QVAESTIONES NATVRALES. Vol. I. No. 1. 1933.

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BEING

THE PROCEEDINGS OF THE READING AND DISTRICT NATURAL HISTORY SOCIETY.

Vol. I. No. 1. Introductory.

Edited by

P. C. SYLVESTER BRADLEY.

READING, 1933.

Price : Five shillings and sixpence.

PLATE I.

Frontispiece.] A family of young Spotted Flycatchers. [*Photo by F. Vear.*

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POYNDER & SON
GUN ST. READING

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THE READING AND DISTRICT NATURAL HISTORY SOCIETY.

The Society exists especially to promote the study of Natural History in its own district. It holds meetings during the winter months, at which papers on the various branches of Natural History are read; the first gathering of the session, however, is usually a specimen meeting, at which members are expected to exhibit anything of interest, especially when connected with the previous summer's field work. During the summer, field meetings are arranged, permission often being obtained from land-owners to visit private grounds. There is a small library for the use of members.

It is very necessary for the successful working of the Society to increase the membership. The subscriptions have intentionally been kept low, but larger subscriptions or donations would be extremely helpful.

Ordinary Members pay an annual subscription of 5/-, and are entitled to attend all meetings, etc. of the Society, and to borrow books from the Society's library.

Persons under 21 years of age, and any "students" recognised by the committee pay an annual subscription of 2/-. The annual subscriptions for members of the same family are 5/- for the first, and 2/6 for each of the succeeding members.

Any societies, schools, libraries or other organisations may apply for membership. Such an organisation will then be affiliated to the Society, and any *one* representative may receive the privileges as enumerated above. Such affiliated organisations are invited to contribute to QVAESTIONES NATVRALES, and they will receive what help the Society can afford in the furtherance of the study of Nature.

You are particularly asked to register as a subscriber to QVAESTIONES NATVRALES 1934, to make its publication possible.

AN INTRODUCTION.

"The discoveries of Charles Darwin in the middle of the nineteenth century gave a tremendous impetus to the study of species and the classification of animals. . . . Half the zoological world thereupon drifted into museums, and . . . the rest of the zoologists retired into laboratories.

"Meanwhile a vast number of local natural history societies burst into bloom all over Britain, and these bent their energies towards collecting and storing up in museums the local animals and plants. This work was of immense value, as it provided the material for classifying the animals properly. But as time went on, and the groundwork of systematics was covered and consolidated, the collecting instinct went through the various stages that turn a practical and useful activity into a mania. At the present day local natural history societies, however much pleasure they may give to their members, usually perform no scientific function, and in many cases the records which are made are of less value than the paper upon which they are written."

Thus wrote Charles Elton in 1927. How far these remarks apply to our society can be gathered, to some extent, from the history included in this number. The society certainly played a part in the early collecting and recording period, but we are happily particularly free from that disease described as "collecting mania," and most of us take a pride in the diversity of life that is to be found around the town, and make some effort to preserve it. It is the last sentence I want to stress. Do we perform any "scientific function?" More important, *are these records, which this number initiates, to be worth "the paper upon which they are written?"*

Natural History has been passing through a period of depression, and this is due to certain easily traceable causes. Picture, for a moment, the origin of the society—the first meeting. Try to imagine that you are amongst those original members, gathered together in one room, helping to put forward the ideals which were to hold you together as a society for all time. "Encouragement" was to be the chief theme. You thought of those long days in the country that you would spend together, helping each other to piece together the links in the story of life. . . . Then many years passed and many things happened. In 1904 something new began to make itself felt, the desire to specialise. Separate sections were formed within the society—botanical, astronomical and microscopical sections. A change was taking place. It no longer seemed possible to be just a naturalist, one had to be a botanist, or an astronomer—*and that is what has happened.* The ordinary naturalist would be in a poor way were he not able to refer specimens for identification to the specialist; the ideal is, as always, to know "something about everything, and everything about something." It is but few people, however, that have either the time or the inclination to undertake the intensive work that specialisation demands, and maybe this is partly the reason for the present dearth of naturalists.

It is by no means necessary for a naturalist to specialise, and this is a point that is repeatedly evident in this number. Since the early days of collecting and recording, which, after the first rush, lead to the desire for specialisation, there has been developing a new ideal in Natural History. We are now concerned not so much with what the animals and plants are, as with an enquiry into what they are doing, and why they are doing it—this is the new science of ecology.

This number has therefore been designed to give some idea of how such a study of Natural History could be conducted. Everything in the geography of Nature can be traced to the local Geology, and Professor Hawkins has opened with an account of Reading's Geology. Three articles follow which deal with different aspects of this new method in Natural History. The "Calendar of Life" is a symposium of observations in all branches of Natural History made by members. A series of articles then deal shortly with something of what is already known about the local Natural History. Lastly comes an account of the archæology of the district, for few naturalists are not eager to know the history of the earlier human inhabitants, as displayed by objects that they are continually coming across.

Should you read very far into this number, you will become aware of a certain feeling of unrest—there is something *new* that you do not quite understand : something that you may not have read about before. In the following pages an outline of this new science has been drawn. Just as, in the early days of systematic classification, it was the local natural history societies that supplied the material, so now, when science has once more changed its direction, we must help to build the road it is to move along. It will be the ordinary, everyday naturalists that will do this, if only they combine and pull together. It is only possible to get this team work by joining a naturalists' society which is able to publish the results of its work in some generally obtainable form, and it is only by an increase in our membership that we can hope to tackle this work satisfactorily. We hope that all those who have shown their interest by reading the introduction as far as this, but who are not already members of our society, will help the scheme by applying for membership on the form to be found on page vii.

There is a tremendous amount of work to be done ; work that is absorbingly interesting, that takes one out of doors and into the ever healthy countryside ; work that even when only partly accomplished will be of invaluable help in the building of a new science.

THE READING AND DISTRICT NATURAL HISTORY SOCIETY, 1881—1933.

J. L. Hawkins and W. C. Fishlock.

It is very unfortunate that most of the early records of the Society have been lost. We are lucky, however, in still possessing two of our original members, and we are thus able to draw a slight sketch, however vague, of the beginnings of the Society.

The late Dr. J. Stevens, who was afterwards the first Honorary Curator of the Reading Museum, was our first President, and Mr. H. M. Wallis (whom happily we still have with us) was our Honorary Secretary. The Society included in its committee the Rev. J. M. Guilding, then Vicar of St. Laurence, and also Professor Hoffert, his son Dr. Hoffert and Mr. B. J. Austin, who were at that time engaged in teaching in Reading. Mr. O. A. Shrubsole, F.G.S., and I believe Mr. Llewellyn Treacher, were among the early or original members, as well as Messrs. Charles Hewett, W. G. Wellman (sometime Mayor of Reading), H. Harrison Jones, William Holland, Howard Messer, F. W. Leslie, George Philbrick, and P. H. Turner. To Mr. Hewett's father we were indebted for the use of a room in St. Mary's Churchyard, where for many years we held our meetings. Later on, the young Society was considerably strengthened by the accession as members of such men as Drs. Hurry, Joy, Lang and Stansfield, names well known now in the Botanical and Entomological worlds. Although many of the earlier members have since passed off the stage, one cannot help thinking that, considering the numbers still alive, the study and pursuit of Natural History must tend to longevity.

Our first outing was to Theale and, through the water meadows of the Kennet, to Burghfield, where we had been invited to visit the "rabbitry" of the Rev. V. H. Moyle, a member who specialized in the breeding and rearing of rabbits. Our President gave us a short talk on heredity as illustrated by some of the specimens in the collection of these animals, as well as greatly assisted us in the identification of the various wild flowers found *en route.* A whole day excursion was soon attempted, and taking advantage of the August Bank Holiday our Hon. Sec. arranged for one to Bucklebury Common with lunch at the Blade Bone Inn. There is a photograph in existence taken by the late Frank Pollard on that occasion. Being a blazing sunny day the entomologists had the best of it and, under the guidance of Mr. Holland, soon filled their collecting boxes. The only notable " find " of the ornithologists was a pair of young nightjars in the heather on the common. The pre-historic " barrows " which had been opened and investigated a few years before by Prof. Rolleston, Genl. Fox Pitt-Rivers and Mr. Walter Money were visited at the suggestion of members. Dr. J. Stevens gave a short address on the geological features of the district.

We had very modest aspirations in those early days. There were not then, as now, trained workers in almost every branch of Natural History. It was the intention of the Society to cultivate the observation of natural objects in the vicinity of Reading, but it was distinctly pointed out at our meetings that we could not expect to make any very great or new discoveries. The ground, to a large extent, had already been covered by the Newbury District Field Club, some of whose members had catalogued most of the rarer plants. The best that could be hoped for was to discover new localities for the species already listed and to encourage the love of Nature generally. However, in 1900 the Society published, through Messrs. Turner Bros., in book form, a complete list of the plants found in this district as then known. This was undertaken, if memory serves, by Messrs. G. Stanton, F. W. Leslie, and Dr. Stansfield and was so exhaustive that barely half a dozen species have been found since. Although botany has always been a leading feature in the Society's activities, the other branches of Natural History have been well represented, both in the papers read at our indoor meetings and also on the excursions. Our district holds out much encouragement for the entomologist and collectors have from time to time reported the occurence of rare species. Nor have the ornithologists neglected the survey of the Reading area. Quite recently there has been published by the Oxford Ornithological Society an account of the birds occurring on the Reading Manor Farm, undertaken chiefly by members of our Society.

The first written record that we have, at present, of the Society is contained in the Annual Report for 1904-5. This year was obviously one of great activity. A strenuous attempt was made to increase the membership, and the session opened with a "Conversazione." No fewer than fifty-five new members were added to the roll, bringing the total up to 105, the largest that we have any record of. In addition to a full winter programme, the society arranged two lectures jointly with the Literary and Scientific Society, and to two others the members of the College Society "Kosmos" were invited. There was also an attempt to run certain specialised sections within the Society, but some considerable difficulty was found in the working of these sections. It is recorded in this report that "the summer excursions of the Society have been by no means so successful as those of the previous year. There are many of our members who have not participated in our excursions, and we would urge upon such that they are missing opportunities of much enjoyment, instruction, and pleasant intercourse with their fellow members." The year marked the Quarter Centenary of the Society's existence. The Committee decided to celebrate the event in some manner, but had not decided as to the form this should take, and no record of such a celebration remains, if any took place. The report refers to the formation in Reading of a Society to promote the Higher Education of the Working Classes, and states that: "From the first there has always been a strong proportion of working men in our ranks, and among them some of the most ardent naturalists. It is hoped that such will continue to be the case. In any event it may be emphasised that our Society knows nothing of class, sect or party, but desires to unite all those together for mutual incentive and help who have any interest whatever in the study of Nature."

Then came a long period of which there is no further record, and we are left to speculate as to how the energy that was such a noticeable feature of 1904 fared in its task of increasing the Society's interests and activities.

With the coming of the war in 1914 the activities of the Society were greatly curtailed. There was no Annual General Meeting in 1915, and at that of 1916 only twelve were present. In 1916, however, the Society became affiliated to the South Eastern Union of Scientific Societies.

At the Annual General Meeting in 1917 two candidates for the office of President were proposed and seconded, both receiving six votes in the ballot. The meeting was adjourned, and resumed a fortnight later, when Mr. W. E. Butler was elected by a majority vote. Mr. Butler, however, at once resigned, and Dr. F. W. Stansfield was then unanimously elected President. Major de C. Laffan and the Rev. S. O. Ridley joined the Society during this year.

From 1918 onwards there was a steady increase in the membership of the Society, until it reached seventy-nine in 1924.

In 1921 the Society moved its headquarters to the New Hall, Blagrave Street. The report for the year records that "some of our members regret the passing of the easy chairs and couches, but many consider our new room more suitable for practical work." In the June of 1921 the South Eastern Union of Scientific Societies held their Annual Congress in Reading. Most of our members attended the lectures and joined the excursions, of which the most successful was that to Pamber and Silchester. The Society helped in the preparation of a small handbook, which contained a list of the local flora and fauna. Twenty new members were enrolled, bringing the membership to 71. The visit of the South Eastern Union of Scientific Societies evidently brought new members to our Society.

There was some falling off in activity during the year 1924–25, only seven meetings and seven excursions being held. The membership declined, being 62 at the end of the year. For the first time in its history the Society elected a lady, Miss M. E. Edmonds, as its President.

Reference is made to the limited train service in May and June of 1926, owing to strikes, and this affected the summer excursions. The following is extracted from the Annual Report for 1926–27, and it will be noticed that there was at that time a considerable lack of enthusiasm: "A glance through the records of our activities for the past twelve months shows variety, if not encouragement. One thing appears evident, that owing to the busy life of mankind today, meetings and rambles must be reduced in number, and for the past year monthly meetings have been arranged, and even then the attendance has not been very encouraging. Early in the year our place of meeting was changed to the Friends' Institute, Church Street, a pleasant room, if not quite so central as at Blagrave Street Hall. . . One member brought to the Museum last year a specimen of *Epipogium aphyllum*, a very rare plant, and this aroused great interest in Reading and London. The Comma Butterfly has been reported in several places in our district, and one larva found shows that the insect is breeding in our county."

In 1931 the Society suffered a great loss in the decease of Mr. H. A. King, who had been for many years one of the joint secretaries. The year 1931–32 was one of increased activity on the part of the Society. The Society's Jubilee was commemorated at the meeting held on 3rd. March, 1932, when there was an exhibition of very interesting lantern slides and photographs made by the late Mr. H. A. King. The following is extracted from the minutes of the meeting: "In commemoration of the Jubilee of the Society, which was founded in 1881, an interesting series of slides was shown illustrating the Society's outings during past years. Some of the earlier slides caused considerable speculation as to the identity of the various individuals comprising the groups, and it is here that we were glad of the help of Mr. J. L. Hawkins, one of the founders of the Society. The floral displays on some of the ladies' hats were also much admired, though no botanist present attempted to name the specimens." The photographs and slides are now in the Reading Museum.

And that brings us to the present year. Natural History does not appear to have recovered as yet from the shock it received during the Great War. We do not seem to have recovered the enthusiasm that was so apparent in 1904, nearly thirty years ago. However, a very successful exhibition has been held this year in the Art Gallery. It was opened by Alderman F. A. Cox, and well attended by the general public. QVAESTIONES NATVRALES is the first attempt to publish proceedings. The South Eastern Union of Scientific Societies is to hold its Annual Congress in Reading for the second time next year. The tide is turning, turning fast, and the time is not far off when the record of 105 members will be left far behind.

A SKETCH OF THE GEOLOGY OF THE COUNTRY AROUND READING.

Professor H. L. Hawkins, D.Sc., F.G.S.

§ 1. *Introduction.*

The following notes are designed to assist workers in branches of Natural History other than Geology, and in no sense constitute an adequate account of the facts, let alone the theories, involved in the structure and character of the district. They attempt to indicate the general distribution of various types of subsoil in the neighbourhood rather than to explain how or why these came to be where they are. It is hoped that this treatment of the subject may prove of service to botanists and conchologists directly, and to entomologists indirectly, when these workers are considering the ecological aspect of their studies.

The area described is mainly within a radius of 15 miles from Reading, but this circle is " squared " so that the corners are actually more than 20 miles from the Town Hall. Abingdon, High Wycombe, Whitchurch and Guildford are near the corners of the square. Except for a small portion in the extreme south-west (where the upper part of the Test valley enters the square) the area can be described concisely as the district of the Middle Thames and of its tributaries the Kennet and Loddon-Blackwater. The Chilterns and Streatley downs dominate the northern and north-western part of the district, and the fringe of the Hampshire Downs, with Kingsclere and the Hog's Back at the extremities, forms a natural southern boundary.

A straight line running through Marlow, Henley and Newbury serves roughly to divide the area into two characteristic and very different regions. To the north of this line are the Chalk hills, bare on the scarp and beech-covered on the dip-slope ; while to the south of it come the low clay-lands leading to the sandy heaths of Aldershot and Chobham. Although this line is arbitrary and far from clearly defined at any particular point, it is of deep significance. Its course (roughly from North-east to South-west) represents a structural feature widely evident in the British

Isles known as the " Caledonian strike." Essentially it may be taken as an expression of the general " tilt " of the British area towards the South-east ; through most of geological time it has been usual for the north-western part of Britain to rise while the south-eastern part foundered towards the Netherlands.

This generalisation serves to illustrate one of the predominant features of the Reading area. We are (and have been through much of the current era) in the depressed and sinking part of Britain (there is no sinister implication in this statement), and such a region is more likely to acquire new coverings of silt than to lose those already present. Elevated districts come under the scour of the weather, and as they are pushed up the rain and rivers eat ever more deeply into their substance ; but depressed areas are sheltered from most of this destruction, and often act as temporary quarters for the débris from the higher areas on its way to the sea-floor, the ideal home of all rock-matter. This superficial covering of broken rock, dropped by glaciers that melt below the snow-line or by rivers that slacken on the plains, is known as " Drift " : Reading is in a drift-laden area. Over almost half of the area under description, the " solid " rocks are obscured by a veneer of clay-with-flints, gravel or river-silt that is often thick enough to decide the character of the subsoil regardless of the nature of the strata beneath. A comparison between the drift-laden Chilterns with the relatively bare Berkshire Downs illustrates this point ; both chains of hills are made of the same Chalk-strata, but in the former case dense beech-woods flourish on the clay-with-flints, and in the latter few trees can grow on the bare chalk. A comparable illustration can still be seen (though the builders have the matter in hand) in the pine-woods around Earley growing on thick Loddon-gravels that quite neutralise the influence of the London Clay beneath, and give a spurious copy of such truly sandy tracts as Mortimer Common or Crowthorne. Hence a description of the genuine geological structure of the district might often prove misleading to a field-naturalist ; just as the drift is often a baffling mask, hiding the features a geologist longs to see.

One of the most characteristic qualities of the topography of the district is directly connected with the prevalence of drift-deposits. Although the area is by no means devoid of hills, and gradients may locally test one's skill in changing gear, it is usual to find at the top of the climb a wide area as flat as, or flatter than, the valley below. At the top of Whitchurch Hill is the plain of Goring Heath; above the Warren slopes is the table-land of Caversham Heights leading to the dissected plateau of Wyfold and Peppard. South of the Thames, Bucklebury, Greenham and Mortimer commons, Finchampstead Ridges and Hartford Bridge Flats are all on the tops of hills that are quite steep-sided. All of these high plains are covered (and sustained) by stretches of the "Plateau drift:" they are relics of more continuous sheets of gravel now separated by the incision of the existing river-valleys. Along the sides of these valleys comparable areas of flat "terrace-gravel" form shelves at various heights above the flood-plains, notably around Wallingford, Englefield, Marlow, Taplow and Eversley Cross. Usually the "bed-rock" appears at the surface only along the slopes that separate one platform of drift from another, and even there it is apt to be obscured by rubbish dribbled down from the edge of the higher platform.

§ 2. *The Solid Rocks.*

The oldest series of strata to reach the surface in our district is the *Lower Greensand*, a representative of the Lower Cretaceous system. The brown sands and soft sandstones of this series appear in the extreme north-west around Clifden Hampden and Burcot and again in the extreme south-east near Seale and Puttenham. The southerly extension of the latter exposure is responsible for the Hindhead country, but within our chosen limits the development and extent of the deposit is so small that it needs only passing mention. It is uncertain whether the Lower Greensand underlies the whole of our area. It has been proved by deep borings to exist under Winkfield, Maidenhead and Slough; but it is a very patchy deposit, and it would be rash to assume that it would be met with everywhere, even near to its visible outcrop.

With reasonable confidence we can regard the *Gault Clay* (the lower member of what may be called the Middle Cretaceous system) as forming a continuous layer over all of the district excepting the tracts of Lower Greensand. It crops out as a belt about 2½ miles wide between Didcot and Chalgrove, and again as a very narrow band at the foot of the southern slope of the Hog's Back. Its yielding nature has allowed the weather to erode it into a low-lying tract, and most of its northern crop (around Wittenham and Dorchester) is obscured by wide and thick terraces of gravel. In spite of its feeble showing at the surface, the Gault clay has an important subterranean influence, for it is a very impervious stratum (and amply thick to be effective) acting as a water-tight floor to the vast spongy reservoir of the Chalk. Indeed, the line of outcrop of the top of the Gault, with its frequent and reliable springs, determined in no small degree the distribution of early human settlement.

The *Upper Greensand*, which follows directly above the Gault, is by way of being a hill-maker. In the north-west it projects through the mantle of gravel to form the Hadden and Sinodun Hills. Under the Berkshire Downs (from Steventon westward from our district) it forms a prominent line of foot-hills traversed by the Icknield Way. In this area the Upper Greensand is very largely composed of a calcareous sandstone known locally as " Malm," and when dry it can easily be mistaken for Chalk but for its gritty " feel." It is famous as orchard ground, but within our area it has small scope for showing its qualities owing to the drift-cover. South of the Hog's Back the Upper Greensand reappears in a harder and sandier guise, but as a very narrow belt. An interesting additional appearance of it occurs in the heart of the Vale of Kingsclere, where a blister-like wrinkle of the strata has (with the aid of denudation) revealed the upper part of the series. Here it is a truly green sand, often including much chert ; and, true to type, even in this case it constitutes Isle Hill in the middle of the Vale.

Next in order follows the *Chalk* or Upper Cretaceous system. This great formation attains a thickness of about 750 feet locally (it is much thicker both to the north and the south of our area) but it is far from being the monotonous series that might be expected. Without making reference to the subdivision of the system based on a study of its fossil contents, we can find in our district ample justification for recognition of four distinct types of chalk. At the base of the series is the " Chalk Marl " (admirably exposed in the railway cutting between Cholsey and Moulsford). This is a hundred-foot succession of seams of greenish-grey calcareous clay and thin harder bands of impure chalk ; its outcrop is usually marked by the belt of low ground at the foot of the Chalk scarp. Next above the Chalk Marl comes the " Grey Chalk," another hundred feet, but this time of massive scarcely stratified impure chalk that is sometimes sufficiently hard to have been used as a building stone. This division usually forms the lower slope of the Chalk scarp and often sustains a wide shelf. The third division of the Chalk in upward succession is the " White Chalk without Flints " (usually called the Middle Chalk), which is tough and nodular at the base and a normal soft chalk above. This division, which is about 200 feet thick, is mainly shown at the surface on the true scarp-face of the Downs. Its lower hard part may join with the Grey Chalk in producing the first shelf, but most of it is carved into the steepest slopes of the hill-front. It is, in consequence, the least obscured by drift of any part of the Chalk ; but unfortunately it has little economic favour and so is rarely exposed by quarrying. Lastly (in our district) comes the " White Chalk with Flints " (the Upper Chalk), some 300 to 400 feet of fairly pure soft chalk frequently reinforced by seams of siliceous concretion known as Flint. This division is responsible for the greatest area of the chalk country, for it occupies the tops and gently inclined dip-slopes. For this reason, it is the most severely obscured by drift, and, were it not for the deep dry-valleys whose steep sides are washed bare, but little of this great mass would be seen at the surface.

The four sections of the Chalk Formation are not merely different from one another in general texture, but the lines of division between them are absolutely clean-cut. Between the Chalk Marl and Grey Chalk comes a thin bed of slightly sandy hard rock known as the " Totternhoe Stone." Between the Grey Chalk and Middle Chalk occurs a somewhat similar bed called the " Melbourn Rock." Between the Middle and Upper Chalks is found the " Chalk Rock," about five feet of splintery

" road-metal " limestone. In our area the Melbourn Rock is well exposed in a quarry by the roadside between Kingstanding Hill and Cholsey, while the Chalk Rock can be studied in several places. The best Chalk Rock pits at present open are at Lower Basildon, Hartslock Wood, Medmenham and Kingsclere. The Totternhoe Stone is not at present exposed. These " rock-bands " have a great significance in the history of the formation of the Chalk; they represent pauses in its progress, when the sea was temporarily too shallow to permit the continued accumulation of ooze. If we liken such pauses to the intervals between scenes on the stage, we can scarcely be surprised to find that some differences are seen when the curtain rises again.

These changes in the character of the Chalk are trivial by comparison with those that follow. We are turned out of the theatre, and kept out for at least as long as we have been in; and when at last we regain admission we find that the stage has been rebuilt, the artistes changed, and a new type of play put on; almost the only link with the previous performances is that of continuity of management.

Perhaps the best place in which the contrast between the Cretaceous and overlying Eocene strata can be studied at the present time is in the lime and sand pit near Pincent's Farm, Theale. A less extensive exposure can be found at the entrance to the adit of the Warren Row whiting works, under Bowsey Hill near Wargrave. In both of these cuttings (and occasionally elsewhere in the district) we find revealed a bed of water-worn pebbles of flint set in muddy greenish sand resting with surprising suddenness on a planed-off surface of pure white chalk. At Pincent's Farm the top part of the Chalk is riddled by borings (of rather problematical origin) into which the green sand has dribbled; but the line of demarcation between the two series is none the less evident. Patches of large Oyster-shells often occur in or just above this gravelly bed, and layers of peaty matter, or of pipe-clay showing beautiful impressions of the leaves of land-plants, appear locally within a few feet of the top of the Chalk. From the still waters of a fairly deep and very open sea we are translated as in a flash to the muddy tidal currents of a narrow estuary with its salt-marshes. In Norfolk and the Isle of Wight we can watch the continuation of chalk-formation for a matter of another four or five hundred feet over and above the topmost portion preserved in our district; but even there the change to the Eocene phase is none the less sudden. We have to go further south or east on to the Continent to find evidence of the gradual transition from marine to terrestrial conditions: here all records of the change, and a very great amount of the chalk formed before the upheaval began, have been utterly swept away during a long land-period. The weather-worn flints at the base of the Reading Beds alone remain to witness to this protracted episode of destruction.

The *Reading Beds* consist of about 75 feet of sands and mottled clays. Except for the lowest ten feet (already described) they are very variable in character both vertically and horizontally: but on the whole the lower part is sandy and the upper part chiefly clay. The sand-banks (perhaps in some cases dunes) yield excellent building sand, and are worked in several pits around Tilehurst and Calcot. Here and there these sands have been hardened to form massive concretions known as Sarsens (these may also be developed in the Bagshot Sands). The brightly coloured clays provide the raw material of one of Reading's claims to fame, for they can be made into tiles and rough pottery of more than ordinary quality.

The *London Clay*, averaging about 350 feet in thickness, naturally covers a wider area than the Reading Beds; but, except along the middle Loddon valley and around Binfield, almost more of it is hidden under drift than reaches the surface. Its lowest layer is usually a sand or sandstone packed with marine shells; the outcrop of this thin porous layer is often marked by a belt of springy ground. The bulk of the London Clay is stiff and blue; it is much dug for brickmaking (especially in the neighbourhood of Wokingham and Bracknell), and it is locally rich in fossils. The presence of the carbonate-of-lime shells has often led to the formation of concretions of cement-stone generally called Septaria on account of the shrinkage cracks by which they are traversed. Westwards, towards Newbury, the London Clay becomes rapidly thinner and more sandy, and banks of coarse shingle enter into its constitution.

By a gradual increase of sandiness the London Clay passes up into the *Bagshot Sands*, which, succeeded by the clayey interlude of the *Bracklesham Beds* and capped by the pure *Barton Sands*, are responsible for the belt of heath country from Bucklebury and Greenham Commons in the west to Finchampstead, Bagshot, Chobham and Aldershot in the east. These sands are not only the uppermost part of the Eocene system, but are the latest records of " solid " geology in the district. Of the next three periods of Tertiary geological history there is no tangible record; and the " drifts " of Pleistocene and Modern origin are separated from the Barton Sands by an interval at least as long as that between the Reading Beds and the Chalk, and one fraught with even greater significance in world-history.

The crisis of the crustal folding that determined the present distribution of the " solid " rocks in the district occurred during this interval. In the succession of wave-like ripples into which the Alpine " Storm " drove the strata of Southern England, our area occupies the greater part of one of the troughs, limited on the south by the steep and locally broken crest of the Kingsclere—North-Weald ridge. In the hollow of the trough the Eocene deposits have been sheltered from the weather, but on the rising sides (over most of which they must once have been spread) they have either been washed away completely or reduced to outlying relics such as Nettlebed, Russell's Water and Lane End. On the crests of greatest elevation the weather has locally eaten right through the Chalk to expose the lower members of the Cretaceous system.

§ 3. *The Drift Deposits.*

Although, as explained above, the drift exercises a very profound influence on the character of the district, it cannot receive proportionate treatment here. The various kinds of drift-deposits can be described fairly concisely, but any attempt at explanation of their origin and history would be vastly voluminous and eminently controversial. For our present purpose we can adopt a crude but sufficient classification of the drift into four main divisions—the Clay with Flints, the Plateau Gravel, the Terrace Gravel and the Alluvium.

The *Clay with Flints* is restricted to the Chalk areas. It caps practically the whole of the top ridge of the Chilterns and extends most of the way along many of their spurs ; it occurs only in odd scattered patches on the North Hampshire Downs. It is the chief support of the beech-and-bluebell woods of the Chilterns, and provides the anomaly of an almost lime-free soil on hills made of pure limestone. Its mixed composition suggests that it may be either a residue of Eocene and Chalk left stranded and blended by the solution of the latter, or that it is a kind of " boulder-clay " connected with the Lower Pleistocene glaciation. Probably both explanations are true in part ; the former perhaps suffices to account for the patches on the Hampshire Downs while the latter is more in accord with the character of the Chiltern capping.

There is no hard and fast separation between the *Plateau Gravels* and those of the higher river-terraces ; but for convenience one may class the wide spreads of gravel that occur more than 100 feet above the present rivers (that is, chiefly between 400 and 300 feet above the sea in our district) as belonging to the plateau type. These high, " common "-forming spreads can further be classified on a geographical basis. North of the Kennet-Thames they belong to the " Northern Drift," and may be recognized by the inclusion of abundant (often quite large) pebbles of quartzite and other rocks that must have been imported into the area from a distance. South of the Kennet-Thames they are part of the " Southern Drift," composed almost entirely of local materials (Flint and Sarsen) with occasional admixture of material derived from the Weald. By their wide distribution and constant height they must be regarded as the product of some events that preceded the excavation of the existing river-valleys ; they may, like the clay-with-flints, be an expression of the abnormal conditions that must have prevailed along the fringe of the Pleistocene ice-sheet.

The *Terrace Gravels*, which represent the successive phases of maturity and rejuvenation of rivers flowing over a spasmodically rising plain, are chiefly grouped into three stages in this district. The highest and oldest (about 90 feet above present river-levels) is named from Boyn Hill, Maidenhead. The middle terrace (from 30 to 50 feet above river-level) is named from Taplow, while the lowest terrace is but a few feet above the flood-plains. The ingredients of these gravels are much like those of the Plateau spreads, and show much the same differences north and south of the Kennet-Thames. Flint implements of various " Palaeolithic " cultures are found in these terraces (most abundantly in the Maidenhead district) ; but bones are scarce, for the gravels have been fairly thoroughly decalcified by percolating water.

The *Alluvium* may be considered as the current gravel-terrace in process of formation. That of the Thames valley is usually silty and gravelly, and often contains fresh-water shells in abundance. That of the Kennet valley is apt to include thick layers of sedge-peat, in which occasional remains of beaver have been found. It is perhaps helpful towards appreciation of the geological perspective to realize that this modern, and unfinished, deposit represents the entire range of time from early Neolithic days to today, while the Plateau drift and Clay-with-Flints, for all the strange conditions that they imply, are things of yesterday by comparison with the Barton Sands.

PLANT ECOLOGY: A MODERN DEVELOPMENT OF FIELD BOTANY.

Professor J. R. Matthews, M.A., F.R.S.E., F.L.S.

Field botany has long attracted the amateur and professional botanist alike, and to the former especially we owe a great deal of our knowledge of the local distribution of plants throughout the country. Not a few county Floras and local lists of plants are the outcome of field work accomplished by members of Natural History Societies. The value of this kind of work has never been seriously doubted, and it would be unfortunate were such work to be discontinued. Without it the Flora of any area cannot be compiled and there are plenty of districts in the country still lacking a local flora. In recent years, however, the attention of botanists interested in field work has tended to be diverted from purely floristic botany, and increasing regard is being paid to the occurrence and distribution of communities of plants, or units of vegetation as they are called. Plants are gregarious organisms, grouped together in association with one another. Some of the more obvious communities resulting from this association have long been recognised, *e.g.* woodland, heathland, moorland and marsh. Not only do well marked plant communities such as these differ, as a rule, in their floristic composition, but they occupy quite different habitats. The conditions under which plants live in a Beech wood are quite different from those of a marsh, and both differ from the conditions of a heathland. Thus the recognition of different plant communities involves also the recognition of different habitats. The one is intimately bound up with the other, and the understanding of a plant community requires knowledge of its habitat. To the study of plants in relation to their habitat, or the sum total of the environmental conditions under which they exist, the term *plant ecology* is applied. The term *synecology* is frequently used for the study of communities of plants, as distinct from the study of individual species, which is called *autecology*.

Ecology is essentially an outdoor occupation, and it is obvious that the ecologist must be enough of a systematic botanist to know the species with which he is dealing. His problems go much further, however, than the identification and listing of species, since they involve, as already stated, some acquaintance with all the conditions which determine the existence of a particular plant or community of plants in a particular area.

It is well to recognise that the ecological outlook upon plant-life is not altogether new. Some of the older generation of field botanists were ecologists without perhaps being aware of the name. To quote from an old Flora,[1] " The geographical distribution of plants, their characters, habitats, appearance, etc. at different elevations, and the general relation which they bear to the soil, the mineral substances, and general rock formations of the county, or district where they grow, are undoubtedly to be regarded as among the most interesting, as well as important researches connected with the study of Botany." As the writer goes on to remark, however, these views have not been much attended to, and although his words were written more than a hundred years ago, the study of plants along the lines he suggests is actually a comparatively recent development of the older field botany.

As might be expected, the early ecological work in this country was descriptive, like the early phases of the parent science of botany itself. The vegetation covering various parts of Britain was described, and the different plant communities which were then recognised were represented on maps by means of different colours. Much of this early survey formed the basis for the account of British plant communities in *Types of British Vegetation*,[2] published in 1911. Such primary survey is by no means exhausted, and although ecology is rapidly becoming more and more allied to plant physiology, there are still large tracts of the country which remain with their vegetation uncharted. Herein Natural History Societies could do useful work in preparing vegetation maps of their own district. Apart from its scientific interest, such a map may have a very definite value in the economic development of the district. As has been shown recently, regional survey is of the greatest importance in relation to stocktaking of the agricultural and forest resources of the country.[3]

The construction of a vegetation map, covering a reasonably large tract of country, at once focusses the attention of the surveyor upon the plant communities which exist within the region of the survey. In a country like Britain, the question soon arises as to what communities are natural, semi-natural or entirely artificial. As a rule, these questions can readily be answered, and the necessary distinctions drawn. We have to consider, however, the units of vegetation to be shown on the map. For cultivated land these may depend on the scale of the map adopted. For natural and semi-natural vegetation, the largest unit now generally recognised by British ecologists is the plant association. This is usually characterised by one or more dominant species, the life-form or growth-form of which determines its general physiognomy or outward appearance. Deciduous forest, coniferous forest, heathland and grassland are examples of plant associations. In addition to the dominant species, a plant association contains numerous other species which are characteristic of it; the complete list of species gives the floristic composition of the association. For a vegetation map to be of real value, however, it is necessary to show communities which are smaller than the plant association. Units of vegetation which are dominated usually by a single species are called consociations. Examples are provided in our district by the Beech woods of the Chilterns and the heaths of the plateau gravels. Small local communities characterised by one or more subdominant species, occurring within a consociation are called plant societies.

The recognition of plant communities leads to a consideration of their structure. As an individual plant possesses structure, so does a community. To understand the structure of vegetation it becomes necessary to study the different life-forms of the plants which are associated together to form vegetation. The existence of distinct life-forms within a community results in a stratification of the vegetation as a whole, and the different forms play an important part in the inter-relations between the plants themselves and the habitat. Stratification is well illustrated in an oak wood, for example, where commonly four layers can be recognised, (1) the tree layer, (2) the shrub layer, (3) the herb layer and (4) the moss layer. With regard to light and atmospheric humidity it is clear that these several layers exist under quite different conditions. Again, the apparently homogeneous vegetation of a marsh or fen will be found on examination to show stratification related to the grouping together of distinct life-forms. Stratification is not only a feature of the exposed shoots of plants but also of their subterranean organs, owing to the different level reached by roots, rhizomes, etc. The ecologist endeavours, therefore, to consider the life-form of a plant as including the whole plant and not just what appears above ground.

Another aspect of the plant community is its seasonal variation, perhaps best illustrated by the annual cycle of change in the vegetation of a woodland, but noticeable in any community. The seasonal periodicity of the deciduous tree or shrub is familiar to all, but a seasonal change of another kind in a woodland area is the varying aspect throughout the year of the herbaceous carpet of vegetation, a feature which affords numerous opportunities for the study of the habits and behaviour of individual species.

Plant communities on first acquaintance may give the impression of being stable and undergoing little or no change. Indeed, many of them do remain for a very long time in a state of relative equilibrium. Vegetation, however, is never completely static. Change is always going on, sometimes slowly, sometimes rapidly. It is occasionally possible to trace these changes by making observations on one and the same area over a number of years, when it will be found that the plant community which is finally established has passed through various stages of development. Progressive change of this kind is called succession and the final, stablished community to develop, which the climate of the region will permit, is called a climax community. Opportunities for the study of succession are frequently provided in our own district, as, for instance, after a heath or forest fire. The resulting bare area is the initial stage of a series of successive phases, or seral stages, which lead eventually to the climax community. The first plants to colonize the bare area are the pioneers in the succession. They may be lichens and mosses, followed by sparsely distributed flowering plants, which form an open community. Ultimately the area becomes fully populated, all the available space being occupied, and a closed community is formed. The successive stages in the development of vegetation can often be more easily reconstructed than actually followed on a given spot, where the process may take much longer than a lifetime. The zones of vegetation frequently seen round ponds and lakes or along ditches are phases in a succession ending sometimes in an alder-willow thicket on the landward side. In such a case it will be clear that topography plays a part in bringing about succession. Again, on sands and gravels to the south of Reading the establishment of Pinewood may, with some degree of certainty, be traced through successive phases by comparison of the different stages available within a comparatively small area. The study of succession is certainly one of the most interesting branches of ecology. For if a once bare area ultimately supports a closed community of plants, questions inevitably arise as to their source, their means of dispersal, their first establishment and future spread, and their competition for ultimate dominance. Where many of our common plants are concerned, the answer to some of these and other related questions has still to be given. Only when our knowledge of the individual species becomes more complete than it is at present, will it be possible to understand more fully the distribution of plants and plant communities.

Descriptive and morphological work alone, however, will not lead to this desirable end. While it was natural that the early phases of botanical science should have been concerned with morphology and classification it is now fully realised that plants, as living organisms, must be studied along physiological lines. The same is true of plant communities. While we can learn something about their distribution and structure by direct observation, we can learn much more by applying methods of experimentation. It has already been emphasised that plant ecology is the study of plants in relation to the environmental conditions under which they exist. These conditions are termed ecological or habitat factors, and although it is beyond the scope of a short paper to deal with them except very briefly, certain general points have to be noted. Habitat factors may be divided into four groups, (1) climatic, (2) edaphic, (3) topographic and (4) biotic. Climatic factors include rainfall, atmospheric humidity, wind, temperature and light. They determine to a great extent the general character and distribution of the large climax types of vegetation over the earth. In Western Europe and south Britain the climatic conditions are such as to favour the development of deciduous forest as the highest type of plant community, while further north coniferous forest is the natural climax vegetation. Edaphic factors, on the other hand, are those relating to the soil, its physical and chemical constitution, water content, etc. They are exceedingly important in regard to the occurrence and distribution of the smaller plant communities within the large climatic regions. The existence of different consociations and societies within a plant association are usually connected with differences in the edaphic factors. The study of the soil is now a special branch of science, and much of the physiological work which has been done in plant ecology relates to soil factors. It must suffice here to state that the physical nature of the soil, its chemical constitution, the amount of organic material and the amount of water it contains are some of the features which determine the kind of vegetation the soil supports. It has long been known, for example, that natural beechwoods favour extensive areas of the chalk in the south of England, yet so important are the edaphic factors, as suggested by recent work, that relatively small differences in the character of the soil over this area are characterised by different types of beechwood. Topography, as an ecological factor, has an influence on plant growth in so far as it produces local variations in the climatic and edaphic factors. Examples may often be met with on valley slopes, but perhaps the best illustration is obtained in ascending a mountain where the zones of vegetation frequently correspond with the changing climatic factors at different altitudes. Biotic factors arise from the activities of animals, including man, or may be due to the reactions of plants themselves. In a country like Britain which has been so long inhabited by man and his domestic animals, there is good evidence to show that the natural vegetation has been greatly modified by the biotic factor. The grazing of sheep will maintain what may be regarded as permanent natural pasture and prevent the development of forest. The burning of a Calluna heath is commonly followed, at least temporarily, by a dominance of Vaccinium until the heather has had time to re-assert itself. The grazing of rabbits on heath-land may prevent the growth of heather and lead to a dominance of grasses. But man's cultivation of the land is, undoubtedly, the most important cause in modifying the original natural vegetation of the country.

In view of these happenings the ecologist may well ask what was the nature and distribution of the vegetation in any part of the country before the effects of man's occupation became so pronounced. Thus another interesting aspect of ecological work is suggested. Is it possible to reconstruct the vegetation of Britain in early historic and pre-historic times? In broad outline this has been accomplished for certain parts of the country by making a careful examination of the plant remains in peat deposits. In late glacial times (10,000 to 8,000 B.C.) much of the country seems to have supported little more than tundra vegetation with scattered birch trees. This was followed by an extension of the birch to form Birch-heath forest with which Pine was associated. During the Boreal period (7,500 to 5,500 B.C.) when the climate was warm and dry, forests of oak, alder and hazel appeared, the latter apparently being most extensive. Later the hazel forests seem to have degenerated, and were replaced by Pine, which in turn degenerated. During the Atlantic period (5,500 to 3,000 B.C.) when Neolithic culture appeared, the climate was warm and moist, and forests of oak and alder largely took the place of Pine, except in central Scotland where pine forests persisted and remnants of them occur to the present day. A second warm, dry period followed—the sub-boreal—lasting from about 3000 to 1000 B.C., towards the end of which the Beech probably appeared in Britain. During the sub-atlantic period, lasting from about 1000 B.C. to the present time, the climate was again moister and cooler, and the oak, alder and birch have apparently been the dominant trees over extensive parts of the country.

No attempt has been made in this paper to deal with the methods employed in ecological work. My aim has been rather to direct attention to a few of the more interesting aspects of the study of plants as they exist in the field. To some, the study of a plant community may make an appeal, to others, the ecology of an individual species may prove more attractive. There is ample scope for work along both lines, and the methods to be employed will vary according to the particular problem it is desired to investigate. Reference should be made to the appropriate books on the subject. Professor Tansley's *Practical Plant Ecology*[4] will be found useful and suggestive, and it contains, moreover, a list of books and papers dealing with British vegetation up to the time of its publication. During the last twenty years much of the ecological work done in this country has been published in the *Journal of Ecology* the official publication of the British Ecological Society, membership of which is open to all who are interested in Ecology.

References.

1 JOHNSTON, G. : Flora of Berwick on Tweed, 1829.

2 TANSLEY, A. G., (Edit.): Types of British Vegetation. *Cambridge*, 1911.

3 BOURNE, RAY : Regional Survey and its relation to stocktaking of the agricultural and forest resources of the British Empire. *Oxford Forestry Memoirs, Number* 13, 1931.

The memoir, beautifully illustrated by air photographs, covers portions of the Chiltern Hills, the London Basin and Bagshot Heaths, and is of special interest, therefore, in connection with survey work which has Reading as a centre.

4 TANSLEY, A. G.: Practical Plant Ecology. *Allen & Unwin*, 1923.

ANIMAL ECOLOGY: THE STUDY OF LIFE IN NATURE.[1]

P. C. Sylvester Bradley.

If you go out on to the Malvern Hills in July you will find some of the hot limestone pastures covered with ant-hills made by a little yellow ant (*Acanthomyops flavus*). This ant, itself forming highly organised colonies, is the centre of a closely knit community of other animals. You may find green woodpeckers digging great holes in the ant-hills, in order to secure the ants and their pupæ. If you run up quickly to one of these places, from which a woodpecker has been disturbed, you may find that a robber ant (*Myrmica scabrinodis*) has seized the opportunity to carry off one of the pupæ left behind by the yellow ants in their flight. The latter with unending labour keep building up the hills with new soil, and on this soil there grows a special set of plants. Wild thyme (*Thymus serpyllum*) is particularly common there, and its flowers are visited by a bumble bee (*Bombus lapidarius*). Rabbits, in common with many other mammals, have the peculiar habit of depositing their dung on some low hummock, and they often use ant-hills for this purpose, thus providing humus, and in some measure repairing the damage done by the woodpeckers. They detest wild thyme as a food, but the larvæ of the moth *Pempelia subornatella* make silken tubes among its roots. Then there is a great army of hangers-on, guests, and parasites in the nests themselves; and so the story could be continued indefinitely, but even this slight sketch enables one to get some idea of the complexity of animal inter-relations in a small area.[1]

It is clear that animals are organised into a complex society, as complex and as fascinating to study as our own. It is for such an investigation that the scientific term " ecology " has been coined.

Men have studied animals in their natural surroundings for thousands of years—ever since the first men started to catch

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[1] This article has been derived entirely from the book " Animal Ecology " by Charles Elton, and large passages have been quoted with little alteration.

animals for food and clothing, but it was not until after the time of Charles Darwin that the subject developed into a science. The immediate difficulty that arose was due to the fact that before the study of the animals themselves could be attempted, there had to be a complete knowledge of the details of their surroundings. And so, since that time, the science of Plant Ecology has been developing. It has only just reached a state of rather insecure maturity, but there is now enough data on which to found a new science—Animal Ecology. Mr. Elton was the first Englishman to realise this, and with an enormous amount of energy he has built up a framework. I have attempted here to give this a birds' eye view, but if we are to build our facts on to it, it would be very much more satisfactory to gain a more intimate knowledge, and a list of Mr. Elton's works is appended at the end of this paper. (See [1] [2] and [3]).

" Ecology is destined to a great future. The more advanced governments of the world, among which, I am happy to say, our own is coming to be reckoned, are waking up to the fact that the future of plant and animal industry, especially in the tropics, depends upon a proper application of scientific knowledge. . . . The discovery of the tubercle bacillus has not led to the eradication of tuberculosis : indeed it looks much more likely that this will be effected through hygienic reform than through bacteriological knowledge. In precisely the same way it may often be found that an insect pest is damaging a crop ; yet that the only satisfactory way of growing a better crop is not to attempt the direct eradication of the insect, but to adopt improved methods of agriculture, or to breed resistant strains of the crop plant. . . . The tropical entomologist or mycologist or weed-controller will only be fulfilling his functions properly if he is first and foremost an ecologist." [1a]

It is a great stimulant in ecological work to have some idea of the value that the final accomplishment will attain. It may throw a light on one of the major theories of biology (e.g. evolution[2]), or solve some economic problem, or provide material for a theory of your own. In any case it is always wise to assume that the final results will be published, for it is a great help in clarifying your own ideas to write up the records so that others can understand them.

It is very important, if your results are to be of any practical use to others, to state clearly the species of every animal and plant that is met with. It is obviously quite impossible for a naturalist to know every species in every branch of the animal kingdom, let alone the plants. The best plan is to take the various specialists into the field to do the actual identification for you, or alternatively, to collect the material and send it to experts. It is much more sensible to get animals and plants identified properly by a man who knows them well, than to attain a fallacious sense of independence by working them out oneself—wrong. Naturalists in the field will have to co-operate on a large scale with experts in museums and universities.

Each different habitat has living in it a distinctive and characteristic animal community, which forms a closely-knit society comparable to our own. Were it not for the fact that no animal can stand up to the wide range of environmental conditions which exist in the world, we might expect the world to be peopled with one general type of animal population. As it is, however, specialisation is the prevailing tendency of all evolution, and the greater its extent, the narrower does the range of environmental conditions become. The range of different animal habitats can be visualised when one considers first the animals living at the poles of the earth, and then those at the other end of the scale, in the equatorial rain forests. In the far north vegetation is very sparse, but as we go south it gradually becomes more luxuriant. It is clear that this vegetation will have a very marked effect on the animals. The boundaries of plant communities tend to be rather sharply defined, and as each community carries with it a special set of "climatic" conditions for the animals living in it, the boundaries will be reflected to a certain extent amongst the animals. Consequently, in any extensive ecological survey of a district, the distribution of the animals will be largely influenced by that of the plants, which are much more easily mapped over large areas. In the Reading district there would be no necessity for a separate primary survey of the animals.

The most interesting and most satisfactory thing to do is to choose some fairly small area and make an intensive study of the life in it. In practice it is found that there are three ecological types in an animal community. Firstly, the type that is "*exclusive*" to its plant community. Those plant parasites that attack only one species must necessarily be exclusive. An example of an exclusive mammal is found in the common grass-mouse (*Microtus agrestis*), which only in years of exceptional over population leaves its underground habitat in grassland. Then there are the "*characteristic*" species, which occur in particular abundance in some one zone, but are not exclusively confined to it. The long-tailed mouse (*Apodemus sylvaticus*) is characteristic of woods, but is not confined to them. And thirdly there are those species that are neither exclusive nor characteristic. Many common and important species come in more than one zone. Thus the common bank vole (*Evotomys glareolus*) occurs in woodland and wood margin, in shrub communities and young plantations.

Of course, there are many other factors that influence the distribution of animal communities besides the effect of plants. To take an example, there is the influence of salt on the aquatic fauna. Some animals are only found in water quite free from salt, others characterise brackish water, and the vast majority are exclusive to the sea. Again, animal communities can be subdivided—e.g. an oakwood community could be divided into tree-top, tree-trunk, lower vegetation, ground surface and underground habitats, each with a distinctive animal community. The amount of subdivision that one employs before reaching the unit will depend on the size of the investigation. The term " animal community " is very elastic.

In ecology, then, we are concerned with *what animals do* as living animals, and not as dead specimens. We also have to find out *why* they do these things, and why they *don't* do certain other things. It is quite clear that an animal is influenced by many factors other than its own caprice, and those influences that control its whereabouts (i.e. the *environmental factors*) come within the scope of a great many sciences, such as physics, chemistry, meteorology, astronomy, psychology, geology, etc. The ecologist cannot be a specialist, and he must have a slight knowledge of all these subjects, even if only a knowledge of whom to ask or where to look up the information that is required.

Animals are nearly always prevented from occupying neighbouring habitats by one or two factors only. Crayfish would be able to live successfully in many rivers where they are not found at present, were it not for the one fact that they have to inhabit water with a definite amount of dissolved calcium carbonate from which to build their shells.[4] An animal is, then, only prevented from extending its habitat by the things at which it is least efficient, and if the disabilities are removed it can at once occupy a new range of habitat.

It is often difficult to determine the *real* limiting factor, but the discovery of a definite limit in the habitat of some animal is of great value. For instance, the spider *Leptyphantes sobrius* is found in a great variety of situations—high up on mountain sides, in lowlands or on the seashore, and it does not seem to be associated with any particular animal or plant, yet it has been found that this spider is invariably found in loose patches of stones. The actual limiting factor has not been discovered, but it must be correlated with this habitat.

Further examples of the action of limiting factors are far too numerous to include here, but the naturalist cannot fail to discover them for himself when doing any ecological work in the field. Perhaps enough has been said here to show that such an enquiry into the behaviour of animals forms one of the most interesting aspects of Natural History.

Once having decided to examine the life on a chosen area, the first thing to do is to have a look round and get an idea of the main habitats that exist, and in particular of the main plant associations. After having obtained a general idea of the big habitats, come down to details, and subdivide these into smaller areas or zones. This listing of habitats does not take very long and gives you a very accurate idea of the exact conditions under which the animals are living. All this while you will, of course, have been making as many observations on the animal life as you can. It is vitally important to make as full notes as possible on the animals, especially with regard to their exact habitat, their food-habits, and their numbers.

Most of the time that an animal spends while it is awake is spent on eating. The whole activity of an animal is dependent on its method of feeding. The basic food of all animals consists of plants, for plants are alone capable of utilising the carbon dioxide gas in the air for the synthesis of edible matter. Consequently herbivores form the basic class of animal society. These are preyed upon by carnivores, which are again eaten by larger carnivores, and so on. We get a string or chain of animals, the one feeding upon the other. The last link of this *food chain* is a herbivore, which feeds on plants. All the food chains in a community form a *food cycle*. Starting from herbivorous animals of various sizes there are, as a rule, a number of food chains radiating outwards in which the carnivores become larger and larger, and the parasites smaller and smaller. The most interesting way to work out a food cycle is to start with one particular species and radiate outwards along its various connections with other animals and follow the train of associations wherever it leads. This method lays bare a host of interesting facts and ideas, and helps to give a very good idea of the real social life of the community under investigation.

The question of the numbers of animals is very interesting and very important. It is obvious that a species of animal is largely limited in numbers by the scarcity of the food supply. At the same time, if there are too few, the species might be completely exterminated by, say, the outbreak of some epidemic. There is therefore a certain optimum number for each species; there is a tendency for all animals to strike a mean between being too scarce and too abundant. It is, however, very seldom that actual starvation limits the numbers of animals—other factors come in long before that. It will be seen that, from the very existence of food chains, all species except those at the end of a chain are preyed upon by some other animals. It is therefore found that, although the *size* of the animals in a chain becomes larger as we progress from herbivore to the largest carnivore, the *numbers* of the animals are graded in the opposite direction, since the smaller animals not only have to support a series of larger ones, but have to maintain a surplus for the continuation of their own species; otherwise they would soon become extinct. The animals at the end of the chains have no such check, and special methods of regulation are apparent. One of the most interesting of such methods is the system of territories, commonly found among birds,[5] and best known in the case of the robin.

The numbers of animals are, however, by no means constant. Periodic fluctuations are always taking place in some species, and these at once affect others in the same community. Rodents are particularly liable to a sudden enormous increase, and mouse plagues have frequently been recorded.

The whole question of numbers is very complicated, and incompletely worked out. Naturalists are very liable to record that "such and such a species is much more abundant than usual," a statement that is quite valueless on account of the vague sense of "usual." It is very difficult to collect accurate information, but the best method is to record the relation of the numbers of a species to those of the year before. A continuous record is then obtained.

The aspects of ecological succession in plants have already been discussed elsewhere. The fact that a similar succession occurs with animal communities can be illustrated by taking a very simple example. A hole in a beech tree was used as a nesting place by an owl, but as the tissues of the tree grew round it, it became too small, and the owl was replaced by a pair of starlings. Still later it became too small to accommodate even starlings, and they were succeeded by a colony of wasps; and finally the hole completely closed up.

The natural climax of plant succession is usually forest, but *biotic factors* (i.e. conditions caused by animals) sometimes prevent the real climax being reached. A portion of heather moor in the New Forest was fenced off for a number of years, and colonisation was immediately started by young birches and pines. The growth of the seedlings was prevented before by the grazing of ponies and cattle, and, in the absence of trees, a heather moor developed, and formed a *sub-climax*. The animals that control vegetation by grazing are usually cattle, sheep, horses, rabbits, or even mice.

Ritchie[6] records an interesting example of succession. In 1892 a few pairs of black headed gulls (*Larus ridibundus*) arrived at a heather moor locality in Scotland, ordinarily peopled with the red grouse (*Lagopus scoticus*). These gulls were protected by the owner, and they increased prodigiously, until in fifteen years there were well over 3,000 birds nesting. The occupation of the ground by gulls, with its accompanying manuring and trampling of the soil, caused the heather to disappear gradually and give way to coarse grass. The grass was then largely replaced by rushes, and the latter ultimately by a mass of docks. At the same time pools of water formed amongst the vegetation and attracted numbers of teal (*Anas crecca*). The grouse meanwhile had vanished. Then protection of the gulls ceased, and their numbers began to decrease again, until in 1917 there were less than sixty gulls nesting, the teal had practically disappeared, and the grouse were beginning to return. In fact, with the cessation of " gull action " on the ground, the place gradually returned to its original state as a heather moor. There must have been a huge number of similar changes among the lower animals which also would be profoundly affected by the succession of the vegetation.

Very few cases of succession have been worked out satisfactorily and little is known about the factors that cause the changes. It is well known that the grey squirrel is fast replacing the red squirrel in many districts, but nobody knows why or how this is occurring.*

Finally, the intimate way in which plants and animals are bound up together cannot be emphasised too much. The grazing factor has already been mentioned, and is of enormous importance. The true ecologist is neither botanist nor zoologist—he is both, and more besides : he is a naturalist.

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* In connection with this question it may interest members to hear that both grey and red squirrels are found at Mortimer. A gamekeeper there told me that he had seen the grey squirrels actually fighting and killing the red. This question might well be further investigated. P.C.S.B.

I have but attempted to give a slight sketch of a new and very fascinating subject as it is set out in Mr. Elton's book, which deals with the science in great detail. I have to thank Mr. Elton for permission to précis a work that must have taken an enormous amount of time to compile, and apologise for the many shortcomings that are the inevitable result of attempting to condense such an immense subject into such a small space, when both the author and his public are new to the science. If anyone has found even a little that interests, I would heartily commend him to sample the original. Finally, I hope that Mr. Elton himself will, in our next number, be able to correct any false impressions that I may have given.

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PHENOLOGY: NATURAL HISTORY BY SEASONS.

R. P. Libbey.

To be familiar with the sights and sounds of the countryside, to know every variety of insect or flower that occurs in the neighbourhood, and to be able to recognise the birds by their song is a happy ideal. It helps the particular person concerned by training his reasoning faculties and powers of observation, and gives him health and strength due to his out-of-door life, but what good can it do to the general public, and how can it further our knowledge of the secrets of nature?

There are numerous problems relating to Nature Study waiting to be solved. What birds, although they appear to be injurious by eating the fruits of our gardens, are really to be regarded as friends, on account of their depredation upon insects? Of our medicinal plants, what are the best conditions under which they should be grown to be of the most economic use? Can we destroy all the insects in the garden without first considering which of them keep in check other, and worse, pests, and which form valuable food for our feathered friends? These are some of the many problems awaiting further investigation and solution.

Climatic conditions, too, have a very important bearing upon our plants and animals. Rain, sunshine, temperature, relative dryness and dampness, all have a marked influence upon the fauna and flora of our own country. If some climatic condition affects the occurrence of insects it must surely affect the distribution of birds feeding upon these insects. And it is this connection—*the relationship between climate and life*—that we are principally concerned with here.

As a typical example of the effect of weather suppose we take the case of a very cold winter with little rain, which kills off numerous insects. This might deprive certain insect-eating birds of their food supply, with the result that many would die of starvation leaving but a few birds to breed in the summer. This would mean that the summer insects would be present in enormous numbers, and if there were not enough birds to prey on them, great loss to our plants and crops would be sustained.

From this example alone we see that the relationship between climate and life is one of great practical and economic importance. Climate, especially in our own country, varies over comparatively small areas, not only from year to year, but even from day to day. Some years may be outstandingly wet, while others may be relatively hot and dry, and all these variations have a direct influence upon life, both animal and plant, which may be felt over considerable periods to follow. To this relationship between climate and life the term *phenology* has been given, the word being derived from the same source as " phenomenon."

Let us now consider some of the more important effects climate has upon life. Elton in his book *Animal Ecology*[1] describes how the gerbille, one of the commonest rodents of the South African veld, lives in sandy warrens. Quite often it makes a network of burrows in places already occupied by two species of carnivorous animals, the yellow mongoose and the suricat; but, although the rodents and the carnivores live in close contact with one another, actually using to some extent the same system of underground runways, they do not usually clash in anyway in their activities, for while the gerbilles come out exclusively at night, the mongooses and suricats feed only during the day. It is only when the gerbilles are smitten with an epidemic of some disease like plague, at which times they wander out of their burrows in the daytime, that they are attacked and eaten by the mongoose. This fact has a practical importance, since the South African plague investigator is able, by examining the excreta of the mongoose, to find out with tolerable certainty whether the gerbilles have been dying of plague, a fact which is rather difficult to establish easily in any other way. If the mongoose excreta contains any gerbille fur, then there is strong evidence of epidemic amongst the latter. In this case day and night have the effect of separating almost completely two animals which live in the same place, and the results have an important practical bearing.

In the same way, flowers that are adapted in their pollination to moths which fly about at night remain open at that time, and are of a light colour so as to be easily visible in the darkness. An example of this is the common White Campion.

Apart from these regular changes from day to night, there are, of course, many irregular fluctuations in the weather, all of which have their particular effect upon the animal or plant concerned. A cloud which momentarily obliterates the sun will cause a change in the movement of insects. An ant-hill, for instance, which in the sunlight swarms with ants running to and fro with restless energy, will, in the shade, be transformed into a mound covered with ants moving slowly about, as if they were overcome with their loads of sticks and cocoons. With many animals the coming of nightfall has precisely the same effect as a cloud passing over the sun, but the stoppage of work is longer and may require the taking of more elaborate precautions. Rooks frequently build their nests at some distance from where they normally live, going to and from their nests every morning and evening, and should the skies become blackened due to an impending storm they often return home thinking that nightfall has arrived.

In woods the separation of animals into day and night species can very easily be studied. In an English Oak wood, for example, during the daytime there would be such birds as sparrowhawks, thrushes, blackbirds, woodpeckers, and also weasels, voles, butterflies, bees and ants, while during the night there would be owls, nightjars, bats, moths, and long-tailed mice. Almost every kind of animal present during the day is replaced by another at night-time, and so are the various food chains. The weasel-vole industry of the day is replaced by the owl-woodmouse, but the woodpecker-ant connection has no equivalent at night, while the nightjar-moth connection is almost unrepresented by day. In fact, one food cycle is switched off and another starts up to take its place.

A careful study of the changes in external conditions during the day and night, with reference to corresponding changes in the activities of the animals, is badly needed. As Elton says, " It is remarkable to reflect that no one really knows why rabbits come out to feed only at certain times, and at different times on different days. Weather and diurnal changes are no doubt partly responsible, but there our knowledge ends. Yet rabbits are common animals, and of great practical importance."

In taking meteorological observations of the conditions under which animals and plants live, great care is necessary in the case of the former. Meteorological instruments are usually placed at about four feet from the level of the ground, and these observations will obviously not be correct for all the animals concerned in the vicinity. Insects living among the humus on the floor of the wood will be subject to quite different conditions from birds up in the trees as regards temperature and humidity, whereas the conditions outside will be different again.

Changes in weather, accompanied by changes in temperature and humidity of the air, have important effects upon animals and plants. Many species are restricted in their activity to certain types of weather. Mammals, for instance, try and avoid damp weather for it wets their fur and destroys the layer of warm air round their bodies, making them more susceptible to cold. The badger has to lie in the sun to dry his coat if he gets wet, and mice tend to stay under cover if it is raining. Birds are not affected so much by rain, as the arrangement of their feathers allows the water to run off, but insects, on the other hand have to be very careful lest they get their wings wet, or become affected by the fall in temperature so often associated with rain. Some animals, however, only come out when it is wet. Slugs form a good example of this class of animal. This does not apply to all slugs for there are some species which always live in damp places, as under vegetation; but it holds good for certain of the larger types of slug. It is a well known fact that the gardener will go out in the evening in search of slugs when the weather is damp, or after it has been raining; at the same time, it should be noted here that slugs show a distinct preference for darkness besides the more humid conditions.

In temperate regions the annual changes in plants and animals are primarily caused by variations in the amount of heat and light received from the sun. In tropical countries the temperature may be practically uniform throughout the year, while rain may be the only climatic factor in which there are marked annual changes. The difference between winter and summer in a country like England is sufficiently great to change the animal communities to a considerable extent. Although the broad outlines of these changes are more or less known, the details and the reasons for them are at present little understood. A study of seasonal changes in the fauna leads us on directly to a number of problems, one of the biggest of which is that of bird migration. The arrival of certain birds in spring is linked up with the outbursts of insect life which in turn depend upon the rise in temperature with the change of climatic conditions.

Coupled with the changes in the animal communities during the seasons of the year, there are the changes in the plant life of the country-side. Whilst our annuals, and so many of our herbaceous perennials, pass the winter underground by means of tubers, bulbs, or other subterranean food storage tissues, our deciduous trees tide over the cold season by losing their leaves and forming a layer of protective cork over the scars which have been left by the leaves. Our evergreen plants seek some other method of protection, such as forming a layer of wax over the leaf surfaces.

In the case of plants, the effect of climatic conditions must necessarily be different from that of animals, since the former are relatively stable. While the animal can move about in search of food, the plant is fixed and can only move to a relatively small extent. Thus with the oncoming of inclement conditions the animal can quickly seek shelter until times are more favourable, but the plant has to put up with things and make the best of it.

Of all the factors influencing the plant, light must be regarded as one of the most important, for it is from the sun that the plant gains its energy whereby it can manufacture its own food. A tree, in the summer, arranges its leaves in such a perfect mosaic that every available ray of sunlight is trapped, and hence the very sparse, if not complete absence of vegetation under the cover of a beech wood. Seedlings grown in the dark become drawn out and yellowish, due to the absence of light. The early flowering of so many of our woodland plants, as blue-bells and anemones, is again largely due to the fact that the trees are not yet in leaf, and the light can reach the ground flora below.

The marked effect of temperature upon plant life is too well known to need much explanation here. All gardeners realise the fatal effect of early frosts in the autumn, or the damage done by late frosts in the spring when the fruit is "setting." Extreme heat, accompanied by lack of water in the soil, causes many of the more shallow-rooted plants to dry up. This summer has seen many such instances, when the drought has been more pronounced than is usual. The soil itself has a rich flora of micro-organisms, and not the least important of these is the organism which is responsible for the manufacture of nitrates, rendering insoluble nitrogenous compounds available for the use of higher plants. The work of these bacteria is arrested during very cold spells, so much so, that the soil may become deficient in nitrogen. A crop of young wheat in the spring frequently becomes yellow owing to the work of the bacteria being checked by a short period of cold weather. Temperature also greatly influences the germination of seeds. For instance, at 40°F. it takes wheat six days, and oats seven days, to germinate, while at 65°F the former will germinate after $1\frac{3}{4}$ days, while oats will only take two days.

The effect of wind and rain has also important results upon plant life. Pollen grains are carried by the wind, and many plants rely solely upon this method for ensuring pollination. Seed dispersal, too, is effected in many cases by wind. The familiar "fluff" of dandelions and thistles is a very common sight in late summer, as is also the scattering of sycamore "keys" some distance away from the parent tree. Or whole plants may be blown about and so distributed, as, for example, the Rose of Jericho, which may be blown vast distances across the desert until it reaches a more favourable locality where there is water, when its seeds can germinate.

Rain has a retarding influence upon various seed dispersal mechanisms, and spoils the flowers of many plants, and thus it will influence the populations of the species concerned during the following season. Or rain, by drowning some insects which prey on others, may cause the latter to be more abundant in later months with possible fatal results to the vegetation. Similarly, very humid conditions assist the increase of various fungi—particularly the lower fungi—which attack plants, causing them to die, or seedlings to " damp off." Yet damp conditions are necessary for the bringing about of the fertilisation of fern and other prothalli.

Altitude must be mentioned here, as wind, rain, and temperature have very different and far-reaching effects upon the vegetation at higher levels. The absence of trees on mountains is very characteristic due largely to the high winds experienced ; and those shrubs which are able to survive the adverse conditions are very small and stunted, showing by their outline the direction of the prevailing wind.

Snow, by covering completely the vegetation, acts as a very effective blanket and protects the plants from cold dry winds. These winds would otherwise cause excessive transpiration by disturbing the relatively humid zones which occur round the stomata of the leaves, and the plants may easily succumb to the cold if the conditions remain for any length of time.

From the foregoing paragraphs the complex effect that climatic conditions have upon life will readily be realised. While many examples have been drawn, either from animal or plant associations, it must not be supposed that any one climatic condition affects only one or two cases. The whole of nature works with complete harmony, all the animal and plant communities, and even species, working together with the utmost concord, animals depending on plants, and plants on animals ; if any one link is omitted, or even temporarily arrested, it will have a very significant effect upon numerous other links, and it is here that climatic conditions play such an important part, for seldom does one factor influence any two integral parts in the scheme of nature in the same way.

One of the biggest key industries in many animal communities is that formed by aphids, which suck the juices of plants. Many small birds depend for their food either directly upon aphids, or indirectly upon them through other animals. The aphids which form their food supply, are only abundant during the height of summer, and thus their seasonal occurrence has an enormously important effect upon the birds. In a similar way, many of our British birds which winter in this country, are largely dependent upon the fruits of many plants, such as "hips" and "haws." Conditions favourable for the formation of fruit during the summer months will make a great difference to the food supply of our birds during the winter, and upon this might depend the relative abundance of the birds during the following summer, which are able to rid the garden of its insects. This example serves only as an illustration, for it is not to be expected, of course, that such a "cut and dried" succession would necessarily follow. We must remember that while the summer is favourable for the ripening of fruit, it may also be favourable to many of our smaller insectivorous animals, and at the same time the conditions may be very adverse to the insects concerned.

Having discussed briefly some of the effects climate has upon life, the naturalist may quite rightly ask, how to be of any use in solving these problems. With the factors varying and interacting upon one another it is obvious that the method of attack must be carefully considered. The study of phenology is no one-man job, for what holds good in one part of the country may have very little connection with the conditions in another part. We must, therefore, have as many observers as possible working at the same time over different parts of the country.

Again there is far too great a volume of animal and plant life for any one person to study, so a judicious selection of typical species must be made that is representative of the whole area concerned. The study of a rare animal or plant which occurs only in one or two localities, while it may be very interesting, is hardly going to be of any benefit to the country at large.

For a complete study of phenology, therefore, we want as many observers as possible, spread over the whole country, working on the same plants and animals at the same time, together with an organisation which will collect and correlate the observations. Such an organisation is the Royal Meteorological

Society, which has been doing this work since 1891. It has a large number of voluntary workers, each of which sends in a summary of their observations to be included in the Annual Report, a copy of which is sent to each observer.

The whole of the British Isles is divided into a number of areas which coincide with the Meteorological Weather Report Districts, and these areas are subdivided into twenty mile squares for the purposes of phenological observations. Each worker has one of these squares from which to collect the necessary data.

The observations are classified under three headings, namely, Plants, Insects, and Birds, and each observer may study one section only, though to do all three is preferable.

For the *Plants*, those chosen are :—

Hazel, Coltsfoot, Wood Anemone, Blackthorn, Hedge Garlic, Horse Chestnut, Hawthorn, White Ox-eye, Dog Rose, Black Knapweed, Harebell, Greater Bindweed, Devil's-Bit Scabious, and Ivy.

The information required is the date of the appearance of the first flower; the plant being considered in flower when the stamens of the first blossom become visible and the other buds are ready to open.

Similar information may also be given for Winter Aconite, Snowdrop, Yellow Crocus, and Lesser Celandine.

For the *Insects*, the information required is :—

The first appearance of the Honey Bee on flowers, Queen Wasp on wing, Small White Butterfly, Orange-Tip Butterfly, Meadow-Brown Butterfly.

And for the *Birds* :—

When the Song Thrush, Cuckoo, and the Nightingale are first heard, when the Swallow and Flycatcher are first seen, and when the Swallow is last seen.

In addition there is space for recording the arrival of the following migrants :—

Chiffchaff, Wheatear, Willow Warbler, Sand Martin, Tree Pipit, Blackcap, Sandpiper, House Martin, Whitethroat, Lesser Whitethroat, Sedge Warbler, Garden Warbler, Swift, Corncrake, Turtle Dove, Nightjar. And also some of the rarer spring migrants as Ring Ouzel, Wryneck, Yellow Wagtail, Redstart, Reed Warbler, Grasshopper Warbler, Whinchat, Wood Warbler, Pied Flycatcher, Red-Backed Shrike.

In addition there are the dates of the first song of the Missel Thrush, Song Thrush, Blackbird, and Lark ; when the cuckoo was last heard ; and the autumn migration of the last Swift, Sand Martin, Swallow, House Martin, and the first Redwing and Fieldfare.

All the instructions are given in the Return, and are most interesting. Observations should preferably be taken within a radius of five miles and any "notes made at the time on any exceptional weather, and its influence on farm and garden crops, trees, birds, insects, etc., will greatly add to the value of returns."

All these observations are collected by the Royal Meteorological Society and tabulated, and published in the Annual Report, a perusal of which will give far more detail than could be explained here.

It is hoped that the Reading and District Natural History Society will, in the near future, in company with many other such societies, send in annually a report on this most fascinating subject.

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(These two books have been referred to throughout the article.)

"THE CALENDAR OF LIFE, 1933."

The "Calendar of Life" is an attempt to bring together a number of observations made in many different places at many different times by naturalists of our society. These observations may often lead up to important new facts, and may sometimes throw a little light on the habits of some animal or plant, but they are usually never published, or even talked about. It therefore seemed well worth while to preserve a selection from those received. Members who have contributed to the scheme this year have been marked with a asterisk (*) in the list of members on page 118, and, in each case, the source of the observation is indicated by a figure which corresponds with the numbers in the membership list.

It is an undoubted fact that every year in England is an exceptional year with regard to the weather, but 1933 has proved itself worthy to stand up above its neighbours in the annals of meteorology, and, indeed, to rank with such companions as 1921, the year of the Great Drought. One would expect that this year's drought, which has been fully dealt with elsewhere in this number, will have made a great change in the world of Nature. Many must have felt that there was little to contribute to the "Calendar of Life;" all around was a calendar of death and desiccation.[21] The extensive heath fires that have occurred out Mortimer way[54] should leave an interesting area for a study of recolonisation by plants and animals during the next few years. Many will have noticed that the leaves were falling much earlier than is usual, and this has been especially noticeable in the counties further North than Reading,[31] while in the South they mostly managed to last the drought, although "autumn tints" were clearly showing quite early in August.[71] Reportson early or late appearances have been so plentiful as to become almost bewildering, and, as some appear to be contradictory, it has been thought wisest to omit them altogether, and wait until it is possible to publish them in a separate Phenological Report.

This year has been one of great sunsets, but that of the 29th. August outstepped them all in grandeur and brilliance.[76]

Rainbows, too, have been playing funny tricks. Twice circular rainbows round the sun have been observed,[51, 71] and, on July 15th., a rainbow did not fade away until 9.8 p.m., three minutes before sunset.[76]

This year there has been a great deal of frost damage to apples in parts of England. The reason for this may be due to the fluctuating temperatures we had in late spring. Frost damage is shown by a severe russetting and sometimes discolouration round the " eye " of the apple, and it is a known fact that the plants are more liable to show it when there has been alternate freezing and thawing. This frost damage may account for the infection through the " eye " of apples by the Brown Rot fungus (*Sclerotina fructigena*) which has been very marked this season. It is also interesting to note how wide-spread the damage due to leaf miners has been this year, for it is exceptionally abundant both in cultivated and wild plants. It is possible that this may have some connection with weather conditions.[43] Caterpillars, too, have been busy. In Cornwall a field of broccoli was observed with only the stems and ribs of the plants left ; a horde of Cabbage White caterpillars had cleared all the fleshy part away, and the walls of the field were infested.[24]

A rather interesting observation has been made dealing with the " thumping " habit of rabbits. The observer was hiding, in a deep ditch on the border of a small cover, in the early morning, before the general awakening of the first appearance of dawn. The rabbits had started their first morning feed before the sun had arisen over the horizon, and were scattered all around him, unaware of his presence ; eventually a fully grown rabbit, which was feeding within six feet of the hiding place, sighted him, but appeared quite unable to make out what was there. After approaching a little nearer, it thumped the ground heavily with its hind legs, apparently with the object of exciting some movement in response, for none of the other rabbits regarded it as a warning signal. After repeating the manœuvre several times, it appeared to decide that the strange figure in the hedge could do no harm, and continued feeding undisturbed.[71] It also appears that rabbits are good jumpers, for one was noticed to jump a stone wall three to four feet high, when disturbed while brousing in a field.[31]

Rabbits are not the only animals that have been providing interesting records. Last March a farmer was threshing some stacked corn in Leicestershire, and towards the end of the stack came across a large number of rats. One big rat ran out of the bottom of the stack, and it was followed by a string of the others. It led them up a water spout in an attempt to escape from the havoc that the farm hands were incurring with pitch-forks. The followers immediately started to scramble in after their leader, but, unfortunately for them, the water-spout was constricted just before it gave out on to the guttering, and the leader was just too big to squeeze through. The pressure from behind prevented any return, and so many were crammed together that the lot were suffocated to death. Those that could not manage to squeeze into this false refuge ran wildly about, trying to escape from the dogs and the men, but nearly all were killed. Over 22 were found dead in the pipe, and about 30 were killed outside.[55] The chief point of interest in this little drama is that the rats appeared to own a leader which was much bigger than usual. It seems that the social life of rats may be much more advanced than is generally supposed.

POND LIFE.

J. A. Hall.

The varieties of animals that one would collect from one visit to a pond would far exceed in diversity and peculiarity of form the inmates of any zoological gardens. Most of these members of the pond community are just mere specks of life, many not exceeding one thousandth of an inch in size.

The microscopist who is not a pond hunter is missing the best of nature's jewels. The principle method of collecting is by the aid of a special fine meshed net with a glass tube attached, a long handle being used for convenience in manipulation; the net serves to get rid of the abundance of water, at the same time conducting the organisms into the glass tube. One such gathering will produce hundreds of specimens to take home to be examined at leisure. The organisms which come into the pond hunter's net will naturally fall into two groups, plants and animals, the majority being unicellular in character. These minute one celled plants and animals offer the most absorbing study. I will describe just a few of the more common subjects that come the micro-fisher's way.

A little animal found living amongst the mud and decaying vegetation will be the first on my list. It is the most simple of living animals, called *Amœba.* This minute speck of proto plasm is at the bottom of the scale of life; it does not possess such things as arms or legs or stomach, nor any of the ordinary organs usually associated with living bodies, yet it lives and moves and has its being.

Examined under the microscope we find it is perfectly transparent, with two distinct body layers, an inner one full of granules and an outer one of perfectly clear protoplasm. An amœba does not eat, it simply engulfs; coming in contact with some suitable food it extends some of its clear outer layer into many arm like processes called *pseudopodia* which surround the captured food, whence it is slowly absorbed into the body. We shall also notice that the amœba has a darker spot within its granular layer; this is the nucleus, whose function is concerned with the phenomenon of reproduction and continuity of life. There is also a clear space or bubble which pulsates at regular intervals; this bubble is known as the *contractile vacuole,* which serves to rid the amœba of waste products, and probably is the most primitive form of respiration. Its body form is of no definite shape—it is altering at every moment: is now nearly a sphere, but a few seconds later assumes a most grotesque figure.

Another animal, higher in the scale of life than amœba, and found nearly everywhere, is called *Paramecium.* Its body is elongated in shape with a depression somewhere about the middle which leads to the mouth of the animal. Also the body, although having the power to contract and expand a little, retains its usual long cylindrical form. Its means of progression is far different from the amœba. The body of *Paramecium* is clothed externally with myriads of very fine projections of protoplasm called cilia, arranged upon the body in a definite manner; the continual rythmical motion of these very fine cilia causes the animal to move in any direction. This means of progression is a very common one among microscopic animals.

I have now described two of the free moving forms of animals found in ponds and ditches; some animals, however, prefer a fixed habitat. A very beautiful species that can be found almost everywhere, clinging to stones, the stems of water plants and upon the backs of the larger inhabitants of the ponds, is called *Vorticella.* Its form closely resembles a bell; the bell portion is the main part of the body and is surmounted with several rows of very long cilia. These can be seen continually lashing the water into a vortex, causing food to swirl into its mouth-opening. A long stalk attaches it to the substratum; one moment your *Vorticella* is swaying majestically upon its straightened stalk, but a slight shock will send it contracting into a cork-screw spiral; its life seems to be a series of ups and downs. To view a colony of some hundreds of these *Vorticellae* is a sight not to be forgotten.

Reference to one of the plant inhabitants of the quieter pools will here be of interest. *Volvox globator* by name prefers a warm shallow pool in which to live. A tiny sphere studded with glistening green knobs, now spinning round and round and at the same time progressing, but now for some reason it has stopped, though still spinning, a truly wonderful sight to watch!

Although the animals and plants found in the ponds are of the most amazing and weird types, one is constantly coming across a species that one has not met with before; there is always something fresh and wonderful in the collector's tube, and material in abundance for all. Peering down the microscope tube we behold a new and strange world, full of weird forms, living and reproducing their like in that everlasting struggle called life.

SOME READING TREES.

Thomas Vear.

It has long been a matter of surprise to me that so few people take an interest in trees. Although nearly everyone can at least identify a few of the commonest species, one occasionally finds people who cannot even do this. A worthy citizen came to see me recently about his trees. As he seemed very hazy about their species, I put the leading question " Are they Oaks? " " I think one is an Oak," he replied, " but the rest are just ordinary trees." And yet he had a university degree and was therefore presumably an educated man. What a lot of pleasure he had missed by not knowing even the names of his own trees.

Reading is a very good centre for a tree-lover. Oaks abound near the town, doing better in the deep soil of the river valleys than on the chalk. The chalk country, however, suits the Beech and it grows to perfection all along the north side of the Thames. Elm grows lustily in every hedgerow and many are blown down by every gale. It is somewhat surprising that so tall a tree should be so shallow-rooted. The roots extend a very long way, but never penetrate deeply. A blown Elm will often up-end a wall of earth fifteen feet square but only a few feet thick. Elm is more often blown down than any other tree, the next in order of frequence being Spruce and Cedar. The timber of the Elm is coarse and has the vice of warping and twisting badly. The Forest Products Research people at Princes Risborough have introduced a method of " reconditioning " Elm to avoid this defect, but the process is at present too expensive to be popularly used. The wood is largely used for coffins. Small trees, bored throughout their length, used to serve as water-pipes and are still occasionally found under London. One of these is exhibited by the roadside at Woodcote. A few Ash remain as hedgerow trees. It was never very common in the district and during the war the government commandeered all the best trees, so there are now but few left. Ash timber, being tough and springy, is used for cart-shafts, tennis rackets and other purposes requiring these special qualities.

The sandy districts of Mortimer to the South and Finchampstead to the East, produce large quantities of Scots Pine. Woodmen always call this Scotch Fir. For them, all conifers are Firs, so they speak of Larch Fir, Spruce Fir and Scotch Fir. The wood of the Scots Pine grown here is usually too coarse for anything but fencing and similar uses, but the same species, grown slowly and in close forest, produces the clean Russian joinery deals that would have been shut out if the embargo had continued. Willows and Poplars are to be seen all along the river banks. Another common tree of the locality is the Birch, the "Lady of the Woods" as Coleridge called it. This grows profusely in the same districts as the Scots Pine. Its white bark and graceful habit make it a universal favourite, but the wood is practically valueless.

But the lover of trees will hardly need to go out of the town to find objects of interest. They are numerous in all the public parks and gardens and every road, at any rate on the outskirts of Reading. In Whiteknights Park there is a fine Wellingtonia near the Shinfield Road entrance. This species produces the largest trees in the world, though not the tallest. It was named after the Iron Duke and a fine avenue was appropriately planted at Stratfieldsaye. There are also many fine Wellingtonias near Wellington College. The largest known specimen, in its native America, is 40 feet in diameter—a size that may be visualized when it is remembered that the recently widened Bath Road through Berks is only 30 feet from kerb to kerb. The Americans proposed to call it Washingtonia, but apparently that idea fell through, for they always call it Big Tree. The wood is red, soft and valueless. The only other species of this genus is the Redwood (*Sequoia sempervirens*). There is a specimen of this on the Wokingham Road, opposite the road that goes down to Sindlesham Mill, another by Bulmershe Lodge in Church Road, Earley, and another in Redlands Road, opposite Southern Hill. The wood, which is not now imported, is so soft that the Americans say the only way to get a polish on it is to apply it at the back and let it soak through.

There are some fine Cedars (*Cedrus Libani*) in Whiteknights

Park. This is the wood that King David bought from his neighbour Hiram for building the temple. Hiram felled the trees in the Lebanon mountains and hauled them to the coast at Tyre. They were then rafted down the coast to Joppa, where David took delivery and arranged transport to Jerusalem. Notwithstanding the well-drawn contract, Hiram seems to have thought that his Jewish customer got the better of him. It is a dignified tree and is always so regarded in the Bible. There are two other species, probably only geographical varieties, the Atlas Cedar (*Cedrus atlantica*) with a rounded top, and the Deodar (*Cedrus deodara*) a pyramidal form from India. This latter flourishes in many town gardens. I was once walking with the owner through a large nursery plantation of Cedars, and as they appeared to me to be somewhat indeterminate in shape I asked whether they were *Libani* or *atlantica*. "Oh," said he, "if customers ask for *Libani*, we send them flat-topped ones, if *atlantica*, round-topped." Cedar wood is not used for pencils, the so-called pencil cedar being a Juniper (*Juniperus virginiana*) which is rapidly becoming scarce. Its place will probably be taken by an African species (*Juniperus procera*).

Whiteknights Park has also some good specimens of the Turkey Oak (*Quercus cerris*). This has a longer straight bole than the common Oak and has handsome, deeply-cut leaves and mossy acorn cups. The Evergreen Oak (*Quercus Ilex*) is well seen in front of the old University library, the onetime residence of the founder of the firm of Huntley & Palmers. On the University lawn is a fine Tulip tree (*Liriodendron tulipifera*) and another in Crescent Road. The flower is like a small tulip, mottled with green and yellow, and the handsome leaves are of a quite unmistakable shape and cannot be confused with those of any other genus. This species produces the American Whitewood of commerce. At Wessex Hall in Redlands Road there stands a good female Tree of Heaven (*Ailanthus glandulosa*). They had a male tree in the grounds here, but it had to be taken down a few years ago, as the smell of the pollen was so offensive. The same thing happened in New York where it was used as a street tree. The popular name was given it by the Chinese, who plant the tree near their temples. The wood is not unlike Ash of a greenish tinge, but is very brittle and therefore worthless. The tree too, is somewhat ash-like in appearance and I have more than once been shewn this species as a fine specimen of Ash.

The finest Indian Bean (*Catalpa bignonoides*) that I know of in Reading is in St. Mary's churchyard. It is easily recognised by its large yellow-green leaves. It bears a large crop of handsome white flowers in July and they are followed by a long, narrow pod, the Indian bean. The wood is brown and soft, but works well and is durable. The late Dr. Henry, professor of Forestry at Dublin University, who probably knew more about trees than any other man then living, once shewed me how to distinguish infallibly between this and a closely allied species (*C. speciosa*). I identified a particular specimen as *speciosa* by the pointed leaf. "This is the way to be sure," he said, plucking a leaf, screwing it between his hands and smelling it. "Yes, this is *speciosa* as it has a pleasant grass-like smell, while *bignonoides* has an unpleasant smell."

Another churchyard, St. Laurence's, has an interesting tree—the Judas tree (*Cercis siliquastrum*). It produces pretty pink flowers with hardly any stalk, which spring from the trunk and large branches. Unfortunately, in this latitude it does not flower every year. It is a native of the Mediterranean region and gets its name from the legend that Judas Iscariot hanged himself on a tree of this species. The wood is yellow-brown and prettily marked. In the same churchyard is a good Weeping Elm.

An interesting survival is the Maidenhair Tree (*Ginkgo biloba*). Its only relatives occur as fossils and it probably owes its present-day existence to its having been planted for untold centuries near Chinese temples. There is a small specimen just inside the Forbury Road entrance to the Forbury Gardens and a better one in Christchurch Gardens, opposite the end of Glebe Road, next to a Himalayan Pine (*Pinus excelsa*). The roads round Christchurch have many good trees to shew. Glebe Road has a common Laburnum on which has been grafted both a purple laburnum and a broom. The result is curious but perhaps not beautiful.

In Northumberland Avenue is a white Lilac, one branch of which bears flowers of a deep purple. Close to Christchurch may be seen both the white and the red-flowered Horse Chestnuts, the white and the red Hawthorn, early and late Laburnum, White-beam, Tree of Heaven, Acacia, Catalpa, Spanish Fir, Yew, Wellingtonia, Glaucous Cedar, Douglas Fir, Staghorn Sumach, Ashleaved Maple, etc. There is also a Monkey Puzzle (*Araucaria imbricata*), properly the Chili Pine. These are common in and around Reading. The fruit is as big as a child's head. There are some trees on the Basingstoke Road at Three Mile Cross that often bear cones. The Purple-leaved Plum (*Prunus Pissardi*) and the Copper Beech are deservedly favourite trees in Reading gardens. The latter originated as a sport in a German forest over a century ago and was decidedly a " find." The upright Irish Yew so common in gardens and cemeteries all come from two trees that were found in Ireland in 1786 by a farmer named Willis. He planted one in his own garden and gave the other to the owner of a neighbouring estate, Florence Court. Willis's tree is now dead, but I understand the Florence Court tree still survives.

In Christchurch Road, a little east of the church, is a Fern-leaved Beech, a variety with narrow, deeply-serrated leaves. Plane trees are planted in the streets in some districts, notably in Kendrick Road and Caversham Road. A Plane leaf can be differentiated with certainty from a Sycamore leaf by noticing that the end of the leaf stalk in the Plane thickens considerably and has a deep hollow in it. This hollow fits over the next year's bud and protects it. A noticeable characteristic of the Plane is the flaking of its bark. There is a wartime story of a colonel who was alarmed at the peeling of the trees and offered a reward for information as to the persons who had done the injury.

The Sycamore (*Acer pseodo-platanus*) is common in Reading and is valued for the dense shade afforded by its broad leaves. The leafstalks are red and the flowers hang like tassels, the fruit being a winged samara. The wood is hard and white and is largely used for bread-trenchers, mangle-rollers and other turnery work, also for violins, but the back of a violin is always made of Spruce on account of the resonant quality of that wood.

A house on the north side of Warwick Road has a tree that will only grow in the south of England and in a sheltered position. This is a native of Australia, known here as Mimosa. It is really a true Acacia (*Acacia dealbata*). The true Mimosa is the Sensitive Plant of the South Seas.

There is a fine Mulberry near the Great Hall of Reading University. The ordinary leaves are heart-shaped, but when leaves spring from the trunk they are often of strange and more or less irregular form and sometimes look more like fig leaves than those of a mulberry. The wood is hard, brownish yellow and handsomely marked.

The Lime (*Tilia europæa*) is common in the streets of Reading, but has to be kept lopped on account of traffic. A well-grown Lime is a thing of beauty. There is a nice one in the Forbury Gardens, close to the archway leading to the Abbey Ruins. There used to be a small one of the broken-leaved variety close to it, but when I took a friend to see it one day, it was gone. For some unknown reason the authorities had destroyed it. The wood is white and rather soft and cuts well in any direction. The famous Grinling Gibbons who did so much wonderful carving during the reign of Charles II., was fond of using Lime.

There is an interesting collection of trees on the Thames Promenade, by Caversham Bridge. Here may be seen among others, Golden Alder, Italian Alder, Cut-leaved Alder, Catalpa, Deciduous Cypress, Turkey Oak, Red Gum, Maple and Purple Plum, Cutleaved Beech, various Willows, including the Shining Willow, and several good specimens of the handsome Weeping Willow (*Salix babylonica*). This is said to have been introduced into this country by planting a piece of a basket that had contained figs. The Red Gum (*Liquidambar styraciflua*) has a star-shaped leaf, not unlike a deeply-cleft ivy leaf, which turns a brilliant red in suitable autumns. The wood bears the strange names of Satin Walnut and Hazel Pine. It is light brown, close grained and easily worked and is much used for cheap furniture. The trees on the Promenade are very artistically grouped, the greys and yellows contrasting with the purples, while the foreground is planted with flowering shrubs. Perhaps the powers that be could be induced to label them so that visitors would know their names and not be obliged to look on them as " just ordinary trees."

There is a Maple that is a prime favourite in gardens, often variegated with white or yellow. The variegated forms are much more handsome than the type. I know of no popular name for it excepting the absurdly misleading American one of Box Elder, though Ashleaved Maple has been suggested. It is the *Acer Negundo* of botanists, an American species, with foliage quite distinct from that of the typical maple. The leaf is compound, divided into three or five leaflets after the fashion of the Elder. The variegated forms originated from a sport that occurred in an Austrian nursery in 1845. When cut back hard, the young leaves are often entirely white.

Elder is common in waste corners and is in fact a sort of weed among trees. It grows very fast and is never valued. Judas is said to have hanged himself on this tree also, but as it does not grow in Palestine the report is probably without foundation. The wood is white and very hard. During the war I came across a couple of Flemish refugees clearing the corner of a wood in which was an old Elder about a foot in diameter. They were a watchmaker and a chemist and were evidently quite new to their duty. I managed to make them understand that I wanted a piece of Elder, and in return for some tobacco they chopped out a huge block with a billhook, for they had no saw. Then I had to shoulder this block and carry it for miles to make a small specimen to add to my collection.

In Basingstoke Road, opposite Christchurch Gardens, is an example of topiary work, a survival from the time when it was fashionable to clip long-suffering trees and shrubs into the semblance of birds and animals. The fashion is said to have been introduced by John Evelyn, who was a useful public man in the reign of Charles II. He wrote on trees and kept a diary at the same time as Samuel Pepys. It was he who introduced Grinling

Gibbons to the king. Pope ridiculed the fad of topiary work in a mock catalogue which ran as follows :—

Adam and Eve in Yew : Adam a little shattered by the fall of the Tree of Knowledge in the great storm : Eve and the Serpent very flourishing.

St. George in Box : his arm scarce long enough but will be in condition to stick the Dragon by next April.

A green Dragon of the same with a tail of Ground Ivy for the present. (N.B. These two not to be sold separately).

Divers modern poets in Bays somewhat blighted : to be disposed of at a pennyworth.

A quickset Hog, shot up into a Porcupine by its being forgot a week in rainy weather.

The Douglas Fir (*Pseudotsuga Douglasii*) was named after David Douglas the intrepid botanical explorer, who lost his life by falling into a pit-trap in the Sandwich Islands in 1834. A wild bull had been trapped, and when poor Douglas fell in he was immediately gored and trampled to death. This tree grows rapidly, though I doubt if it will ever become a valuable timber tree in this country. Its wood is the Columbian Pine or Oregon Pine of commerce, now used in very large quantities for doors and building timber. The flagstaff in Kew Gardens is of this wood and is 215 feet high. The tree is shapely, not so stiffly formal as the Spruce, and is readily distinguished by its cones, which are pendant, red-brown and have a trident tongue projecting between the scales.

The Horse Chestnut (*Aesculus Hippocastanum*) must not be confused with the Sweet or Spanish Chestnut (*Castanea vesca*). Many popular books on trees will tell you that it gets its name from the fact that horses eat its nuts. Do they? Or, if that is not a satisfactory explanation, then the leaf scar is like a horse-shoe. But popular names do not arise in this way. Horse is simply a depreciatory epithet, given because the nuts are uneatable. Similar derogatory names are horseradish and dog-violet. The tree was introduced for ornamental purposes in about 1615. When not in flower, the white may be distinguished from the red by its leaves. It holds its handsome leaf like an outspread hand, while the red droops its fingers. The Sweet Chestnut was probably introduced by the Romans for its fruit. It has a long, glossy leaf and the flower is a long catkin. In Redlands Road there is a specimen of each of these trees in the

University grounds, growing side by side. When bare of leaves the Sweet Chestnut looks very like an Oak, though the bark has a flatter appearance and often shews a spiral twist. The wood, too, is oak-like and durable and is largely used for the popular staked wire fencing.

Caversham Court is well worth a visit for its trees. There is a row of Poplars about ninety feet high, and the tallest Catalpa and Ashleaved Maple that I know of. There are several Cedars, Himalayan Pine, Wellingtonia and Yews, the latter being very fine, also a very high clipped Yew hedge. Perhaps the gem of the collection is the large *Arbutus* or Strawberry Tree. This has rugged, red bark and evergreen leaves. The fruit is a rough, red berry not much unlike a strawberry and from this of course it takes its popular name. The taste, however, is not that of a strawberry. The wood is hard and reddish. There is also an Acacia, bearing two huge bunches of Mistletoe.

In Basingstoke Road, just above Elgar Road, is an unusually large Tamarisk. This is usually only a bush and is common along the South Coast. Its light feathery foliage and pink spikes of blossom and red stems make it a very graceful object. It grows readily from cuttings. The wood is pink and hard.

There are of course many other varieties of trees to be found in our town, but perhaps I have said enough to prove that Reading is not without interest to a tree-lover.

ORCHIDS OF THE READING NEIGHBOURHOOD.

W. A. Seaby.

It was the writer's intention to limit the area covered by this paper to that shown upon the Geological Survey Sheet No. 268 (1 inch : 1 mile) in which Reading is placed almost centrally upon the map. Careful inspection, however, showed that a few localities where several important species thrived were just over the margin of the map, and the district under review has been extended to include these. Sheets 254, 268, and 284 have therefore been used in determining the geological formation of the particular locality referred to.

So much has been written on this important family of the plant kingdom that the only excuse, which may be offered for further adding to the mass of literature, is that a few personal observations and records filed in the Botanical Index at the Reading Museum, not previously published, may be helpful to those interested in the flora of the district.

It is proposed here to give a short account of the more important species found in and around the middle part of the Upper Thames Valley, noting the soil, altitude, and some of the accompanying flora in the localities where they occur.

That orchids need, both in the formation of the embryo and development of the protocorm, the services of the fungus *mycorrhiza* is such a well established fact that the subject need not be discussed here. Yet the benefits which each derive from this symbiotic association are necessarily of importance in any attempt to discover the reasons why a particular species of orchid should favour one particular kind of soil and the companionship of other plant species. As yet too little study has been given to this ecological question for the setting out of a detailed formula. In generalising one might say that the majority of our native orchids prefer a dry calcareous soil and that many derive nutriment from organic matter which is " fed " to them by a species of the fungus *Rhizoctonia*. Most of the others are to be found on acid peaty soils ; a few on stiff clay often rich in mineral salts.

In southern Britain the habitat of orchids may broadly be divided into five fairly distinct kinds of environment :—

(*a*) dry woods of beech and yew where the subsoil is covered with a layer of decaying leaves,

(*b*) open downs and bushy slopes on chalk and limestone,

(*c*) bogs and swampy parts of sand or plateau gravel areas and hard peaty heathlands on the same deposit,

(*d*) damp clay woodlands of oak, ash and hazel,

(*e*) low-lying marshes, damp meadows on alluvium of a siliceous nature and pond areas on heavy loams.

At first sight this list may seem to cover almost the entire part of uncultivated land in southern England but one must not forget that on the enormous tracts of Tertiary clays and sands, where flora is often prolific, the family Orchidaceae is but sparingly represented. The rule may therefore be generally applied, that where the subsoil is of a calcareous or peaty nature (i.e. alluvial deposits laid down by rivers draining hills of chalk or limestone formation ; heathland and sphagnum bogs ; downlands of chalk ; hills of oolitic or carboniferous limestone), there will be found the greatest number of species.

Paradoxical as it may sound it was probably during the Eocene period at the beginning of the Tertiary epoch—when the waters of the Thames, then a tributary of the Rhine, flowed into the North Sea, its banks luxuriantly covered with a dense tropical vegetation comparable with that found in equatorial parts to-day—that numerous epiphytic orchids of splendid beauty and colouring hung over the placid stream from the tall trees which lined it. As the tropic conditions of the Oligocene and Miocene periods gave way to the more temperate climate of Pliocene times this rich flora disappeared, and all, or practically all plant life must have subsided when the great ice sheet reached the Thames at the commencement of the Pleistocene era. After the recession of the glaciers there was a return to less severe conditions through warm, cold, wet and dry phases, when vegetation again spread north across Europe till it reached the limit of its distribution and development as we know it to-day.

The generic order and classification given by Col. M. J. Godfery in his recent work on British Orchids[1] have been followed throughout. The sections dealing with orchids in the late

Dr. Druce's two Floras of Berkshire[2] and Oxfordshire[3] have also been made use of.

The total number of species given by Druce in his Oxfordshire and Berkshire books is 27 but more recent investigation has shown that at least 30 are known to flower or have flowered in the district defined by South Oxfordshire and Buckinghamshire, Berkshire and northern Hampshire.

GENUS I. *Cephalanthera.*

C. grandiflora. Col. Godfery considers the genus *Cephalanthera* the most primitive as it possesses no rostellum, the organ developed from the stigma, for the purpose of keeping the ends of the pollinia in a viscid or sticky state for their attachment to the insect which acts as pollinating agent. For this and other reasons Godfery has placed it first in his generic order. The species *C. grandiflora* or *pallens* (White Helleborine) must be accounted the commonest orchid of our beech woods. It is not, however, confined to the shade of the beech for there are some places where it grows extremely well on the open downland, yet never very far from this tree. In a spot on the Whitchurch slopes it was noted during May 1931 that the specimens of *grandiflora* growing there were taller and far in advance of their neighbours in the wood close by. The White Helleborine may be found in almost any of the thick woods on the Berkshire bank of the river, while small colonies reach the beech copses on the downs. Darwin[4] suggested, that minute insects crawl into the flowers and bring about a close self-pollination by spreading the pollen grains over the stigma.

C. ensifolia (Narrow- or Sword-leaved Helleborine). This species is much rarer than the last, its nearest station to Reading being on a bushy western slope of the Chiltern Hills in the Stokenchurch--Chinnor district. The colony is restricted to a piece of ground about one acre in extent on the summit of the lower chalk (Druce).[3] The appearance of the flowers is spasmodic. A record filed in the Botanical Index at the Reading Museum shows that *C. ensifolia* was discovered in mid-May 1928, on the gravel in a district to the west of Reading. This would seem to be the first record of the species having been found in Berkshire.

GENUS II. *Epipactis.*

This genus seems to present much difficulty in the determination of its species, as the colour and shapes of the plants seem to differ considerably from district to district. All the local species flower late in the season, and with the exception of *E. palustris* are pollinated by wasps and inhabit the deep shade of the woods.

E. palustris (Marsh Helleborine) has been found in the marshy districts to the east of Reading, notably on the London Clay and river alluvium of the Loddon valley. It is now becoming increasingly rare. The last occasion when it was brought to the Reading Museum was in July 1928.

E. latifolia (Broad-leaved Helleborine). Commoner and more widely distributed, being found in the woods on both sides of the River Thames as well as those along the Loddon Valley. Varieties of this species Druce included under the name of *E. media.*

E. violacea (Violet Helleborine) is also found in the same localities but in shadier places. In one spot it is found less than twenty feet above the river showing that the habitat of this helleborine is not confined to the upper slopes. Some years it comes up in good numbers. The appearance of the shoot in May or early June four or five weeks before the period of flowering, as also in the last species, is noteworthy.

E. leptochila (Slender-lipped Helleborine). Although the writer is not acquainted with this form, recognised by Col. Godfery as a distinct species, specimens have been found growing near Maidenhead and are in all probability elsewhere in this part of the Thames Valley. It is possible that Druce included this species in *E. latifolia* or *E. media.* Hybrids between this species and *E. latifolia* are known.

GENUS III. *Spiranthes.*

S. autumnalis (Autumn Ladies' Tresses). An orchid found but rarely in this district. Druce records scattered localities in the Kennet valley, the nearest to Reading being Burghfield. Streatley and Remenham are also mentioned. In the Read. Mus. Botanical Index there are records of its having been brought into the museum during mid-September 1928, 1931 and 1932, both from the Berkshire and Oxfordshire slopes of the Thames. It is a beautiful little plant, only a few inches high, the spiral of flowers up the stem distinguishing it from other genera. Step[5] notes that its stations are identical with those of *Lycaena bellargus* (the Adonis Blue butterfly), which perhaps is an agent in the pollination of the plant.

GENUS IV. *Listera.*

L. ovata (Common Twayblade). Very common and found on widely differing soils and at varying heights in mid-summer. It has a preference for dark woods, although at times is found well in the open. It appears to like thick undergrowth and is less satisfied with the bare carpet of fallen beech foliage.

GENUS V. *Neottia.*

N. nidus-avis (Bird's Nest Orchis). A yellow and brown saprophyte deriving its nutriment from decaying beech leaves supplied to it through the filaments or mycelia of the fungus *mycorrhiza*. The orchid is found extensively in the beech woods which slope down to the Thames in Oxfordshire and to a less degree in Berkshire. In the more open woods on the Chilterns it grows less abundantly and there seeks the profoundest shade. On the steep southern slope in the Hardwick Woods, near Mapledurham, where yews and beechs grow in close association affording deep umbrage, so that even on the brightest summer days few of the sun's rays penetrate, the finest specimens of *Neottia* grow. At a height of between 250 and 300 feet O.D. they form almost a straight band through the wood.

GENUS VI. *Malaxis.*

M. paludosa (Bog Orchis). Mention must be made of the smallest orchis in Britain as there is the possibility of its being a local species, although apparently not yet recorded from Berkshire. It has been found amongst sphagnum in bogs on the heathlands in Surrey, so there is every reason to believe that vigilant search in the Easthampstead–Sunningdale area may reveal its identity. Inconspicuousness caused by its small size, colour in harmony with its surroundings and the usual inaccessibility of its habitat are reasons enough for its apparent scarcity.

GENUS VII. *Epipogon.*

E. aphyllum (Leafless or Banana-scented Orchis). Undoubtedly the rarest species in Britain, *Epipogon aphyllum* has been recorded probably less than twenty times in this country. It was first discovered in 1854 close to a path, near Bromyard, Herefordshire and between 1876 and 1892 three or four times in a Shropshire wood. It was reported to have been seen in Staffordshire, 1881, while in 1910 a solitary example was discovered near Ross, Herefordshire. During June 1924 several specimens were found in a south Oxfordshire wood. Towards the end of May 1926 another plant was discovered near the same locality and was presented by the finder, Mr. Wallace Brown, to the Reading Museum, where it is still kept in spirit. The stem, which was taken off at the rhizome was three inches high. There were two small rather shrivelled flowers, the spike terminating in an undeveloped bud. Another specimen, found in a wood on the Chilterns by a member of the Society, Miss Vera Smith, on 28th June 1931, was identified by Dr. Somerville Hastings and brought to the Reading Museum on the following day. After the specimen had been examined and photographed it was put on exhibition and later preserved in spirit. The plant was growing in the stump of a rotten tree filled with decaying beech leaves. The spot was just below the 400 foot contour, on a fairly steep S.W. chalk slope. The stem was cut off at the rhizome; it was nine inches high and bore three flowers, the lowest having a damaged lip. The life history of this species, nearly as rare in its European localities as here, was studied in some detail by a German scientist, Dr. Rohrbach, who published a monograph on the orchis in 1866.[6] He saw the plant twice visited by a humble-bee (*Bombus lucorum*), which removed the pollinia. It is probable, however, that the plant is more dependent for its existence on vegetative propagation by sending out underground runners and that only very occasionally flowering shoots are produced. This must be accounted the reason for its extreme rarity.

GENUS VIII. *Herminium.*

H. monorchis (Musk Orchis). Usually very small with two leaves, it is an inconspicuous plant and likely to be passed over. It occurs in but one or two spots in the extreme S.W. of Berkshire but nowhere has it been found in the immediate district. The flowers open in June. This orchis prefers slopes on the open chalk downs to any other environment. It is found in those places where *Aceras* grows and also *L. ovata* (Step).[5]

GENUS IX. *Coeloglossum.*

C. viride (Frog Orchis). Although said to be a local species, *C. viride* may be found fairly abundantly in the long grass on the top of the downs, where some years it is very plentiful. The writer noticed that it grew along the whole extent of the Sussex Downs in July 1931 and the same year it could be found in many places on the Berkshire hills.

GENUS X. *Platanthera.*

P. chlorantha (Greater Butterfly Orchis). This species occurs in damp woodlands all over the county but more on the hills than in the valleys. It also grows on bushy hillsides and grassy slopes. It flowers in midsummer, some weeks before *P. bifolia.* The scent of the flowers has been described as oppressive, fragrant and negligible by three persons who smelt the same specimen. Whatever may be the true verdict as to its odour the scent is powerfully attractive to night-flying lepidoptera, who insert their proboscides into the long nectaries.

P. bifolia (Lesser Butterfly Orchis). Much rarer in this area than the last species, although, when found, it is usually growing close to *P. chlorantha.* One of the chief differences between the species lies in the fact that the viscid ends of the caudicles of *chlorantha* are set widely apart, so that when a moth inserts its head into the flower the pollinia become attached to its eyes. In *bifolia* these caudicles lie close together and become attached to the insect's proboscis.

GENUS XI. *Gymnadenia.*

G. conopsea (Fragrant Orchis). No one can but agree that the scent of this species is exceptionally sweet-smelling and where colonies of this orchis are met with the aroma is indeed a pleasing one. Blewburton Camp near Blewbury, Ilsley and Moulsford Downs, Lowbury Hill near Aldworth may be cited as downland stations, but it also grows in low-lying meadows in the Vale of the White Horse and Druce recorded it from bogs around Oxford. *G. conopsea* hybridizes with the marsh orchids when flowering in these latter localities. The long spur again suggests that the flowers are solely pollinated by lepidoptera, but it is probable that where *conopsea* grows on the downs butterflies play as large a part as moths in this all-important operation.

GENUS XII. *Anacamptis.*

A. pyramidalis. The Pyramidal Orchis with its little cone of bright red flowers is familiar to all those who visit the downs or climb the slopes above the Thames in mid-summer. Most years it is plentiful on nearly every sunny chalk hill. Whereas so many orchids choose the upper parts of the slopes, *A. pyramidalis* covers almost the whole hillside, being most concentrated about the middle or a little below. This is noticeable near Whitchurch. It usually makes its appearance about the middle of June and goes on flowering until August.

GENUS XIII. *Himantoglossum.*

H. hircinum (Lizard Orchis). Its appearance is probably more spasmodic than that of any other orchid. It is hardly possible to generalize upon the situations it most enjoys, but often it comes up singly in a clearing or border of a wood on chalk. Its nearest station to Reading is close to Odiham, where it has occurred on fairly high ground on the edge of the chalk. The same tuber has several times sent up a spike in recent years, and in July 1930 Mr. Willis, curator of the Basingstoke Museum, sent the flowering stem to the Reading Museum, where it was included in the Herbarium. The odour given off is reminiscent of goats, from which circumstance the orchis receives its folk-name, " Great Goat Stones."

GENUS XIV. *Aceras.*

A. anthropophora. (Man Orchis). Another species which has no certain record for the county. It has been reported from Berkshire and all the surrounding counties but these records are without confirmation except from Surrey. It should be looked for in the same situation as *H. monorchis.*