investigated by physiologists; and they find that in the glandular cells of the ferns mucilage is secreted in the form of drops, and that each drop is further differentiated with a ground substance (gum mucilage), in which are embedded numerous spherical droplets (gum).

The secretion commences by the breaking down of a portion of the innermost layers of the endoplasm of a number of contiguous but isolated areas, and the result of these catabolic changes in the protoplasm is the formation of small but rapidly-growing mucilage-drops. The first formation takes place just beneath the free surface, equally around the whole cell cavity, and the phenomenon steadily continues from within outwards, producing new drops basipetally, until the whole of the endoplasm has taken part in the process. The cell is now full of isolated drops, each inclosed by a portion of the delicate protoplasmic framework which still remains. A remarkable sequence of changes occurs in the drops themselves. At their first formation they are watery and by no means well defined; they shortly become denser, and then in the drops themselves a delicate reticulation may be observed, which gives way to the appearance of numerous minute and brightly shining droplets, all separate and distinct. The result of their observations makes the authors disposed to believe that during secretion the protoplasm gives rise to a gummy mucilage, and the latter undergoes further differentiation into a ground substance, which still retains its mucilaginous character, and into a gummy substance which is present as a number of isolated spherical droplets. Excretion takes place by the rupture of the cell-wall, all that remains in the cell being a layer of endoplasm with the disintegrated nucleus.

In the case of animal glands, *e.g.* serous and mucous salivary glands, the state of active secretion is followed by a resting-period, during which the protoplasm grows, forms new hyaline substance, and this again produces new granules. The authors believe that a series of changes essentially similar in character occur in plant-cells also. Usually speaking, plant-cells are incapable of such active and repeated secretion, and in many cases, *e.g. Blechnum* and *Osmunda*, the secretion-changes occur in the cell once and for all, and then the cell dies; in other instances, however, *e.g.* the glands of *Dionæa*, it appears exceedingly probable that the phenomena which accompany the repeated secretion are quite similar to those which happen in so many animal cells. They believe that in their main features the phenomena attending the formation of the secretion are very wide-spread, and limited neither to the ferns nor to the particular case of the secretion of mucilage.

Royal Meteorological Society, June 15.—Mr. W. Ellis, President, in the chair.—The following papers were read:—Amount and distribution of monsoon rainfall in Ceylon generally, with remarks upon the rainfall in Dimbula, by Mr. F. J. Waring. The principal feature in Ceylon as determining both the amount and distribution of rainfall is a group of mountains situate in the