TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

(A CONTINUATION OF THE TRANSACTIONS OF THE WATFORD NATURAL HISTORY SOCIETY.)

VOL. I.

TRANSACTIONS

OF THE

HERTFORDSHIRE

NATURAL HISTORY SOCIETY

AND

FIELD CLUB.

EDITED BY JOHN HOPKINSON, F.L.S. F.G.S.

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CONTENTS.

LIST OF ILLUSTRATIONS.

PLATES.

OTHER ILLUSTRATIONS.

Dates of publication of the several parts contained in this volume.

Part 1.	Pages	1–48	... ...	September, 1880.
,, 2.	,,	49–96	... ...	December, 1880.
,, 3.	,,	97–144	... ...	March, 1881.
,, 4.	,,	ix–xxxii	... ...	April, 1881.
,, 5.	,,	145–192	... ...	July, 1881.
,, 6.	,,	193–232	... ...	October, 1881.
,, 7.	,,	233–264	... ...	December, 1881.
,, 8.	,,	xxxiii-lxviii	... ...	April, 1882.
,, 9.	,,	i-viii, and 265-272...	...	May, 1882.

PROCEEDINGS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

Ordinary Meeting, 2nd October, 1879, at Hertford.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mr. W. M. Armstrong, Brook Lea, Hertford; Mr. H. Beningfield, High Street, Ware; the Rev. Edward H. Bradby, M.A., Honorary Canon of St. Albans, Haileybury College, Hertford; Mr. Arthur Butler, The Slopes, Hertford; Mr. Frank M. Campbell, F.L.S., F.Z.S., F.R.M.S., Rose Hill, Hoddesdon; Mr. James William Carlile, Ponsbourne Park, Hertford; the Honourable Henry Frederick Cowper, M.P., Brocket Hall, Hatfield; the Rev. Thomas D. Croft, M.A., Kimpton Vicarage, Welwyn; Mr. F. Macdonogh Davies, Fore Street, Hertford; Baron Robert J. Dimsdale, Essendon Place, Hertford; Dr. J. Tasker Evans, Mayor of Hertford, Fore Street, Hertford; Mr. Ernest R. Evans, Fore Street, Hertford; Mr. Jasper Gripper, Danes Hill, Bengeo, Hertford: Mr. Robert Hanbury, Poles, Ware; Mr. Richard Hoare, Marden Hill, Tewin, Hertford; Mr. Alfred Manser, Lampits, Hoddesdon; Mr. Thomas Piper, Redbourn; Mr. George Price, Baldock Street, Ware; Mr. Arthur Giles Puller, Youngsbury, Ware; Mr. Abel Smith, M.P., Woodhall Park, Hertford; Mr. John F. B. Sharpe, Christ's Hospital, Hertford; and Mr. Edward Taylor, Bishop's Stortford, were proposed as Members of the Society.

The President delivered an Address. (*Transactions*, Vol. I, p. 1.)

A vote of thanks to Dr. Gwyn Jeffreys having been proposed by the Mayor of Hertford (Dr. J. Tasker Evans), seconded by Mr. R. P. Greg, and carried, Mr. R. B. Croft proposed that the thanks of the meeting be accorded to the Council for having enlarged the sphere of the Society so as to allow of meetings being held in the eastern part of Hertfordshire. The Watford Natural History Society was, he said, well-established, had a large number of members, and was in a good financial position, and yet at the request of members residing on this side of the county, the name of the Society had been changed, some of its meetings at Watford had been given up, and the rules had been materially altered.

The President said that he could thoroughly endorse the remarks of Mr. Croft. He was sure the Watford members had acted in a most liberal spirit by so generously allowing residents in this part of the county to share the privileges those at Watford had hitherto exclusively enjoyed.

The Rev. R. H. Webb, in supporting the resolution, said a few words of encouragement to the younger members, mentioning the gradual steps by which he acquired his knowledge of botany, until, in 1849, he and his friend the Rev. W. H. Coleman were enabled to produce their "little work" on the botany of the county—the 'Flora Hertfordiensis.'

The meeting then resolved itself into a conversazione, and tea and coffee, etc. (kindly provided by the President and Mr. Croft), were served.

The following objects were exhibited :—

Microscopic.

Circulation of the blood in a frog's foot; by Mr. R. T. Andrews.

Phylloxera vastatrix, an insect-pest which is committing ravages in the vineyards of France and Italy; by Mr. F. M. Campbell, F.L.S.

"A dip at a venture," comprising a number of Algæ, Desmidiæ, and Entomostraca, from a pond in the neighbourhood, also *Vorticella convallaria*, etc.; by Mr. R. B. Croft, F.L.S.

Spongilla fluviatilis (the fresh-water sponge) and *Daphnia pulex*; by Mr. H. Gilbertson.

Sphagnum acutifolium (a bog-moss) from the Hoddesdon Marshes; by Mr. John Gregory.

Rotifer vulgaris (a "wheel-animalcule"), and microscopic fungi known as "cluster-cups," on the leaves of the berberry; by Mr. C. W. Nunn.

Volvox globator, *Carchesium polypinum* (a gregarious vorticella-like rotifer), *Acineta* (supposed to be a transitional stage of *Vorticella*), and *Philodina*, the "beautiful rotifer"; by Mr. F. W. Phillips.

The parasite of the ox; by Mr. J. F. B. Sharpe.

General.

A collection of ferns; fossils from the Oolite, Lias, Gault, Crag, etc.; Anglo-Saxon, Roman, and British coins; and "tokens" of Hertfordshire tradesmen of the 17th century; by Mr. R. T. Andrews.

A miniature American microscope; by Mr. E. R. P. Francis.

A collection of flints, showing their spongeous origin; specimens of rocks from the New River Company's boring at Ware; and a collection of butterflies; by Mr. H. Gilbertson.

Carapace of tortoise; by Mr. S. Harry.

A case of tropical birds, etc.; by Mrs. G. Newman.

Butterflies and other insects from the West Indies; by Mr. C. Tween.

The rooms were decorated with beautiful shrubs and flowers, amongst which were noticed *Seaforthia elegans*, *Aralia elegans*, *Abutilon variegata*, *Adiantum gracile*, *Dracæna Cooperii*, and *Dionæa Muscicapula*, lent by Mr. Francis and Mr. G. Cooper; and with fine antique and modern china, mezzotints, and pictures, lent by Mr. H. Robins.

ORDINARY MEETING, 21ST OCTOBER, 1879, AT WATFORD.

J. GWYN JEFFREYS, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mr. W. M. Armstrong, Brook Lea, Hertford; Mr. H. Beningfield, High Street, Ware; the Rev. Canon Bradby, M.A., Haileybury College, Hertford; Mr. Arthur Butler, The Slopes, Hertford; Mr. Frank M. Campbell, F.L.S., F.Z.S., F.R.M.S., Rose Hill, Hoddesdon; Mr. James William Carlile, Ponsbourne Park, Hertford; the Honourable Henry Frederick Cowper, M.P., Brocket Hall, Hatfield; the Rev. Thomas D. Croft, M.A., Kimpton Vicarage, Welwyn; Mr. F. Macdonogh Davies, Fore Street, Hertford; Baron Robert J. Dimsdale, Essendon Place, Hertford; Dr. J. Tasker Evans, Fore Street, Hertford; Mr. Ernest R. Evans, Fore Street, Hertford; Mr. Jasper Gripper, Danes Hill, Bengeo, Hertford; Mr. Robert Hanbury, Poles, Ware; Mr. Richard Hoare, Marden Hill, Tewin, Hertford; Mr. Alfred Manser, Lampits, Hoddesdon; Mr. Thomas Piper, Redbourn; Mr. George Price, Baldock Street, Ware; Mr. Arthur Giles Puller, Youngsbury, Ware; Mr. Abel Smith, M.P., Woodhall Park, Hertford; Mr. John F. B. Sharpe, Christ's Hospital, Hertford; and Mr. Edward Taylor, Bishop's Stortford, were elected Members of the Society.

Mr. Alfred Fowell Buxton, Easneye Park, Ware; Mr. Thomas Fowell Buxton, Easneye Park, Ware; Miss Emily Camp, 167, High Street, Watford; Mr. Alfred Chapman, Poles, Ware; the Rev. Henry Hallet Coddington, M.A., High Cross Vicarage, Ware; Dr. George Elin, Leahoe, Hertford; the Most Noble the Marquis of Salisbury, K.G., F.R.S., Hatfield House; Colonel Smyth, The Grange, Welwyn; the Rev. W. Yalden Thomson, St. Andrew's Parsonage, Watford; the Right Honourable the Earl of Verulam, Lord Lieutenant of Hertfordshire, Gorhambury, St. Albans; and Miss Rose C. White, Maisonette, St. Albans, were proposed as Members.

The following paper was read:—

"Animals which have become Extinct in Britain within Historic Times." By James Edmund Harting, F.L.S., F.Z.S. (*Transactions*, Vol. I, p. 5.)

The President, in proposing a vote of thanks to Mr. Harting, said that the proofs he had given of the existence in Britain, within historic times, of the animals enumerated, were so numerous and conclusive, that, with one possible exception, they might be considered as established. He was not quite certain as to the reindeer. It was known that reindeer bones had been found both in this country and in France associated with bones of the mammoth, rhinoceros, and hippopotamus, all of which became extinct here long before the historic period. There had, however, been found, near Swansea, no less than 500 antlers of the reindeer, in a spot where it could not have roamed as it did in Upper Norway, Finland, and Greenland. He remembered a pair of horns of the red-deer, which was well known to have lived into historic times, being trawled up in the Bristol Channel, fifteen miles from land, having become entangled in a fisherman's net.

Dr. Brett inquired if the British rat was not now believed to be extinct. He had read that it was, or at least was becoming so.

Mr. J. Logan Lobley referred to the insular character of our country as conducing to the extinction of its wild animals. The five animals treated of by Mr. Harting were still, he said, existing in continental areas, but had become extinct here because they had no places to retreat to at a considerable distance from enclosed and cultivated areas. The influence of insular areas was exemplified in the case of the moa or dinornis of New Zealand and the dodo of the Mauritius. The date of the extinction of the dinornis was uncertain, but its bones, and even their ligaments, had been found, and it certainly was living, and was somewhat abundant, within the historic period. The dodo existed until 1602 and was tolerably abundant up to then. Neither would have become extinct had they been living on continental areas. The insular character of this country had conduced to the extinction of other animals at periods preceding that now brought before them; for there were abundant remains of animals, now inhabiting continental areas, such as lions, tigers, and elephants, which were living in this country previous to the time when it was separated from the Continent of Europe, and which became rapidly extinct after this separation took place. It was also a remarkable fact that the greater mammalia, with the exception of the elephant, only lived in continental areas, and no doubt the elephant became rapidly extinct in Britain after its separation from the Continent by the Straits of Dover. At any rate it was an important fact to bear in mind that the insular character of any country was greatly conducive to the extinction of the wild animals of that country.

Mr. Harting, in replying, said that the incident mentioned by the President, of 500 reindeer antlers being found in one cavern, might be accounted for in this way The reindeer was an animal that migrated in large numbers in the spring and autumn; in Siberia, for instance, at the present time, coming down in herds of several thousands, crossing extensive tracts of country, and swimming rivers. The strongest and boldest taking first to the water, the weaker ones followed, until at last the water was covered, nothing being seen but the antlers and a small portion of the head. In swimming large rivers and lakes the weaker animals would succumb and their bodies perhaps be trodden down by their comrades, carried away by currents, and stranded in numbers on the first convenient place.

With regard to the English rat, or black rat, it was thought to be on the verge of extinction, but during the last twelve months he had made inquiries and had found that it still existed at various places, chiefly seaport towns From this it might be inferred that the old race was kept up by the importation of others from abroad.

The observations of Mr. Lobley were very suggestive, and he quite agreed with him that the insular character of this country had much to do with the extermination of these animals. This was particularly noticeable in the case of the reindeer, which, as was known from the discovery of its bones, once inhabited England and Ireland. From England it appeared to have been driven north to Caithness by the red-deer, there to die, simply because there was no further point to retreat to.

The President mentioned that Mr. J. W. Carlile, of Ponsbourne Park, had discovered in his grounds some curious ruins of a house, of historic interest, dating from the time of Henry the Seventh, and would be pleased to show them to any member of the Society.

Ordinary Meeting, 6th November, 1879, at Hertford.

Richard B. Croft, Esq., R.N., F.L.S., etc., in the Chair.

Mr. Charles E. Longmore, Hertford, was proposed as a Member of the Society.

The following paper was read:—

"Work for the Society." By R. B. Croft, R.N., F.L.S., F.R.M.S., Hon. Sec.

The 15th rule of the Society, prohibiting the extermination of rare animals and plants, was first referred to as leading to the question of acclimatization, and the re-introduction of such plants as the daffodil and fritillary, now known in only a few stations in Hertfordshire, was advocated, as also was the planting of hardy species not indigenous but which could only fail to become acclimatized from being up-rooted as new or rare and transplanted into gardens; though while success might add to the loveliness of many a beautiful spot, it might puzzle many a future botanist.

Another work for members, and one in which, Mr. Croft said, he was himself especially interested, was the recording of periodical natural phenomena, or, in other words, the noting of the time of blossoming of wild flowers, of the migration or commencement of song of birds, and of the appearance of insects. Such observations, on a selected number of species, would be recorded in the 'Transactions' of the Society, and copies would be furnished to the Meteorological Society to be embodied in the annual reports of observations taken throughout England. For the young, even the very young, keeping such a record would be found a very useful discipline, not only in scientific but also in general observation, and it would add to the pleasure of every walk by giving it an object, would foster an interest in botany, and teach the observer the names of those common wild flowers which ought to be known by every one. A few observations might fix the arrival of our common migratory birds in the valley of the Lea; the cuckoo, for instance, had for years been heard at Amwell a day earlier than on the north of Ware, and the same remark applied to the nightingale. A succession of observations for several years, on even a single object, might lead to most interesting results.

Again, those who possessed microscopes might do plenty of work for the Society, not necessarily with first-class stands and high powers, for the most valuable histological work had been done with microscopes which would be considered very inferior now, and even at the present day in Germany, where perhaps biology was more studied than in any other country, stands equal to those by our first-class English makers were almost unknown. Nor should any microscopist think that his instrument was not good enough to bring to the meetings of the Society, for at the Scientific Evenings of the Royal Microscopical Society instruments of every class were always to be seen, and if the first microscopical society in the world admitted and encouraged such latitude, surely a society of amateurs ought to feel that no instrument, however small or inexpensive, was unworthy of a place at its meetings.

There was one other kind of work that he might suggest, and that was tracing to the right plants names which had become obsolete. In Izaak Walton's 'Complete Angler' the flower "culverkeys" was twice mentioned, and the question as to what it was had recently been asked in 'Science Gossip.' He would therefore suggest that an endeavour should be made to find out what flower culverkeys was.

Referring, in conclusion, to natural-history observation in general, Mr. Croft said that a very common question was, What is the good of it? The answer to that question might well occupy an entire evening, but he might briefly say that the study of Natural History sharpened the power of observation to an extent hardly to be believed by those who had not tried it, gave a perfectly harmless and very inexpensive form of recreation, always accessible, and excited a new interest in, and a greater power of appreciation of, the marvellous works of our Creator.

After some remarks by Mr. Henry Gilbertson, who advocated fern-spores being sown in moist places in the roads and lanes of Hertfordshire, the Chairman announced that a microscopic-object cabinet, similar to the Society's cabinet at Watford, had been purchased for Hertford, and would be kept at the rooms of the Literary and Scientific Institution, where it would be at all times open to the inspection of the members.

The meeting then resolved itself into a conversazione, and the remainder of the evening was devoted to the study of microscopic objects, and the comparison, with the usual test-objects, of the highest powers of the various microscopes in the room.

Ordinary Meeting, 18th November, 1879, at Watford.

Alfred T. Brett, Esq., M.D., Vice-President, in the Chair.

Mr. Alfred Fowell Buxton, Easneye Park, Ware; Mr. Thomas Fowell Buxton, Easneye Park, Ware; Miss Emily Camp, 167, High Street, Watford; Mr. Alfred Chapman, Poles, Ware; the Rev. Henry Hallet Coddington, M.A., High Cross Vicarage, Ware; Dr. George Elin, Leahoe, Hertford; Mr. Charles E. Longmore, Hertford; the Most Noble the Marquis of Salisbury, K.G., F.R.S., Hatfield House; Colonel Smyth, The Grange, Welwyn; the Rev. W. Yalden Thomson, St. Andrew's Parsonage, Watford; the Right Honourable the Earl of Verulam, Gorhambury, St. Albans; and Miss Rose C. White, Maisonette, St. Albans, were elected Members of the Society.

Sir Edmund Beckett, Bart., Q.C., Batch Wood, St. Albans; the Rev. Henry Wade Hodgson, M.A., The Vicarage, King's Langley; and the Rev. Edward Cumming Ince, M.A., Sunbury House, Watford, were proposed as Members.

The following paper was read:—

"Our British Beetles: Notes on their Classification and Collection." By Arthur Cottam, F.R.A.S. (*Transactions*, Vol. I, p. 25.)

Remarks were made by the Chairman, Mr. Sydney Humbert, and Mr. W. L. Smith. In replying Mr. Cottam said that he could not find that the Entomology of Hertfordshire had been worked out at all. There was a great need of workers, and he wished that any one finding insects would send them to him, so that they might be recorded.

Ordinary Meeting, 2nd December, 1879, at Hertford.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mr. J. Lyon Foster, Millbrook House, Ware, and Mr. Charles H. Merritt, Trinity Villa, Bengeo, were proposed as Members of the Society.

The following paper was read :—

"General Observations on Spiders." By F. M. Campbell, F.L.S., F.Z.S., F.R.M.S. (*Transactions*, Vol. I, p. 37.)

Several questions having been asked, Mr. Campbell, in reply, said that the duration of life of a spider varied very much, and was greater in a female than a male. He had a house-spider which he had kept for two years, and it was full grown when he got it, as shown by its not casting its skin. The male spider certainly did not spin a web. The number of webs a spider would spin would depend upon the quantity of food it had; and Dr. Wilder, when he wanted the silk to be stronger than usual, gave his spiders flies which had been feeding on raw meat.

Diagrams and specimens were exhibited by Mr. Campbell in illustration of his paper.

Ordinary Meeting, 16th December, 1879, at St. Albans.

Joseph Pollard, Esq., in the Chair.

The following lecture was delivered :—

"Homology and Analogy of Plant Organs." By the Rev. George Henslow, M.A., F.L.S., F.G.S. (*Transactions*, Vol. I, p. 49.)

The Chairman, in proposing a vote of thanks to Mr. Henslow, said that he had noticed during the past season that many rose trees had developed a crop of buds instead of roses, and inquired as to the cause of this.

Mr. John Hopkinson remarked that he had noticed on Mr. Henslow's diagrams illustrating certain abnormal functions of the leaf, their carnivorous habits named, and as he was exhibiting a leaf of the sundew dining off an insect it had captured, he would ask Mr. Henslow to give an explanation of this habit, which he presumed had been *acquired* by the *Drosera* and other carnivorous plants.

Mr. Henslow replied that the abnormal growth of roses which had been mentioned was doubtless due to the damp weather. He then gave an account of the carnivorous habits of the flowers and leaves of certain plants, illustrating his remarks with drawings of *Drosera*, *Dionæa*, and other carnivorous plants, and explaining the different methods by which insects are captured, killed, and finally absorbed by them.

After some discussion as to the best time of the year for holding meetings at St. Albans, resulting in a suggestion that the opening meeting of the following session (in October) should be held there, the meeting resolved itself into a conversazione, at which microscopic and other natural-history objects were exhibited by Mrs. Blagg, Mr. Cole, the Rev. H. N. Dudding, Mr. A. E. Gibbs, the Rev. Dr. Griffith, Mr. Harris, Mr. John Hopkinson, Mrs. Masters, Mr. Nowell, Mr. Henry Lewis, the Rev. C. M. Perkins, and Mrs. S. Monkton White.

Bye Meeting, 1st January, 1880, at Ware.

This meeting was held in conjunction with the Ware Institute, and was devoted principally to microscopic study and to the examination of objects of interest in science, art, and antiquity. Many of the objects, including several natural-history collections, had been found in the neighbourhood. Of these may be mentioned a collection of lichens from Amwell, exhibited by Miss Middleton;

butterflies and moths caught in the neighbourhood of Ware, exhibited by Mr. F. W. Chuck; butterflies, moths, and beetles collected at High Cross, exhibited by Mr. S. M. Leake; and fossils from the Chalk, etc., exhibited by Mr. R. T. Andrews, Mr. S. M. Leake, and Miss Middleton.

There were also exhibited microscopic and other objects by Mr. R. T. Andrews, Mr. Barton, Mrs. Bland, Mr. H. O. F. Butcher, Mr. Joseph Chuck, Mr. R. B. Croft, Mrs. Ellis, Mr. Harrison, Miss Hide, Mrs. Hudson, Mr. Joseph Hunt, Mr. J. C. Johnson, the Rev. C. Lilley, Mr. H. Page, Mr. F. W. Phillips, Mr. George Price, Mrs. Sheppard, Mr. H. Ward, Mr. Wickham, and Mrs. Worpell, and two microscopes were lent by Messrs. R. and J. Beck.

A short address, chiefly on the wonders of the microscope, and with especial reference to the objects exhibited, was given by the President, Dr. Gwyn Jeffreys, F.R.S.

Ordinary Meeting, 20th January, 1880, at Watford.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Sir Edmund Beckett, Bart., Q.C., Batch Wood, St. Albans; Mr. John Lyon Foster, Millbrook House, Ware; the Rev. Henry Wade Hodgson, M.A., The Vicarage, King's Langley; the Rev. Edward Cumming Ince, M.A., Sunbury House, Watford; and Mr. Charles H. Merritt, Trinity Villa, Bengeo, Hertford, were elected Members of the Society.

Mrs. Bishop, The Platt, Watford; Miss Eliza Church, London Road, St. Albans; Mr. Henry Lewis, St. Peter's Street, St. Albans; Mr. C. T. Part, The Pré, St. Albans; the Rev. Henry Smith, M.A., Christ's Church, St. Albans; Miss Vicars, The Limes, St. Albans; Mr. S. Monkton White, Thorne House, St. Albans; and Mr. E. S. Wiles, London Road, St. Albans, were proposed as Members.

The following communications were read:—

1. "On the Occurrence of *Vertigo Moulinsiana*, Dupuy, in Hertfordshire." By Henry Groves. Communicated by the President. (*Transactions*, Vol. I, p. 81.)

The President said that lists of the Mollusca of many counties in England had been published, and he thought that Hertfordshire ought not to be left in the background, for it was peculiarly suited to their habitability in the diversified nature of its hills and valleys, woods and waters. The animal or soft parts of *Vertigo Moulinsiana* had, he said, been described by him in the 'Annals of Natural History' for November, 1878, and its discovery by Mr. Groves in Hants and Herts was then noticed. He mentioned another rare Hertfordshire mollusk, a species of *Succinea*, of which he had found a single specimen at St. Albans, on the bank of the river Ver, near the Great Northern Railway Station. This form he had published in his 'British Conchology' as a variety of *S. putris*, but subsequent investigation had induced him to consider it a distinct species. This *Succinea* he described as extremely thin and finely striated lengthwise, the spire very small, the last whorl disproportionately large, and the mouth more open and expanded than in any other European species. He recommended any members of the Society who could do so to search at St. Albans next summer for this *Succinea*, which would be found with the two common British species, *S. putris* and *S. elegans*; and he said that he would always be glad to assist any conchological members in the determination of this and other Hertfordshire land and fresh-water mollusca.

2. "Note on the Pupation of the Stag-beetle, *Leucanus Cervus*." By Arthur Cottam, F.R.A.S. (*Transactions*, Vol. I, p. 83.)

3. "On the Appearance of *Nudaria mundana* at Harpenden." By John J. Willis.

Mr. Willis stated that on the evening of the 13th of December, which was a tolerably warm night, succeeding a number of excessively severe frosts, soon after the lights were lit in his room, an immense swarm of moths appeared against the panes of the window. A few were caught and were found to be of the species *Nudaria mundana*, Linn. After a short time they took to flight and were not again seen.

4. "Notes on Birds observed in 1879." By John E. Littleboy. (*Transactions*, Vol. I, p. 70.)

5. "On the Abundance of Moles in the Neighbourhood of Much Hadham." By the Rev. H. S. Mott, M.A.

Mr. Mott mentioned that at Much Hadham moles had been showing great activity this winter. He had resided in the neighbourhood about 60 years and had never seen such quantities of mole-casts in the fields and roadsides as at present. He inquired whether this was generally the case, and what was the cause.

The President said that it had been generally observed that moles were very numerous this season, and that he had heard the explanation given that the worms upon which they fed were abundant in consequence of the wet summer and autumn. Whether or not moles really did any harm to a field was an interesting question, and he thought that if the mole-heaps were spread and raked the mould might be useful as a top-dressing. Another question was as to whether their food, the worms, did harm. Some said that worms eat the fibres of the roots of grasses and other plants, and others, with more reason, that they had no organs capable of biting roots. They certainly swallowed large quantities of earth in order to extract nourishment, animal or vegetable, from it.

Dr. Brett said that even if a wet season were not conducive to the existence of many worms, the air being moist the worms would come to the surface of the ground, and the moles need not go so far in search of them. He had noticed the abundance of mole-heaps, but thought that it did not necessarily follow that moles were unusually abundant.

Mr. John Hopkinson remarked that, with regard to the seasons, after six months of unusually wet weather there had been nearly four months unprecedentedly dry, the present month, and October, November, and December last year. That being the case, he thought that moles might now have to work harder than usual and so make more mole-heaps on account of the scarcity of their food, or the difficulty in getting it, rather than its abundance.

Mr. J. E. Littleboy said that he had never before seen so many mole-heaps in the neighbourhood of Hunton Bridge, as he had this winter; and

Mr F. W. Silvester stated that the moles were also unusually busy at St. Albans.

A photograph of Professor Draparnaud, a celebrated French conchologist, was presented to the Society by the President.

Mr. F. Littleboy and Mr. F. W. Silvester were appointed auditors of the accounts for 1879.

Anniversary Meeting, 17th February, 1880.

(At Watford.)

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Charles Cardale Babington, M.A., F.R.S., F.L.S., F.S.A., F.G.S., Professor of Botany in the University of Cambridge, 5, Brookside, Cambridge, and Philip Lutley Sclater, M.A., Ph.D., F.R.S., F.L.S., F.G.S., Secretary of the Zoological Society, 11, Hanover Square, London, W., were elected Honorary Members of the Society.

The Report of the Council for 1879, and the Treasurer's Account of Income and Expenditure, were read and adopted.

The President delivered an Address. (*Transactions*, Vol. I, p. 85.)

The Balloting-glass having been removed, and the lists examined by the Scrutineers, the following gentlemen were declared to have been duly elected as the Officers and Council for the ensuing year.

President.—J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., F.G.S., etc.

Vice-Presidents.—The Rev. Canon Bradby, M.A.; Alfred T. Brett, M.D.; the Right Hon. the Earl Cowper, K.G.; John Evans, D.C.L., LL.D., F.R.S., F.L.S., F.S.A., F.G.S.; John E. Littleboy; Reginald A. Pryor, B.A., F.L.S.

Treasurer.—Charles F. Humbert, F.G.S.

Honorary Secretaries.—John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.M.S.; Richard B. Croft, R.N., F.L.S., F.R.M.S.

Librarian.—Arthur Cottam, F.R.A.S.

Curator.—W. Lepard Smith.

Other Members of the Council.—Prof. John Attfield, Ph.D., F.R.S., F.C.S.; E. M. Chater; the Right Hon. the Lord Ebury, F.M.S.; the Right Hon. the Earl of Essex; H. George Fordham, F.G.S.; James U. Harford; Sydney Humbert; J. Logan Lobley, F.G.S., F.R.G.S.; the Rev. Herbert R. Peel, M.A.; Joseph Pollard; Frank W. Silvester, F.M.S.; the Rev. R. Holden Webb, M.A.

It was then resolved—

That the thanks of the Society be given to Mr. Arthur Cottam, retiring from the office of Vice-President; to Mr. John Hopkinson, Hon. Sec., retiring from the office of Librarian; and to Mr. R. R. Carew, and the Rev. C. M. Perkins, retiring from the Council.

Report of the Council for 1879.

The Council of the Hertfordshire Natural History Society and Field Club, in presenting the fifth Annual Report since the foundation of the Society as the Watford Natural History Society and Hertfordshire Field Club, has much pleasure in announcing that the change which on the 1st of July took place in the constitution of the Society has had very satisfactory results, having largely increased the number of members in the eastern part of the county, without having in any way detracted from the position the Society has attained, and the interest taken in it by the members, in the western part.

During the year eighty-seven ordinary members have been elected; two ordinary members have been elected honorary members; four members have compounded for their annual subscription; eighteen members have resigned; three after their election have declined to be members; one has been excluded from the Society for non-payment of subscription for three years; and the Council regrets to have to record the loss of four members by death —Mr. Edward H. Ambler, M.R.C.S.; Mr. Robert Clutterbuck, F.G.S.; the Rev. F. W. Goadby, M.A.; and Mr. Alfred O. Sedgwick.

The census of the Society at the end of the years 1878 and 1879 was as follows:—

	1878.	1879.
Honorary Members	10	12
Life Members	22	26
Annual Subscribers	138	193
	170	231

Four parts of the Society's 'Transactions' have been published and distributed to the members during the year, making six parts of the second volume, which when completed will contain the proceedings to the end of last session. With the third volume will therefore commence the proceedings of the Society under the name it now bears.

The following are the principal papers and lectures which have been read or delivered during the year 1879:—

Jan. 9, at Watford.—Poisons not always Poisons; by Professor Attfield, Ph.D., F.C.S.

Feb. 13, at Watford.—Anniversary Address; by the President, Alfred T. Brett, M.D.

March 13, at Watford.—The Study of Geology; by J. Logan Lobley, F.G.S., F.R.G.S.

April 10, at Watford.—Bees and Bee-keeping; by the Rev. Herbert R. Peel, M.A.

May 13, at Watford.—Reduction of Meteorological Observations; by William Marriott, F.M S.

—— Meteorological Observations taken at Wansford House, Watford, during the year 1878; by John Hopkinson, F.L.S., F.M.S., etc., Hon. Sec.

—— Report on the Rainfall in Hertfordshire in 1878; by the Hon. Secretary.

—— Report on Phenological Observations in Hertfordshire in 1878; by the Honorary Secretary.

—— Remarks on the Winter of 1878-79; by W. Marriott, F.M.S.

June 12, at Watford.—The Recent Discovery of Silurian Rocks in Hertfordshire, and their relation to the Water-bearing Strata of the London Basin; by John Hopkinson, F.L.S., F.G.S., Hon. Sec.

Oct. 2, at Hertford.—Address; by the President, J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., F.G.S.

—— 21, at Watford.—Animals which have become Extinct in Britain within Historic Times; by J. E. Harting, F.L.S., F.Z.S.

Nov. 6, at Hertford.—Work for the Society; by R. B. Croft, R.N., F.L.S., F.R.M.S.

Nov. 18, at Watford.—Our British Beetles: Notes on their Classification and Collection; by Arthur Cottam, F.R.A.S.
Dec. 2, at Hertford.—Observations on Spiders; by F. M. Campbell, F.L.S., F.Z.S., F.R.M.S.
—— 16, at St. Albans.—Homology and Analogy of Plant Organs; by the Rev. George Henslow, M.A., F.L.S., F.G.S.

Several short communications have also been read, and microscopic and other objects of interest have been exhibited.

It will be seen that the papers read at the Watford meetings have quite equalled in number and value the average of those of former years; and it may be added that at no former period has the interest taken by the members in these meetings been greater than in the past year. The last meeting in the year, held at St. Albans, was also eminently successful, and the prospect of meetings being occasionally held there has induced several of its residents to become members of the Society.

The meteorological and phenological reports for 1878 have already appeared in the 'Transactions,' and the reports for 1879 will shortly be presented. The number of observers of periodical natural phenomena continues to increase, observations having been taken in 1879 at Hertford and Sawbridgeworth, as well as at the former stations—Watford, St. Albans, Harpenden, Ware, and Odsey.

On Saturday afternoon, the 19th of April, a visit was paid to the Museum of the Geological Survey of Great Britain, in Jermyn Street, London, where the members were received by Mr. Robert Etheridge, F.R.S., the Palæontologist to the Survey, who gave an account of the origin of the Museum; showed how its chief feature was to exemplify the applications of the mineral productions of the British Islands and our Colonies to purposes of use and ornament, hence being called the "Museum of Practical Geology"; explained in detail the contents of what is known as the "horse-shoe case," which is devoted to the illustration of non-metallic minerals and their uses; and gave information on other objects in the Museum, including various models, and boring, blasting, and other machines. About two hours were thus spent in the Museum, and under the guidance of Mr. Etheridge the members present had an opportunity of acquiring information which they could not have had in any other way, their appreciation of which was evidenced by the cordial vote of thanks Mr. Etheridge received at the conclusion of the visit.

A larger number of Field Meetings were held than in any previous year, all that were projected having been carried out; and, as far as the weather permitted, all were successful. Of the six meetings held, the first, second, and fourth were on fine days, and the third, fifth, and sixth on wet days. The following are the dates of these meetings, and the localities visited:—

May 3.—Abbot's Langley and Leavesden.
—— 17.—Colne Valley Water-works, and Colney Butts and Hagden Lane Gravel Pits, Watford.
—— 31.—Rickmansworth Common Moor.
June 14.—Harpenden, Rothamsted, and Redbourn Bury.
—— 25.—Tewin Water, Digswell, and Ayot Green, Welwyn.
July 12.—Chiltern Green, Luton.

Four of these meetings were held in conjunction with other societies. The second, in the neighbourhood of Watford, took place in conjunction with the Geologists' Association, and was the most numerously attended of all; at the third, at Rickmansworth Common Moor, which, owing to the very wet weather, was the least numerously attended, members of the Quekett Microscopical Club were present; the fifth, the annual whole-day meeting, held in the neighbourhood of Welwyn, was attended by members of the Luton Natural History Society; and the sixth was held in the neighbourhood of Luton, by invitation from that Society.

For hospitality kindly afforded at the Field Meetings the Society is indebted to Mr. Arnold, Redbourn Bury; Mr. Wilshere, The Fryth, Welwyn; and Alderman Cumberland, Luton. The thanks of the Society are also due to Mr. W. Whitaker, of the Geological Survey of England, for his demonstrations on the geology of Watford at the second Field Meeting, and to Dr. J. H. Gilbert for his explanations of the experiments carried on at the Rothamsted experimental farm, and at the "Lawes Testimonial Laboratory" at Harpenden.

All these meetings, except the last, which was conducted by the Secretary of the Luton Natural History Society, were planned and arranged by your Secretary, who desires to take this opportunity of asking other members of the Society to suggest localities to be visited at future Field Meetings, and afterwards to write and forward to him reports of them for the 'Proceedings.'

The donations to the Society's Library have quite equalled the average of former years. They consist, as usual, principally of the publications of societies, and of other periodical publications, received in exchange. The list of the latter now comprises 'Science Gossip,' the 'Naturalist,' the 'Midland Naturalist,' the 'Scottish Naturalist,' Symons' 'Monthly Meteorological Magazine' and 'British Rainfall,' 'Grevillea,' and the 'Journal of Conchology,' the two last-named having been added during the year. The Society continues to subscribe to the 'Geological Record,' the 'Journal of Botany,' the 'Entomologist,' and the 'Zoologist,' and to the publications of the Ray Society.

An additional vote for books, to the amount of £6, has this year been made by the Council, and with it fifty-seven volumes of works on various branches of Natural History have been purchased. Forty-five volumes have been bound during the year, and about thirty more are now ready for binding. Owing to these considerable accessions another book-case is required, and it is hoped that, by the courtesy of the Public Library Committee, it will shortly be provided.

A microscopic object cabinet has been purchased for Hertford and now contains thirty slides—twelve presented by Mr. R. T. Andrews, twelve by Mrs. Croft, and six by Mr. F. W. Phillips. The cabinet is under the care of Mr. Phillips, by whom donations will be gladly received and acknowledged. To the cabinet at Watford seven slides of rock-sections have been presented by Mr. J. Vincent Elsden.

A museum show-case has also been purchased, and the Curator will be glad to receive, for exhibition in the case, geological specimens and recent Invertebrata collected in the county, and also plants, similarly collected, for the Society's herbarium, the Council having decided to restrict the Society's Museum to specimens collected in Hertfordshire.

Since 1876, when a policy of insurance for £50 was taken out, the property of the Society deposited in the Watford Public Library has so considerably increased that it has been thought advisable to increase the fire insurance to £150, and the policy for that amount in the same office as before, now covers museum, show-cases, and specimens, as well as the Society's library and surplus stock of 'Transactions.'

The financial condition of the Society continues to be satisfactory. A slight alteration has this year been made in the balance-sheet. In order to simplify the accounts, subscriptions received in advance are included in the balance, instead of being appended to it as in former years. In addition to the balance of £20 3*s.*, of which amount £20 represents subscriptions paid in advance, the sum of £22, being the amount received for entrance fees in 1876 and 1877, has been withdrawn from the Society's current account and placed on deposit at the London and County Bank. The whole of the amount representing the 26 life-memberships is also invested in Consols or placed on deposit with a view to future investment. The arrears of subscriptions and entrance fees amount to £17, of which about £10 may be considered good. To show clearly the present financial position of the Society, and the general nature of the receipts and expenditure, a résumé of all the balance-sheets is here given.

Receipts.	£	*s.*	*d.*	Expenditure.	£	*s.*	*d.*
Annual subscriptions	386	10	0	Books, stationery, and miscellaneous printing	70	15	6
Entrance fees	64	10	0	Printing 'Transactions'	200	6	11
Life compositions	130	0	0	Library and property purchased	49	17	7
Sale of 'Transactions'	5	14	5	Expenses of meetings	43	0	0
Interest on Consols and deposit account	6	10	6	Postages and sundries	57	1	11
				Purchase of £103 4*s.* 6*d.* Consols.....	100	0	0
				Deposit account at Bank.....	52	0	0
				Balance, being current account at Bank	20	3	0
	£593	4	11		£593	4	11

Some account has now to be given of the origin and present results of the change made during the year in the name and constitution of the Society. In a letter received by your Secretary in January, 1879, a member who has always taken a great interest in the Society suggested the formation of a branch in East Herts, the members of which might hold meetings at Hertford, Ware, and other places; and also, in the possible event of a considerable accession of members in the eastern part of the county, the change of name of the Society from the Watford to the Hertfordshire Natural History Society.

To this scheme your Secretary at once gave his attention, and, the matter being favourably received by the Council, a revised code of rules was drawn up, and subsequently adopted at a special meeting called for the purpose in June, when it was also decided that the new rules should date from the 1st of July. The Council requested the originator of this change to act as Honorary Secretary *pro tem.* for East Herts, and in this capacity Mr. Croft has from that time most ably and successfully conducted the affairs of the Society in the eastern part of Hertfordshire.

The immediate effect of this extension of the Society's scope has been, as already stated, a large increase in the number of members; and it is still more gratifying to be able to add that the number of workers has also increased. Three of the newly-elected members have read, or promised to read, original papers at the meetings in East Hertfordshire, and the Council has reason to believe that other members there will be able to fill, or nearly to fill, next session's programme.

The hope that the Society might be a medium for bringing together the microscopists of East Herts has not been falsified. At the opening meeting at the Shire Hall, Hertford, on the 2nd of October, several microscopes were in the room; and as the season was late and favourable there was a remarkably good display of pond life. The meeting on the 6th of November was principally devoted to microscopic study with special reference to comparisons of high powers, and one practical result of this was the discovery of errors in the denomination of object glasses.

For the success of these meetings in East Herts, and the increase in the number of members, the Society is indebted to others besides Mr. Croft, who have worked energetically in its interest, and amongst them may be specially mentioned Mr. R. T. Andrews, Mr. Stephen Austin, and Mr. F. W. Phillips. There is one other member of the Society whose services have been of very great benefit. Your President has from the time of his election to the office entered heartily into the affairs of the Society, has been most assiduous in presiding at the meetings on both sides of the county, and has added largely to the list of members. The Society has been most fortunate in having Dr. Gwyn Jeffreys as its President at the time of its extension from a comparatively local to a county institution.

INCOME AND EXPENDITURE DURING THE YEAR ENDING 31st DECEMBER, 1879.

Dr.	£	s.	d.
To Balance	19	1	7
,, Subscriptions for 1876	1	0	0
,, ,, ,, 1877	1	10	0
,, ,, ,, 1878	7	10	0
,, ,, ,, 1879	77	10	0
,, ,, ,, 1880	19	10	0
,, ,, ,, 1881		10	0
,, Entrance Fees	35	0	0
,, Life Compositions	20	0	0
,, Dividend on £103 4*s.* 6*d.* Consols, for 1877 and 1878	6	3	8
,, Sale of 'Transactions'	2	4	11
	£190	0	2

Cr.	£	s.	d.
By Books and Stationery	5	16	8
,, Printing 'Transactions'	59	13	6
,, Miscellaneous Printing	12	15	8
,, Rent—Watford Public Library	5	0	0
,, Attendance at ditto	1	5	0
,, Expenses of St. Albans Meeting	0	17	0
,, Reporting	1	1	0
,, Library	14	14	11
,, Microscopic Object Cabinet	1	17	0
,, Museum Show Case	5	11	0
,, Addressing Notices and 'Transactions'	1	11	0
,, Postages	16	6	2
,, Sundry small expenses	1	8	3
,, Amount placed to Deposit Account at the London and County Bank	42	0	0
,, Balance	20	3	0
	£190	0	2

	£	s.	d.
Amount invested in Consols	100	0	0
,, on deposit at the London and County Bank	52	0	0

Audited and found correct, Feb. 4th, 1880, { FREDERICK LITTLEBOY, F. W. SILVESTER.

Donations to the Library in 1879.

Title.	Donor.
Butt, Rev. J. M. Introduction to English Botany. 8vo. London, 1825	*Mr. J. Hopkinson.*
Clutterbuck, Rev. J. C. A Letter on . . . . supplying the Metropolis with Water from the Valley of the River Colne. 8vo. Watford, 1841	*Dr. A. T. Brett.*
Cornwall, Royal, Polytechnic Society. Annual Reports for 1875-77. 8vo. Falmouth, 1876-78 . .	*Mr. J. Hopkinson.*
Davy, Dr John. Physiological Researches. 8vo. London, 1863	,,
Elliot, Sir Walter. Extracts from the Opening Address of the President of the Botanical Society of Edinburgh, 1870. (*Trans. Bot. Soc.* 1871.) . .	*The Author.*
Galton, Francis. Meteorographia, or Methods of Mapping the Weather. Folio. London, 1863 . .	*Miss E. A. Ormerod.*
Geikie, James. The Great Ice Age and its Relation to the Antiquity of Man. 8vo. London, 1874 . .	*Mr. W. Whitaker.*
Geographical Magazine. Vol. v, Nos. 7-12. 4to. London, 1878	*Mr. R. B. Croft.*
Hayden, Prof. F. V. Sun Pictures of Rocky Mountain Scenery. 4to. New York, 1870	*The Author.*
Jevons, Prof. W. S. On the Movement of Microscopic Particles suspended in Liquids. (*Quart. Journ. Science*, 1878.)	*Dr. A. T. Brett.*
Linnean Society. Journal. Botany, Vol. xvii, Nos. 98-100 (1878). Zoology, Vol. xiv, Nos. 75-77 (1878-79). 8vo. London	*Mr. R. B. Croft.*
Marriott, W. Sur le Psychromètre. (*Assoc. Française pour l'avancement des Sciences*, 1877.)	*The Author.*
Martin, Prof. T. Thirty-eight Plates with Explanations; intended to illustrate Linnæus' System of Vegetables. 8vo. London, 1799	*Dr. A. T. Brett.*
Mello, Rev. J. M. Handbook to the Geology of Derbyshire. 8vo. London and Derby, n.d.	,,
New Athenæum Club, London. List of Members, August, 1879. 8vo. London	*Mr. J. L. Lobley.*
Ormerod, Eleanor A. The Prevention of Insect Injury by the use of Phenol Preparations. (*Trans. Entomological Society*, 1878.)	*The Author.*
———. Notes of Observations of Injurious Insects; Report, 1878. 8vo. London, 1879	,,
Page, Dr. David. Introductory Text-book of Geology. 8vo. Edinburgh and London, 1869	*Mr. J. Hopkinson.*
Phipson, Dr. T. L. Phosphorescence, or, the Emission of Light by Minerals, Plants, and Animals. 2nd edition. 8vo. London, 1879	,,
Preston, Rev. T. A. Wiltshire Rainfall, 1878. 8vo. Marlborough, 1879	*The Editor.*
Ray Society. Reports on the Progress of Zoology and Botany, 1841, 1842. 8vo. London, 1845 . .	*Dr. A. T. Brett.*
———. Reports and Papers on Botany. *Ib.* 1846 .	,,
———. Reports on Zoology for 1843, 1844. *Ib.* 1847	,,
Solly, Prof. E. Rural Chemistry. 3rd edition. 12mo. London, 1850	*Mr. J. Hopkinson.*

Title.	Donor.
Symons, G. J. British Rainfall, 1878. 8vo. London, 1879	*The Editor.*
———. Monthly Meteorological Magazine. Vol. xiv. 8vo. London, 1879	,,
Whitaker, W. The Geology of the N.W. Part of Essex and the N.E. Part of Herts, etc. 8vo. London, 1878	*The Author.*

Received in Exchange, 1879.

Barrow Naturalists' Field Club. Proceedings. Vol. iii. 8vo. Barrow, 1879.

Bath Natural History and Antiquarian Field Club. Proceedings. Vol. iv, No. 2. 8vo. Bath, 1879.

Belfast Natural History and Philosophical Society. Proceedings. Session, 1877-78. 8vo. Belfast, 1878.

Belfast Naturalists' Field Club. Proceedings. New Series. Vol. i, part 4. 8vo. Belfast, 1878.

Berwickshire Naturalists' Club. History. Vol. iii, No. 3. 8vo. Alnwick, 1879.

Bristol Naturalists' Society. Proceedings. New Series. Vol. ii, parts 2-3. 8vo. Bristol, 1878-79.

Cardiff Naturalists' Society. Transactions. Vols. vi-viii. 8vo. Cardiff, 1875-77.

Chester Society of Natural Science. Proceedings. Nos. 1-2. 8vo. Chester, 1874-78.

———. Annual Report for 1878-79. 8vo. Chester, 1879.

Conchology, Journal of. Vol. i, Nos. 5-17, Vol. ii, Nos. 1-9. 8vo. Leeds.

Croydon Microscopical and Natural History Club. The Meteorology of Croydon. By George Corden. 8vo. Croydon, 1879.

Eastbourne Natural History Society. Papers. Session 1878-79. 4to. Eastbourne, 1879.

Edinburgh Botanical Society. Transactions and Proceedings. Vol. xiii, part 2. 8vo. Edinburgh, 1878.

———. Royal Botanic Garden of Edinburgh: Report of the Regius Keeper for the Year 1878. 8vo. Edinburgh, [1879].

Edinburgh Geological Society. Transactions. Vol. iii, part 2. 8vo. Edinburgh, 1879.

Edinburgh, Royal Physical Society of. Proceedings. Sessions 1876-78. 8vo. Edinburgh, 1878.

Entomological Society. Proceedings for 1878. 8vo. London, 1879.

Geological Society. Abstracts of the Proceedings. Session 1878-79. 8vo. London, 1878-79.

———. Addresses delivered at the Anniversary Meetings, 16th February, 1877, and 15th February, 1878. By Prof. P. Martin Duncan, President. 8vo. London, 1877-78.

———. Address delivered at the Anniversary Meeting, 21st February, 1879. By Henry Clifton Sorby, President. *Ib.* 1879.

Geologists' Association. Proceedings. Vol. v, Nos. 7-8, Vol. vi, Nos. 1-3. 8vo. London, 1879.

———. Annual Report for 1878. *Ib.* 1879.

Glasgow, Philosophical Society of. Proceedings. Vol. xi, No. 2. 8vo. Glasgow, 1879.

Ireland, Royal Geological Society of. Journal. Vol. iv, parts 3-4, Vol. v, parts 1-2. 8vo. Dublin, 1876-79.

Irish, Royal, Academy. Proceedings. Polite Literature and Antiquities. Series II, Vol. i, No. 13. Science. Series II, Vol. iii, No. 3. 8vo. Dublin, 1879.

Liverpool Geological Society. Proceedings. Vol. iii, part iv, Vol. iv, part i. 8vo. Liverpool, 1878-79.
Liverpool, Literary and Philosophical Society of. Proceedings. Vol. xxxii. 8vo. Liverpool, 1878.
Manchester Field Naturalists' and Archæologists' Society. Proceedings, 1878. 8vo. Manchester, 1879.
Manchester Geological Society. Transactions. Vol. xv, parts 1-9. 8vo. Manchester, 1878-79.
Manchester Scientific Students' Association. Annual Report for 1877-78. 8vo. Salford, [1878-79].
Marlborough College Natural History Society. Report for the Year 1878. 8vo. Marlborough, 1879.
Meteorological Society. Quarterly Journal. New Series. Vol. iv, No. 28, Vol. v, Nos. 29-31. 8vo. London, 1878-79.
Microscopical, Royal, Society. Journal. Vol. ii. 8vo. London, 1879.
Midland Naturalist. Vol. ii. 8vo. London and Birmingham, 1879.
Naturalist. Vol. iv, Nos. 42-48, Vol. v, Nos. 49-53. 8vo. Huddersfield, 1879.
Norfolk and Norwich Naturalists' Society. Transactions. Vol. ii, part 5. 8vo. Norwich, 1879.
Rugby School Natural History Society. Report for 1878. 8vo. Rugby, 1879.
Science Gossip. Vol. xv. 8vo. London, 1879.
Scottish Naturalist. Vol. iv, Nos. 25-28, 33-36. 8vo. Edinburgh and London, 1877-79.
Smithsonian Institution. Annual Report for 1877. 8vo. Washington (U.S.A.), 1878.
United States Geological and Geographical Survey of the Territories. Bulletin. Vol. iv, Nos. 3, 4. Vol. v, No. 1. 8vo. Washington, 1878-79.
———— . List of the Publications. 3rd Edition. *Ib.* 1879.
West London Scientific Association and Field Club. Annual Report for 1878-79. 8vo. London, 1879.
Wiltshire Archæological and Natural History Society. Magazine. Vol. xviii, No. 53. 8vo. Devizes, 1879.
Yorkshire Geological and Polytechnic Society. Proceedings. New Series. Vols. v-vi, Vol. vii, part i. 8vo. Leeds, 1871-79.

Ordinary Meeting, 24th February, 1880, at Hertford.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mrs. Ackworth, the Hooke, Northaw, Barnet; Mr. G. Norman Braund, London and County Bank, Ware; Mr. H. O. F. Butcher, High Street, Ware; Mrs. Carvosso, The Warren, Bayford, Hertford; Mr. Joseph Chuck, High Street, Ware; Mr. Robert H. Harrison, Highfields, Great Amwell; the Rev. C. W. Harvey, M.A., F.M.S., Throcking Rectory, Buntingford; the Rev. F. Lipscomb, M.A., Frogmore Vicarage, St. Albans; Miss Ludlow, Christ's Hospital, Hertford; Mr. George Pavy, Ware; Mr. Alfred Ransom, Benslow, Hitchin; Mr. Charles Edward Shelly, B.A., M.B., M.R.C.S., Hertford; and Mr. Horace James Smith-Bosanquet, Broxbourne Bury, Hoddesdon, were proposed as Members of the Society.

The following paper was read:—

"Notes on Sponges, Recent and Fossil." By Henry Gilbertson. (*Transactions*, Vol. I, p. 97.)

The President said that he would supplement Mr. Gilbertson's remarks by producing a specimen of the siliceous sponge which he had procured during his deep-sea explorations, at a depth of about a mile and a quarter. This sponge was never found in shallow water, but occurred in enormous numbers in deep water, each individual having its root planted, as it were, in the muddy bed of the sea. No horny sponge was found at any great depth. The latest attempt at an explanation of the formation of flint was, he said, that by Dr. Wallich in his paper recently read before the Geological Society. But the subject was still a debatable one, for they did not, as yet, know sufficient about the formation of flint and how certain sponges were converted into flint.

A large number of flints, many of which showed a close resemblance to sponges, and dried specimens of *Spongilla fluviatilis* and *S. lacustris*, besides several varieties of the sponges of commerce, were exhibited by Mr. Gilbertson, in illustration of his paper.

Ordinary Meeting, 16th March, 1880, at Watford.

John Evans, Esq., D.C.L., LL.D., F.R.S., etc., Vice-President, in the Chair.

Mrs. Ackworth, The Hooke, Northaw, Barnet; Mrs. Bishop, The Platt, Watford; Mr. G. Norman Braund, London and County Bank, Ware; Mr. H. O. F. Butcher, High Street, Ware; Mrs. Carvosso, The Warren, Bayford, Hertford; Mr. Joseph Chuck, High Street, Ware; Miss Eliza Church, London Road, St. Albans; Mr. Robert H. Harrison, Highfields, Great Amwell; the Rev. C. W. Harvey, M.A., F.M.S., Throcking Rectory, Buntingford; Mr. Henry Lewis, St. Peter's Street, St. Albans; the Rev. F. Lipscomb, M.A., Frogmore Vicarage, St. Albans; Miss Ludlow, Christ's Hospital, Hertford; Mr. C. T. Part, The Pré, St. Albans; Mr. George Pavy, Ware; Mr. Alfred Ransom, Benslow, Hitchin; Mr. Charles E. Shelly, B.A., M.B. (Cantab), M.R.C.S., Hertford; the Rev. Henry Smith, M.A., Christ's Church, St. Albans; Mr. Horace James Smith-Bosanquet, Broxbourne Bury, Hoddesdon; Mr. S. Monkton White, Thorne House, St. Albans; and Mr. E. S. Wiles, London Road, St. Albans, were elected Members of the Society.

Mr. Charles E. Geake, Hansteads, Bricket Wood, St. Albans, was proposed as a Member.

Letters were read from Professor Babington and Dr. Sclater thanking the Society for their election as Honorary Members.

The following paper was read:—

"The Post-Tertiary Deposits of Hertfordshire." By J. Vincent Elsden, B.Sc. (Lond.), F.C.S. (*Transactions*, Vol. I, p. 103.)

Dr. Brett, referring to Mr. Elsden's statement that the oldest flint implements were found in the river-gravels, said that he had seen flint implements which were stated to have come from beds of Miocene age, though he believed that this was a disputed point. He should like to know whether the Post-tertiary deposits were increasing or decreasing in thickness. The ground-level at Watford had risen seven fieet above the natural soil, and in London fifteen feet. He believed that worms and moles, by decomposing vegetable material, increased the thickness of the superficial soil.

Mr. Littleboy remarked that the extent to which roads were cut up during the great storm of the 3rd of August showed how it was possible by the action of water to produce great results in a very short time. With regard to Mr. Elsden's remark as to the well-wooded appearance of our county being due to the post-glacial deposits, he had seen beeches growing almost on the bare chalk, and the beeches of Hertfordshire were unsurpassed.

Mr. J. Hopkinson said that there was one point bearing upon Dr. Brett's question as to the supposed increase in the thickness of the superficial soil which might perhaps be overlooked, and that was that the surface of the earth, where not perfectly horizontal, was constantly, though perhaps imperceptibly, on the move. Frost and rain and other agencies disturbed the surface-soil, and the tendency of every movement must, by the force of gravitation, be towards the lower level. One result of this movement was that whenever a bank or wall ran across sloping ground in any other direction than that of the slope, the ground would be seen to be raised on the higher side above the general level, the bank forming a barrier which interfered with the downward movement though it did not entirely stop it.

Mr. John Evans said that he would make a few observations on Mr. Elsden's very interesting paper. One of the principal merits of the paper was this, that it brought before them in a succinct form the opinions enunciated by various geologists—Professor Hughes, Mr. Penning, Mr. S. V. Wood, and others—as to the superficial deposits, not only of this county, but generally of the east of England. Their discussion had run off on one or two points in connexion with some of these, but he would just say a few words with regard to the more immediate subject of the paper, the drifts of our county. Although he regarded the paper as a very interesting contribution to our knowledge, he felt that in order to give a thoroughly comprehensive account of all the drifts of this district an author must be acquainted, not only with the eastern part of the county, but also with the western. What might hold good concerning the neighbourhood of Hertford and that side of the county would not always hold good of the neighbourhood of Watford and this side of this county; for on the eastern side of the county we had all those marine glacial deposits of which the first part of the paper treated, and on the western side, in this neighbourhood, although to some extent those deposits may have existed at some time, at present the traces of them were imperfect, and we had not the middle and lower glacial gravels in position.

But in addition to this there was another important superficial deposit over the greater part of the Chalk of this district, which though of the nature of drift, was not, strictly speaking, a drift deposit by running water, salt or fresh. All over certain districts of the chalk would be found a red clay, containing angular flints, and they were evidently flints which had originally been in position in the chalk, and from some reason or other the chalk had disappeared, leaving a red clay. If we analysed the chalk, we should find a certain portion of clay present. It was merely the insoluble part of the chalk-clay that was left in position, the chalk having been dissolved out by the aid of carbonic acid filtering into it. A great deal of the dissolution must have taken place in pre-glacial times, for before the last glacial submergence this country was dry land, and this deposit was being produced in the same manner as at the present day.

There was still another class of deposits over a considerable portion of the western portion of the county,—the London Clay and the beds below, which extended very considerably further to the north-west than they now do. We had proof of this in the small Tertiary outliers at Tyler's Hill and elsewhere, showing that the London Clay beds which now terminated at Bushey must originally have extended to Ashridge and nearly to Chesham; for we had little islands left from the denudation from the great Tertiary deposits of the London Clay and the beds beneath. What we had left of the Tertiary beds was not so much of the nature of drift as of slightly disturbed Tertiaries, and they were deposited during the early part of the Tertiary period. Above the Tertiaries we had the Lower Glacial beds, which had been deposited over an eroded surface, showing that even before the glacial times there had been a considerable denudation, which had taken place in some manner or other before the glacial beds were deposited. Then we had the Middle Glacial deposits coming in, of which we might find traces even in the western part of the county, for in the gravels on the outer slopes of some of our dry valleys—Whippendale Bottom and elsewhere—we should find that a very considerable portion of the pebbles were not flints derived from the chalk, but pebbles of older rocks which came with ice-borne deposits from the Midland Counties or even further. This showed that we had at one time a geater extent of glacial deposits than can now be traced. Before the glacial period closed, it would appear probable that we had all over the Chalk and some portion of the London Clay a regular ice-cap, which ground up the chalk and clay into the chalky boulder-clay we now find, and carried off the flints, dragging them one against another, producing the scratched flints so characteristic of the boulder-clay deposits.

It was not improbable that some of the outlines of the valleys were carved out and subsequently enlarged by the action of rivers and other subaërial forces. The author of the paper spoke of valleys being cut through the boulder-clay, and inasmuch as we had no evidence of submergence, it appeared very probable that denudation had taken place by the action of rain and rivers operating through a long period of time and removing the surface of the ground.

The question as to whether in former times we had a larger amount of rainfall was one of considerable interest, and it did appear probable that at some geological period there might be a larger rainfall than there was now; but in all river-valleys there had been another force at work which we did not thoroughly appreciate at the present time—rivers were more subject to floods, for the reason that in former times they were not "domesticated." Now we looked after the banks of rivers and removed obstructions, but in former times fallen trees and accumulations of ice stopped up rivers and produced floods, the operation of which would be greater in a few days than in many years if the river had a free and unimpeded course. That was a well-known fact pointed out by Sir Charles Lyell and others long ago, but it was well to bear it in mind.

There was a great difficulty, as was pointed out, in distinguishing the river-gravels from the older deposits from which the constituent parts have been derived, as in the case of a river running through a country where there are deposits of marine gravels, the drift consists of the same ingredients, but arranged in a different manner, and contains land animals instead of marine shells. That made him doubt whether some of the brick-earths which contained remains of the reindeer and mammoth did not belong to the Post-glacial instead of the Pre-glacial period; but it was shown that the mammoth did exist in Pre-glacial times and had been found in the Middle Glacial period. Mr. Prestwich found the tooth of one near Bricket Wood.

With regard to the question of the timber depending on the soil, he thought that the author of the paper appreciated the possibility of the fine growth of beech on a chalky soil. There was one thing about the dependence of the timber on the soil. It would generally be found that where the beds of London Clay were seen overlying the Chalk, the district was distinguished by the luxuriant growth of trees, and from that it could be predicted where such an outlier was to be found.

As to the sanitary influence of the drifts, he was a little doubtful how far they were advantageous to health, and how far the air of Hertfordshire could be regarded as being so very valuable that a house there was worth so many years' purchase; for he was afraid that in some of the valleys the consumption death-rate was almost greater than in other parts of England, especially where, regardless of all ideas of sanitary science, the houses were built within a foot or a foot and a half of the ordinary water-level. He believed that there was more done in promoting the increase of consumption by injudicious building on improper sites than by any other means. But there was another idea, the possibility of obtaining water from shallow wells. Shallow wells, where there were only one or two people living in the neighbourhood, were not bad sources of supply; but where there was a village on a Tertiary outlier or the boulder-clay—where there were some gravels, and houses congregated around the supply of water, and no attempt was made at a proper system of drainage, he could not think that the results were so much to the credit of the drift deposits as the author of the paper seemed to think.

With regard to Dr. Brett's question as to the date of the earliest appearance of man, Dr. Brett was quite right in saying that it was a matter for discussion. Some geologists had admitted that man might have existed in Pre-glacial times, but very few antiquaries had accepted the idea; and there was an *à priori* improbability of the flint implements alluded to being actually the work of man, as they had been found in marine deposits, associated with the remains of a kind of dugong and marine shells.

As to the increase of post-tertiary soil, he thought it would be found that the heaping up of the soil only takes place on the sites of human habitations. It was partly from the remains of old buildings getting covered with sand and dust blown over them, rubbish being shot near, and various artificial means, that the rising of the ground took place. No doubt worms had an effect in giving the appearance of an increase of soil. For instance, when a layer of chalk was put on a meadow, in the course of years it would be found some inches under the surface, being let down by the action of worms. The only other way was the accumulation of carbonic matter in the form of humus, but they would not get great accumulations of that kind, unless after a long series of years, as in the great prairies. There humus was found to the depth of two or three feet, but not to the depth of fifteen feet. He was sorry that the author was not present to reply himself to the questions to which his paper had given rise.

Ordinary Meeting, 23rd March, 1880, at Hertford.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mr. W. Lewis Horley, High Street, Hoddesdon; Mr. Thomas Hunt, High Street, Ware; and Miss Julia Stokes, Cecil House, Hertford, were proposed as Members of the Society.

The following letter was read:—

Royal Microscopical Society,
King's College, London,
15th March, 1880.

Dear Sirs,—I have the honour to inform you that your Society having been duly nominated under the bye-law relating to Ex-officio Fellows, and the same having been approved by a general meeting held on the 10th inst., your President for the time being is now entitled to the privileges of an Ex-officio Fellow of this Society.—I am, dear Sirs, yours truly,

Walter W. Reeves,
Assist. Sec. Royal Microscopical Society.

To the Secretaries of the Hertfordshire Natural History Society.

The thanks of the Society were accorded to the Royal Microscopical Society.

The following paper was read:—

"Observations on Rotifers, with special reference to those found in the Neighbourhood of Hertford. By F. W. Phillips. (*Transactions,* Vol. I, p. 113.)

Ordinary Meeting, 20th April, 1880, at Watford.

John E. Littleboy, Esq., Vice-President, in the Chair.

Mr. Charles E. Geake, Hansteads, Bricket Wood, St. Albans; Mr. W. Lewis Horley, High Street, Hoddesdon; Mr. Thomas Hunt, High Street, Ware; and Miss Julia Stokes, Cecil House, Hertford, were elected Members of the Society.

Mr. Brackenbury Comyns Berkeley, Collett Hall, Ware; and the Rev. J. S. ffoster Chamberlain, M.A., Great Hormead Vicarage, Buntingford, were proposed as Members.

The following communications were read :—

1. "Meteorological Observations taken at Wansford House, Watford, during the Year 1879." By John Hopkinson, F.L.S., F.M.S., etc., Hon. Sec. (*Transactions*, Vol. I, p. 121.)

2. "Report on the Rainfall in Hertfordshire in 1879." By John Hopkinson. (*Transactions*, Vol. I, p. 127.)

3. "Report on Phenological Observations in Hertfordshire in 1879." By John Hopkinson. (*Transactions*, Vol. I, p. 133.)

4. A Letter from Mr. J. Vincent Elsden to the Secretary, in reply to remarks made in the discussion on his paper on the "Post-Tertiary Deposits of Hertfordshire."

Mr. Elsden said that his idea that bare chalk would have been comparatively treeless appeared to be questioned, but he could not help thinking that this was characteristic of a chalk country. As instances he might cite the Chalk of Dorset, or the immense difference in the aspect of North and South Wiltshire, though perhaps no district would so well illustrate this as the treeless chalk prairies of North-eastern America, which he thought represented the natural condition of bare chalk; although beech trees would grow on a very thin soil over the chalk.

With respect to the omission of a special mention of the "clay-with-flints" he felt that the length of the paper would only allow a general mention of "soils of disintegration" under the head of subaërial deposits.

As to floods having been more common in former times, he thought it was a question whether the extensive felling of forests for cultivation, and the great extent of deep draining, etc., did not in themselves tend to increase our liability to floods in the present day.

5. "Section of Stanmore Brewery New Well and Boring." By George Tidcombe, Jun. (*Transactions*, Vol. I, p. 143.)

6. "Notes on a Cutting in Hamper Mill Lane, Watford." By Alfred T. Brett, M.D.

The section, beginning at the east, near Bushey Station, showed a series of beds in the following succession:—1, red loam; 2, mixed loam and sand, variable; 3, sand; 4, sand impregnated with iron, and perhaps also with manganese; 5, mixed loam and sand, variable; 6, sand; 7, sand with small oval black pebbles; 8, red loam; 9, clay; 10, sand; 11, red loam; 12, gravel; 13, red loam; 14, clay.

The very variable character of the Woolwich and Reading beds, to which these deposits should be referred, was pointed out, no two sections in the neighbourhood showing the same succession of strata.

A coloured section of the cutting in Hamper Mill Lane, drawn by Mr. Lovejoy on the scale of four feet to an inch, was exhibited.

7. "Note on the Origin of Beech Bottom, near St. Albans." By A. E. Gibbs.

Mr. Gibbs enquired if anything were known as to the origin of the curious narrow valley called Beech Bottom. If naturally formed it seemed too deep and regular to be attributed to the action of running water; but if of artificial formation, for what purpose could such a huge excavation have been made? The popular idea was, he believed, that it had been dug during one of the battles of St. Albans, in the Wars of the Roses, for the purpose of defence.

8. "Notes on some Plants not previously recorded as growing in certain districts near St. Albans." By A. E. Gibbs. (*Transactions*, Vol. I, p. 143.)

9. "Note on Woodcocks carrying their Young." By George Rooper, F.Z.S. (*Transactions*, Vol. I, p. 144.)

10. "Notes on the Fluke in Sheep." By Alfred T. Brett, M.D. (*Transactions*, Vol. I, p. 139.)

Ordinary Meeting, 27th April, 1880, at Hertford.

This meeting was held in conjunction with the Hertford Literary and Scientific Institution, and was devoted to microscopical study and the exhibition and examination of objects of interest lent by members of the two Societies and their friends.

Field Meeting, 15th May, 1880.

RADLETT.

Here and there, over a considerable portion of Hertfordshire, there occur blocks of stone of a peculiar kind, totally different from any of the strata in their immediate neighbourhood. This stone, masses of which, of very various shapes and sizes, are thus widely scattered, has long been known as the Hertfordshire conglomerate or "plum-pudding stone." It consists of rounded flint-pebbles in a siliceous matrix which is generally as hard as the pebbles which it encloses, and frequently even harder. Except in being consolidated, it resembles a pebble-bed which occurs in the lower portion of the Woolwich and Reading Series below the mottled clays to which these beds owe their former name of the "plastic-clay formation."

To the north of London this series forms the base of the "London Tertiary Basin," reposing immediately on the Chalk and extending across the southern part of Hertfordshire in a south-westerly and north-easterly direction. Just on its edge Radlett is situated, and here its pebble-bed is seen to be consolidated, or formed into a conglomerate similar to that of which pieces are found scattered far and wide to the north and west. Here therefore it appears that we have the Hertfordshire conglomerate *in situ*, and it was the object of this meeting to examine it at a spot where it was known to be exposed.

The members assembled at Bricket Wood Station and strolled across the fields, crossing the Colne at its confluence with the Ver, visiting a chalk-pit, noticing a large "swallow-hole," ascending the hill by the Hill Farm, and descending on the Radlett side, the highest ground affording an extensive view of the surrounding country. After crossing the then dry bed of a tributary of the Colne, the source of which when flowing is the Elstree Reservoir, Aldenham Lodge was reached, and here Mr. C. T. Part joined the members and pointed out the most interesting objects in his garden and greenhouses, and the extensive gravel-pits in his grounds. The adjoining park, Newberries, was then entered, and beyond the house, in the centre of a field, a small opening not easily found, exposed to view the section of the Hertfordshire conglomerate before referred to.

After a careful examination of the section had been made by the members, and a few pieces of the rock had been collected, the writer of this report gave a brief account of the geology of the neighbourhood, chiefly as leading to a knowledge of the position of the conglomerate as a member of the Woolwich and Reading Series, and the relation this series bears to the older Chalk and newer gravels which had just been seen. Noticing then more fully the chief points of interest with regard to the conglomerate itself, he said that it was composed of flint-pebbles originally derived from the flint-beds in the Upper Chalk and rounded by attrition probably on some sea-shore, for the Woolwich and Reading beds in this neighbourhood were rather of marine than of fluviatile or estuarine origin, and wherever a pebble-bed was found dry land must have existed at no great distance, the heavier matter or larger pebbles remaining near the land, and the softer or more finely divided material being carried out farther from the shore. The presence of the pebble-bed was not exceptional, for it occurred elsewhere in the same position in the Reading beds, as near Watford for instance, but its consolidation into a conglomerate was so, for probably it only occurred in this position here and at one or two other places in the immediate neighbourhood, as at Radlett Church, near to which it had recently been found in digging the foundations for new school-rooms. It was also noteworthy that the cementing agent was not as in many other cases of a calcareous nature, for the pebble-bed was consolidated by silica, which, it might be remarked, had been detected in a gelatinous or soluble state in the mottled clays which form the next higher beds.* Here and there the surface of the conglomerate was smooth and rounded, apparently showing that it had been subjected to the action of ice, and the way in which it was split up into blocks bore evidence of past upheavals. The hardness and durability of the siliceous cement was evident from the splitting of the pebbles in the general lines of fracture, and sometimes even the pebbles had become softened by a portion of their silica being dissolved out, so that they might be cut with a knife, while the matrix preserved its hardness.

Returning to Newberries, the members, numbering about forty, were received by Mr. Bagnall, who kindly provided tea and other refreshments, after partaking of which some went by train from Radlett to St. Albans, and others walked back to Bricket Wood Station by The Wylde, slightly varying the route taken in coming.

* Prestwich, 'Quart. Journ. Geol. Soc.,' vol. x, p. 123.

Field Meeting, 24th May, 1880.

AYLESBURY, HARTWELL, AND STONE.

Although this meeting, which took place in conjunction with the Geologists' Association of London, was the annual whole-day meeting, and might therefore seem to warrant a full report, the locality in which it was held being outside the limits of our county, and a complete account of the proceedings of the day, by Mr. W. H. Hudleston, the director of the meeting, having already been published, a very brief notice will here be given, and Mr. Hudleston's report in the 'Proceedings of the Geologists' Association' (vol. vi, p. 344) may be referred to for a detailed account of the geology of the neighbourhood, full descriptions of the sections examined, lists of fossils, and an exposition of the most recent views as to the origin and relations of the various beds.

On arriving at Aylesbury, Mr. Hill's brickfield in the Bierton Road was first visited, and here the Kimmeridge Clay was seen, with the basal conglomerate of the Portland series reposing upon it in one part of the pit. Proceeding towards Hartwell, beds of the same geological age were seen in Mr. Locke's brickyard, the clay here being termed the Hartwell Clay, and the base of the Portlands being represented, as usual in this neighbourhood, by the lydite series, here more calcareous and less glauconitic than at Aylesbury. The Hartwell Clay appears from its fossils to occupy a higher horizon than the Kimmeridge Clay at Oxford, representing more nearly the Middle Portlandian of Boulogne. At the "Bugle" pit near Stone, which was next visited, the junction of the Portland limestone with the Purbecks was seen. From the limestone here, which appears to be higher in geological position than the Portland beds at Aylesbury, most of the ammonites (*Ammonites boulogniensis*) which were seen built into the wall of Mr. Lee's park have been obtained.

The "Round Hill" was then ascended, and on the summit, from which a fine view of the Vale of Aylesbury was obtained, Mr. Hudleston pointed out the relation between the physical features of the valley and its geological structure. The concluding portion of his remarks, in which he speculated on the possible shore-lines of the Portland seas, will be of interest in their bearing upon the early geological history of Hertfordshire. "The remarkable analogy which," he said, "in some respects the Portland beds of Bucks present to those of the Boulonnais, which all geologists agree were deposited not far from a promontory of the old Ardennes ridge, might lead to the supposition that the influences of such a ridge, even if not actually above water, have made themselves felt in the migrations of Mollusca, and also in the nature of the deposits, though those of the Boulonnais are even more sandy than in Bucks, where there is at least one tolerably pure limestone. From recent borings the undulating character of the old Palæozoic floor, upon which the Secondary beds must rest, may be inferred, but it is equally clear that the Mesozoic column becomes thinner as we advance northwards from London, as shown by the boring at Ware which reached Silurian rocks at a depth of 800 feet.* It is also equally certain that the Jurassic rocks are absent altogether beneath Ware and London. We cannot therefore expect that these various beds seen to-day, including the clays on which they rest, have any great extension within the Chalk area, beneath which we see them dipping. Somewhere between here and London they are sure to knock up against the old rocks, and when we remember the oscillations that have taken place at various epochs, it is not difficult to believe that, during the Portland period, either a shore-line or a line of rocky shallows was not far off in a south-easterly direction. At present the thickness of the Secondary rocks here may be about 1,000 feet; they are 800 feet thick at Ware, thirty miles to the east, and 1,200 feet thick at Burford, thirty-six miles to the west. The boring at the Asylum, near Stone, close by, went through 570 feet of beds, and terminated somewhere in the Oolitic formation. For a long period, in the interval which preceded the deposition of the Chalk, this region underwent considerable vicissitudes, accompanied by much denudation. Then came a time when the whole region, far and wide, sank, and the Cretaceous sea flowed over everything for ages. The story of the uprise of its deposits and of their sculpture, whereby the great escarpment of the Chilterns was produced, belongs to another chapter in the chequered history of the earth." †

A vote of thanks was then accorded to Mr. Hudleston, and the members of the two societies walked back to Aylesbury, and after having tea there, left by train for their respective destinations.

Field Meeting, 12th June, 1880.

ASHRIDGE.

A large number of members assembled at Tring Station, and walked, some by Aldbury and others by a more circuitous route, to the hill on which the Bridgewater Monument stands. Before ascending the hill a search was made for orchids, but, owing probably to the very wet weather at the time of flowering the year before, few were seen. *Epipactis latifolia*, the broad-leaved helleborine, and *Ophrys Apifera*, the bee-orchis, were however detected, and also the deadly nightshade, *Atropa Belladonna*.

Near the Monument, on sloping ground commanding a fine view of the country to the north, a halt was made, and here, sitting in groups under the pleasant shade of wide-spreading beech trees, the

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 245.
† 'Proc. Geol. Assoc.,' vol. vi, p. 352.

members listened to an address on the geology of the district by Mr. E. W. Lewis of Leighton Buzzard, author of a work on the geology of that neighbourhood.

Mr. Lewis said that it would be scarcely necessary to remind his hearers that they were now on the Chalk, one of the members of the Cretaceous series, another, the Gault, not being far off, the boundary between these two formations running in a north-easterly and south-westerly direction past the villages of Pitstone and Ivinghoe. Beyond this boundary, just this side of Cheddington Station, an outlier of the Chalk formed a terraced hill—West End Hill. Nearer the present spot, on the farther side of the valley just below, which was cut out of the Chalk, an escarpment of the Upper Chalk might be seen, and beyond again, by Ivinghoe, the Lower Chalk, with the Totternhoe Stone, a hard bed forming the highest portion of the Chalk Marl, the lower ground beyond being occupied by the softer beds of the Chalk Marl, followed by the Gault and the Upper Greensand. The Chalk once extended much beyond its present limits, as shown by outliers and beds of gravel containing chalk-flints, which might be seen far to the north-west. Rain and rivers, floods and frost, had removed a mass of clay, sand, and chalk, of vast thickness and great extent. The Chalk resisted denudation from its permeable nature rather than its hardness, for a porous bed allowed water falling upon it as rain to sink into and pass through it, thus dissolving it in an even manner, and to this character the Dunstable Downs owed their present form and the hills in all chalk-districts their gently-rounded contours. The irregular outline of Totternhoe Knoll was not due to denudation, but to the tumuli and earthworks upon it.

After alluding to the former extensive use of the Totternhoe Stone for building purposes, treating of the origin and composition of the Chalk, and showing that its escarpment must have been formed by subaërial and not marine denudation, Mr. Lewis referred to the numerous springs at the foot of the Chalk escarpment, due to the Totternhoe Stone arresting the flow of water in the Chalk, the Ordnance Map showing that the little feeders of the Ouse took their rise at the line of outcrop of the Totternhoe Stone.

At the conclusion of this address, here but briefly reported, many of the members ascended the Monument, and from the summit, which commands a view of portions of six counties, some of the geological features of the country pointed out by Mr. Lewis were clearly seen. Moneybury Hill, with its Roman tumulus, was also visited, and tea was then provided near the Monument by Mr. Littleboy. In proposing to their host a vote of thanks, the present writer remarked that it was not the first or even the second time that Mr. Littleboy had provided refreshments on similar occasions.

A descent was then made towards Aldbury, and Tring Station was reached by a shorter route than that before taken.

Field Meeting, 24th June, 1880.

THUNDRIDGE AND FANHAMS HALL, WARE.

At the place of meeting, Thundridge Old Church, the members, most of whom arrived by conveyances from Hertford, were received by the Rev. T. Woodward, Rural Dean.

The only part of the church remaining was seen to be the tower, but this is, in itself and in its contents, of great archæological interest. From a fine example of Norman moulding, and other indications, the church was inferred to date from about the year 1100. Mr. Cussans, in his 'History of Hertfordshire,' says that it is about the oldest in this part of the county, but "not a vestige of the church itself now remains; it is impossible even to trace its foundations, as the entire churchyard, and the site of the building itself, is covered with a rank and luxuriant growth of weeds," * some portion of which had however been mown down for the present visit. The old parish registers, dating from the year 1556, were inspected; and on the tower it was noticed that the Pelham buckle twice occurred. The tombstones of the Gardiner family, to which the manor of Thundridge once belonged, were also pointed out.

In a meadow adjoining the churchyard, several fine trees, including hickories, American walnuts, and limes, attracted attention, and then the party passed through the nursery-garden, where, surrounded by underwood, stands the old kitchen-chimney of Thundridge Bury, the summer residence of the monks of Ware Priory before the Reformation. Passing between two of the four moats from which the monks obtained their fish for fast-days, some fine old elms were seen, and farther on, after crossing the river Rib and entering Youngsbury Park, a group of very beautiful poplars (*Populus alba*), an oak supposed to be about 800 years old, and a *Wellingtonia gigantea*, 30 years old, were noticed in succession.

Returning then towards the old church across the two branches of the Rib, in a meadow near to which the tuberous-rooted comfrey (*Symphytum tuberosum*) was found, a path through the fields was followed, somewhat hurriedly owing to an approaching storm, and just as the rain commenced, Fanhams Hall, the residence of Mr. Croft, was reached. Here tea was provided, and after a hearty vote of thanks to Mr. and Mrs. Croft for their kind reception and hospitality, the party dispersed, most of the members returning to Hertford by way of Ware in the conveyances by which they had arrived at Thundridge Old Church.

Field Meeting, 10th July, 1880.

COLE GREEN, WOOLMERS, ESSENDON, AND HATFIELD PARK.

The gravel-pit and brick-fields near Cole Green Station were first visited, and it was remarked that although the Chalk formed the

* 'Hist. Herts, Braughing Hundred,' p. 162.

sub-stratum of the country, it was completely covered up over a large area by the glacial gravels and brick-earth which were here seen, and to the presence of which the luxurious growth of the trees in the neighbourhood was inferred to be due.

From Cole Green the members proceeded by Letty Green to Woolmers, where they were received by the owner, Mr. W. H. Wodehouse, who showed everything of interest in his grounds. Some fine old trees, yews, pencil or red cedars, cedars of Lebanon, pollard and other oaks, and, growing on the banks of the River Lea, a splendid horse-chestnut, attracted attention; but the chief object of interest was the well-known spring, which, rising in a wood about a quarter of a mile from the house, pours into the Lea a constant supply of water, calculated at 300,000 cubic feet or 2,000,000 gallons in 24 hours. The water issues into a large round pool, about 24 feet deep, from numerous interstices which must communicate with, or be the openings of, crevices extending for considerable distances, and perhaps in various directions, in the Chalk, and thus collecting the rainfall of a large area.

From the pool, and the picturesque wood in which it is situated, Mr. Wodehouse conducted the party to the meadow in front of his house, where his famous prize cows—the "Countess" and her descendants—were seen; and by the splendid lime-tree avenue leading to the Essendon road Woolmers was then left, and a path taken to the village of Essendon and its church, which had a peculiar interest to the members of the Society from its having for many years been the scene of the labours of the late Rev. R. Holden Webb, one of the authors of the 'Flora Hertfordiensis.'

Hatfield Park Kiln was then visited, by permission of the Marquis of Salisbury, and here Mr. J. Logan Lobley described the section exposed. This spot was, he said, on the northern edge of the London and Hampshire Tertiary Basin, the junction of the Chalk with the Tertiary beds above being here seen; neither the highest beds of the Chalk, the Maestricht beds, nor the lowest beds of the Tertiaries, the Thanet sands, were however present. On the top of the Chalk were green-coated flints (the colouring due to silicate of iron), these flints being present in this position whether the Chalk was covered by the Thanet sands, or as here by the sands of the Woolwich and Reading series. Above these beds the basement-bed of the London Clay was seen, above this the lowest zone of the true London Clay, and above again far more recent gravels of glacial or post-glacial age.

The park was then entered, and after noticing on the way Queen Elizabeth's Oak, the "Vineyard" was visited. Although vines are no longer cultivated here, it is on record that when the gardens were first laid out upwards of twenty thousand vines were planted; now, however, the peculiar beauty of the place is due to the avenues of trained and clipped yews, and the turfed slopes and terraces, with the River Lea expanded into a fine sheet of water at the bottom. The gardens are on the opposite side of the river.

On the way to the new gates opposite Hatfield Station, by which the park was left, a visit was paid to the fine old oaks described and portrayed in the Rev. Canon Gee's paper on "Famous Trees in Hertfordshire."*

Field Meeting, 22nd July, 1880.

HERTFORD HEATH AND HAILEYBURY.

This meeting having been arranged for the purpose of collecting microscopic objects in the pools on Hertford Heath, these were first diligently searched,† and then, passing along the Ermine Street, an old Roman road here of considerable width and picturesquely fringed on either side with trees, the "orchis" or "skipper" field was visited; but, as at the Ashridge meeting, few orchids were found.

Haileybury College was then visited, and here the members, numbering over forty, were hospitably entertained at tea by the Rev. Canon Bradby, Head Master of the College, and after visiting the chapel and the principal rooms in the College, the party dispersed, most of the members walking either to Hertford or Ware.

Ordinary Meeting, 26th October, 1880, at St. Albans.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mr. Ernest O. Fordham, Odsey, Royston; Mr. John E. Legg, B.A., Grammar School, Berkhampstead; and Mr. Robert William Mylne, F.R.S., F.S.A., F.G.S., Amwell, were proposed as Members of the Society.

The following lecture was delivered:—

"A Few Words on Tertiary Man." By John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.G.S. (*Transactions*, Vol. I, p. 145.)

A discussion ensued in which Mr. A. W. Franks, F.R.S., Dr. A. T. Brett, and the President, took part, and the thanks of the Society were accorded to Mr. Evans.

The meeting then resolved itself into a conversazione, at which microscopic and other natural-history objects, fossils and antiquities from the neighbourhood of St. Albans, and other interesting objects were exhibited by Mr. B. Baker, Mrs. Blagg, Mr. J. Chapple, Mayor of St. Albans, Mr. I. N. Edwards, Mr. A. E. Ekins, the Rev. H. Fowler, Mr. A. E. Gibbs, Mr. H. Gibson, the Rev. Dr. Griffith, Mrs. Harry Hine, Mr. John Hopkinson, Dr. Lipscomb, Mrs. Masters, Mr. G. N. Marten, Mr. T. P. Marten, the Rev. C. M. Perkins, Mr. Rhodes, and Miss Rose C. White.

* 'Trans. Watford Nat. Hist. Soc.,' Vol. II, pp. 7 and 11.

† The following species were obtained by one of the members, Mr. F. W. Phillips, from the ponds on the heath:—*Carchesium polypinum*, *Arcella aculeata*, *A. vulgaris*, *Actinophrys Ehrenbergii*, *Vaginicola decumbens*, *V. crystallina*, *Dinobrion Sertularia*, *Trachelomonas caudata*, *Phacus longicaudus*, *Anthophyra vegetans*, and *Mallomonas Plosslii*.

ORDINARY MEETING, 2ND NOVEMBER, 1880, AT WARE.

J. GWYN JEFFREYS, Esq., LL.D., F.R.S., etc., President, in the Chair.

The Rev. John T. Bell, M.A., Christ's Hospital, Hertford; the Right Honourable the Earl of Lytton, Knebworth; Miss Anne White, North Crescent, Hertford; and Miss E. Wigram, Moorplace, Hadham, were proposed as Members of the Society.

Numerous objects of interest in science, art, and antiquity were exhibited by the following members of the Society, and of the Ware Institute:—Mrs. Bland, Mr. R. B. Croft, Mr. Culver, Mrs. Foster, Dr. Gwyn Jeffreys, Mrs. Martinson, Dr. May, Miss Middleton, Mr. F. W. Phillips, Mr. George Price, and Mr. W. Wickham, and electrical phenomena were displayed and explained by Mr. R. H. Harrison.

ORDINARY MEETING, 16TH NOVEMBER, 1880, AT WATFORD.

J. GWYN JEFFREYS, Esq., LL.D., F.R.S., etc., President, in the Chair.

The Rev. John T. Bell, M.A., Christ's Hospital, Hertford; Mr. Brackenbury Comyns Berkeley, Collett Hall, Ware; the Rev. J. S. ffoster Chamberlain, M.A., Great Hormead Vicarage, Buntingford; Mr. Ernest O. Fordham, Odsey, Royston; Mr. John E. Legg, B.A., Grammar School, Berkhampstead; the Right Honourable the Earl of Lytton, Knebworth; Mr. Robert William Mylne, F.R.S., F.S.A., F.G.S., Amwell; Miss Anne White, North Crescent, Hertford; and Miss E. Wigram, Moorplace, Hadham, were elected Members of the Society.

Mr. Charles Butler, Warren Wood, Hatfield; the Rev. E. Ernest W. Kirkby, M.A., The Vicarage, Ware; the Rev. Charles James Langley, M.A., Grammar School, Berkhampstead; Mr. Alexander McKenzie, Hoddesdon; Mr. Alexander Caius McKenzie, Hoddesdon; Mr. George Nisbet Marten, St. Albans; Mr. James Mitchell, Ponfield, Hertford; Mrs. A. F. Phillips, Woad Mead, St. Albans; and the Rev. Charles Lee Wingfield, M.A., Honorary Canon of St. Albans, The Rectory, Welwyn, were proposed as Members of the Society.

The following lecture was delivered:—

"The Glaciers of Switzerland." By the Rev. George Henslow, M.A., F.L.S., F.G.S.

Mr. Henslow exhibited, in illustration of his lecture, a number of photographs, drawings, maps, and diagrams, and made experiments on the regelation of ice; and, on the proposition of the President, seconded by the Secretary, a vote of thanks was accorded to him.

Ordinary Meeting, 30th November, 1880, at Hertford.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mrs. Carlile, Ponsbourne Park, Hertford; Mr. George Gisby, Ware; Mr. Thomas Odell, Castle Street, Hertford; Commander John H. E. Parker, R.N., Ware Park; Mr. Henry Robins, Railway Street, Hertford; and Mr. Robert Smith, Goldings, Hertford, were proposed as Members of the Society.

The following lecture was delivered:—

"The Voyage of the 'Challenger.'" By H. N. Moseley, M.A., F.R.S.

Mr. Moseley exhibited, by means of the oxy-hydrogen lantern, beautifully-executed illustrations of the rarer or more interesting organisms dredged or otherwise obtained in the course of the 'Challenger' expedition; and at the conclusion of the lecture a vote of thanks was accorded to him, on the proposition of the President, seconded by Mr. Abel Smith, M.P.

Ordinary Meeting, 14th December, 1880, at Watford.

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Mr. Charles Butler, Warren Wood, Hatfield; Mrs. Carlile, Ponsbourne Park, Hertford; Mr. George Gisby, Widbury Hill, Ware; the Rev. E. Ernest W. Kirkby, the Vicarage, Ware; the Rev. Charles James Langley, M.A., Grammar School, Berkhampstead; Mr. Alexander McKenzie, Hoddesdon; Mr. Alexander Caius McKenzie, Hoddesdon; Mr. George Nisbet Marten, St. Albans; Mr. James Mitchell, Ponfield, Hertford; Mr. Thomas Odell, Castle Street, Hertford; Commander John H. E. Parker, R.N., Ware Park; Mrs. A. F. Phillips, Woad Mead, St. Albans; Mr. Henry Robins, Railway Street, Hertford; Mr. Robert Smith, Goldings, Hertford; and the Rev. Canon Wingfield, M.A., the Rectory, Welwyn, were elected Members of the Society.

The following communications were read:—

1. "Rainfall in Hertfordshire, 1840-79." By the Rev. C. W. Harvey, M.A., F.M.S. (*Transactions*, Vol. I, p. 151.)

2. "The Flood in the Valley of the Gade, 3rd August, 1879." By John E. Littleboy. (*Transactions*, Vol. I, p. 159.)

3. "On the Importance of recording Erratic Blocks." By H. George Fordham, F.G.S. (*Transactions*, Vol. I, p. 163.)

4. "List of Plants found in the neighbourhood of Berkhampstead in the year 1880." By A. S. Eve. Communicated by J. Hopkinson, Hon. Sec.

5. "List of Plants seen in flower near St. Albans, 28th June, 1880." By John Hopkinson, F.L.S., Hon. Sec.

A few Members of the Society * met at St. Albans on the evening of the 28th of June to take a walk for the purpose of recording all the plants they could find in flower. Starting from the old yew tree by the Abbey Cloisters they crossed the river Ver and commenced to record at the foot of the Verulam Hills. The route taken on reaching the higher ground was along the St. Stephen's road to Prae Woods, and through the woods to Gorhambury Park, returning along the Gorhambury road and the Water Walk to St. Albans. The walk occupied about two hours and the following plants were seen in flower:†—

LILIACEÆ.
 Endymion nutans.
ORCHIDACEÆ.
 Listera ovata.
 Orchis maculata.
URTICACEÆ.
 Urtica dioica.
EUPHORBIACEÆ.
 Mercurialis perennis (in seed).
POLYGONACEÆ.
 Polygonum aviculare.
 Rumex Acetosa.
 ——— obtusifolius.
PRIMULACEÆ.
 Lysimachia nemorum.
SCROPHULARIACEÆ.
 Scrophularia aquatica.
 ——— nodosa.
 Verbascum Thrapsus.
 Veronica Chamaedrys.
 ——— officinalis.
 ——— serpyllifolia (in seed).
PLANTAGINACEÆ.
 Plantago lanceolata.
 ——— major.
LAMIACEÆ.
 Ajuga reptans.
 Lamium album.
 Lamium purpureum.
 Nepeta Cataria.
 Stachys sylvatica.
BORAGINACEÆ.
 Myosotis arvensis.
 ——— palustris.
CONVOLVULACEÆ.
 Convolvulus minor.
ASTERACEÆ.
 Achillea Millefolium (in bud).
 Arctium minus.
 Bellis perennis.
 Carduus arvensis.
 Centaurea nigra (in bud).
 Chrysanthemum Leucanthemum.
 Crepis virens.
 Lapsana communis.
 Senecio vulgaris.
 Taraxacum officinale.
DIPSACACEÆ.
 Scabiosa succisa.
VALERIANACEÆ.
 Valerianella olitoria.
RUBIACEÆ.
 Asperula odorata.
 Rubia peregrina.
 Sherardia arvensis.
CAPRIFOLIACEÆ.
 Lonicera Periclymenum.
 Sambucus nigra.
CORNACEÆ.
 Cornus sanguinea.
APIACEÆ.
 Anthriscus sylvestris.
 Bunium flexuosum.
 Heracleum Spondilium.
 Sanicula europaea.
 Scandix Pecten-Veneris.
CUCURBITACEÆ.
 Bryonia dioica.
ONAGRACEÆ.
 Circaea lutetiana.
 Epilobium hirsutum.
 ——— montanum.
ROSACEÆ.
 Agrimonia Eupatoria.
 Fragaria vesca.
 Geum urbanum.
 Potentilla anserina.
 ——— reptans.
 ——— Tormentilla.
 Poterium Sanguisorba.
 Rosa arvensis.
 ——— canina.
 Rubus fruticosus.
 Spiraea Ulmaria.
FABACEÆ.
 Lathyrus Aphaca.
 Lotus corniculatus.
 Trifolium minus.
 ——— pratense.
 ——— repens.
 Vicia sepium.
GERANIACEÆ.
 Geranium Robertianum.

* The members present were—Mrs. Arnold, Miss Rose White, Mr. A. E. Gibbs, and Mr J. Hopkinson (Recorder).

† A few in bud and in seed, included and thus specified in the list, were noted as being *near* the period of flowering.

HYPERICACEÆ.
Hypericum pulchrum.
CARYOPHYLLACEÆ.
Cerastium triviale.
Lychnis vespertina.
Silene inflata.
Stellaria Holostea.
——— media.
——— nemorum.
VIOLACEÆ.
Viola canina (in seed).
——— hirta (in seed).
——— tricolor.
CISTACEÆ.
Helianthemum vulgare.
BRASSICACEÆ.
Capsella Bursa-pastoris.
Sinapis arvensis.
Sisymbrium officinale.
FUMARIACEÆ.
Fumaria officinalis.
PAPAVERACEÆ.
Chelidonium majus.
Papaver Rhœas.
RANUNCULACEÆ.
Clematis vitalba.
Ranunculus acris.
——— bulbosus.
——— peltatus.
——— repens.
——— sceleratus.

ORDINARY MEETING, 21ST DECEMBER, 1880, AT BENGEO.

R. B. CROFT, Esq., R.N., F.L.S., in the Chair.

Mr. Gerard Joshua H. Gosselin, Bengeo Hall, Hertford; the Rev. C. J. Marshall, M.A., Bengeo, Hertford; and Mr. Henry Abel Smith, Woodhall Park, Watton, were proposed as Members of the Society.

The meeting was devoted to the examination of microscopic objects, and of collections of fossils, etc., exhibited by members of the Society and of the Bengeo Working-Men's Club. Mr. Croft gave an address on the objects of the Society and the work which is being carried on by it, and also on the value of the microscope in natural-history researches as especially illustrated by the exhibits of the evening.

ORDINARY MEETING, 18TH JANUARY, 1881, AT WATFORD.

ALFRED T. BRETT, Esq., M.D., Vice-President, in the Chair.

Mr. Gerard Joshua H. Gosselin, Bengeo Hall, Hertford; the Rev. C. J. Marshall, M.A., Bengeo, Hertford; and Mr. Henry Abel Smith, Woodhall Park, Watton, were elected Members of the Society.

The attendance of members, owing to the snow-storm of this day, being very small, the two papers announced for the meeting were deferred.

Mr. C. F. Hollingsworth and Mr. William Verini were appointed Auditors of the accounts for 1880.

ORDINARY MEETING, 25TH JANUARY, 1881, AT HERTFORD.

R. B. CROFT, Esq., R.N., F.L.S., in the Chair.

Mr. R. C. Allen, Ware; Mr. Richard Ginn, Castle Street, Hertford; and Mr. George Turner, Hoddesdon, were proposed as Members of the Society.

The following papers were read :—

1. "Note on the Schwendenerian Theory of Lichens." By R. B. Croft, R.N., F.L.S., etc. (*Transactions*, Vol. I, p. 166.)

2. "On a species of *Chætospira* found at Hoddesdon." By F. W. Phillips. (*Transactions*, Vol. I, p. 168.)

3. "Notes on Protococcus." By C. W. Nunn.

Mr. Nunn said that he presumed the green form of *Protococcus pluvialis* was well known, but he wished to draw attention to the red variety, which he had noticed year by year for the last ten years in a cast-iron shell at the base of a fountain. He had never found the green variety in it, and he mentioned this because it was supposed that the latter in its still form took a red tint, afterwards becoming green with a small red spot once supposed to be an eye. The shell had been thickly painted with red lead and then with white lead, so that the colour could not be due to the iron. In a tank not ten yards distant the green variety appeared as regularly as the red one did in the cast-iron shell.

Anniversary Meeting, 15th February, 1881.

(At Watford.)

J. Gwyn Jeffreys, Esq., LL.D., F.R.S., etc., President, in the Chair.

Miss Eleanor A. Ormerod, F.M.S., etc., Dunster Lodge, Spring Grove, Isleworth, was elected an Honorary Member of the Society.

The Report of the Council for 1880, and the Treasurer's Account of Income and Expenditure, were read and adopted.

The President delivered an Address. (*Transactions*, Vol. I, p. 173.)

The Balloting-glass having been removed, and the lists examined by the Scrutineers, the following gentlemen were declared to have been duly elected as the Officers and Council for the ensuing year.

President.—George Rooper, F.Z.S.

Vice-Presidents.—Professor John Attfield, Ph.D., F.R.S., F.C.S.; the Rev. Canon Bradby, M.A.; Alfred T. Brett, M.D.; the Right Honourable the Earl Cowper, K.G.; J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., F.G.S.; John E. Littleboy.

Treasurer.—Charles F. Humbert, F.G.S.

Honorary Secretaries.—John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.M.S.; Richard B. Croft, R.N., F.L.S., F.R.M.S.

Librarian.—E. M. Chater.

Curator.—Frank W. Silvester, F.M.S.

Other Members.—Arthur Cottam, F.R.A.S.; the Right Hon. the Lord Ebury, F.M.S., F.R.G.S.; the Right Hon. the Earl of Essex; John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S.; H. George Fordham, F.G.S.; the Rev. C. W. Harvey, M.A., F.M.S.; Sydney Humbert; J. Logan Lobley, F.G.S., F.R.G.S.; the Rev. Herbert R. Peel, M.A.; Joseph Pollard; Reginald A. Pryor, B.A., F.L.S.; W. Lepard Smith.

It was then resolved—

That the thanks of the Society be given to Dr. J. Gwyn Jeffreys, F.R.S., etc., retiring from the office of President; to Mr. Arthur Cottam retiring from the office of Librarian; to Mr. W. Lepard Smith retiring from the office of Curator; and to Mr. James U. Harford and the Rev. C. M. Perkins retiring from the Council.

The thanks of the Society were also accorded to the Honorary Secretaries, Mr. R. B. Croft and Mr. John Hopkinson.

Report of the Council for 1880.

The Council of the Hertfordshire Natural History Society and Field Club, in presenting the sixth Annual Report, has the pleasure of announcing that the Society has considerably increased in the number of its members during the year, that the papers read and lectures delivered have equalled in value and interest those of former years, and that both the ordinary and field meetings have been successful and well-attended.

During the year fifty-three ordinary members and two honorary members have been elected; five members have compounded for their annual subscriptions; eleven members have resigned; one after election has declined to be a member; four have been excluded from the Society for non-payment of subscriptions for three years; and the Council regrets to have to record the loss by death of one of its earliest and most valued members—the Rev. R. Holden Webb, M.A.

The Census of the Society at the end of the years 1879 and 1880 was as follows:—

	1879.	1880.
Honorary Members	12	14
Life Members	26	31
Annual Subscribers	193	225
	231	270

The Council has to announce the completion of the second volume of the 'Transactions of the Watford Natural History Society' and the commencement of the first volume of the 'Transactions of the Hertfordshire Natural History Society,' two parts of each having been published during the year. The 'Transactions' of the Society under its former title cease therefore with the second volume, the two volumes published forming a complete work—a work which has very greatly added to the knowledge of the natural history of the County, especially in the departments of Meteorology, Geology, Botany, and Ornithology. In Conchology, Entomology, Ichthyology, and other branches of Zoology, something has also been done, but much yet remains to be accomplished, and the same may be said of the Cryptogamic Botany of the County, which has not received nearly the amount of attention which has been given to the Phanerogamic Botany.

For the illustrations which have appeared in the second volume of the 'Transactions' the Society is indebted almost entirely to the liberality of authors, Dr. Hood having provided the plate illustrating his paper on the May-fly; Mr. J. Hopkinson the plate of Well-sections in the London Basin; Professor Attfield the woodcuts of mites from medicinal extracts; and Miss Ormerod most of the woodcuts illustrating her papers on "Economic Botany" and "Injurious Insects"; the remainder of these, and also the woodcuts illustrating the Rev. Canon Gee's paper on "Famous Trees in Hertfordshire," being reproduced from the 'Gardeners' Chronicle' by the kind permission of the Editor, Dr. Maxwell T. Masters, F.R.S.

The following are the principal papers and lectures which have been read or delivered during the year 1880:—

Jan. 20, at Watford. — On the Occurrence of *Vertigo Moulinsiana*, Dupuy, in Hertfordshire; by Henry Groves.
—— Note on the Pupation of the Stag-beetle; by Arthur Cottam, F.R.A.S.
—— Notes on Birds Observed in 1879; by John E. Littleboy.
Feb. 17, at Watford.—Anniversary Address; by the President, J. Gwyn Jeffreys, LL.D., F.R.S., etc.
—— 24, at Hertford.—Notes on Sponges, Recent and Fossil; by Henry Gilbertson.
March 16, at Watford.—The Post-Tertiary Deposits of Hertfordshire; by J. Vincent Elsden, B.Sc., F.C.S.
—— 23, at Hertford.—Observations on Rotifers, with special reference to those found in the neighbourhood of Hertford; by F. W. Phillips.
April 20, at Watford.—Meteorological Observations taken at Wansford House, Watford, during the year 1880; by John Hopkinson, F.L.S., F.M.S., Hon. Sec.
—— Report on the Rainfall in Hertfordshire, in 1880; by John Hopkinson.
—— Report on Phenological Observations in Hertfordshire in 1880; by John Hopkinson.
Oct. 26, at St. Albans. — A Few Words on Tertiary Man; by John Evans, D.C.L., LL.D., F.R.S., etc.
Nov. 16, at Watford.—The Glaciers of Switzerland; by the Rev. George Henslow, M.A., F.L.S., F.G.S.
—— 30, at Hertford.—The Voyage of the "Challenger"; by H. N. Moseley, M.A., F.R.S.
Dec. 14, at Watford.—Rainfall in Hertfordshire, 1840-49; by the Rev. C. W. Harvey, M.A., F.M.S.
—— The Flood in the Valley of the Gade, 3rd August, 1879; by John E. Littleboy.
—— On the Importance of Recording Erratic Blocks; by H. George Fordham, F.G.S.

Meetings have also been held on the 27th of April, at Hertford, on the 2nd of November, at Ware, and on the 21st of December, at Bengeo. These were devoted to microscopical study and the exhibition of objects of general interest. A Bye-meeting for the same purpose was held on the 13th of January, at Ware.

At these meetings, or resulting from them, a certain amount of good work in microscopical research has been done by members on the eastern side of the County, but there is still a wide field open for workers in this branch of science, and it is hoped that an attempt may be made to obtain at least a list of the microscopic fauna and flora of Hertfordshire. With this view each microscopist is requested to make a note of every animalcule observed and positively identified, and to send a list of them to Mr. F. W. Phillips, Maidenhead Street, Hertford, who has kindly consented to receive and tabulate such returns. Lists of microscopic water-plants may for the present be sent to your Secretary, Mr. Croft.

As registrar of observations of birds Mr. Littleboy continues to act to the great benefit of the Society. Your Secretary, Mr. Hopkinson, will always be glad to receive and record notes of sections examined, lists of fossils found, and any other geological observations which any members may make; while the Rev. C. W. Harvey, Throcking Rectory, Buntingford, will in future act as your registrar of meteorological observations. If other members would undertake to collect information and furnish reports upon different branches of natural science, many interesting facts might be brought to light, and a record of many occurrences, which otherwise would be forgotten, might be preserved.

The reports on the rainfall and on phenological phenomena for 1879 will appear in the next part of the 'Transactions' now in the press, and the reports for 1880 will shortly be presented.

On Wednesday afternoon, the 5th of May, a large number of Members visited Kew Gardens, and under the able guidance of the Rev. George Henslow inspected many objects of interest. The large palm house, the orchid house, the house containing succulent plants, the museum of economic botany, and the new museum of British botany, were successively visited, Mr. Henslow giving most interesting demonstrations on the palms, orchids, insectivorous plants, and representative succulent plants. The Society is greatly indebted to Mr. Henslow for the interesting information conveyed to the members on this occasion, and also for his ever ready assent to lecture at an evening meeting.

All the Field Meetings announced, a larger number than in any previous year, were duly carried out, and each one attracted a considerable number of Members. The following are the dates of these meetings and the localities visited:—

May 15.—Radlett.
—— 29.—Aylesbury, Hartwell, and Stone.
June 12.—Aldbury and Ashridge.
—— 24.—Thundridge and Fanhams Hall, Ware.
July 10.—Cole Green, Woolmers, Essendon, and Hatfield Park.
—— 22.—Hertford Heath and Haileybury.

The second of these meetings, the annual whole-day meeting, was held in conjunction with the Geologists' Association. Owing, probably, to the inaccessibility of Aylesbury from the greater part of Hertfordshire, this was the least numerously attended meeting.

The next, at Ashridge, was the most numerously attended. On the whole the weather was favourable, the only meeting with which rain interfered being the fourth, near Ware.

For hospitality kindly afforded at the Field Meetings the Society is indebted to Mr. Bagnall, Newberries, Radlett; Mr. Littleboy, of Hunton Bridge, at the Ashridge Meeting; Mr. Croft, Fanhams Hall; and the Rev. Canon Bradby, Haileybury College. The thanks of the Society for permission to visit or pass through private grounds are also due to Mr. Part, Aldenham Lodge, Radlett; Mr. Wodehouse, Woolmers; and the Marquis of Salisbury, Hatfield House.

To the Society's Library the donations have been more numerous than during any previous year. This is, however, almost entirely owing to the botanical library of the late Rev. R. H. Webb, consisting of about forty volumes, having been presented to the Society by Mrs. Webb. Many scientific papers have been presented by their respective authors. Such papers are arranged and bound in volumes, so that, as far as possible, each volume is limited to memoirs treating of a single science. Thus there are in the library volumes of pamphlets relating to Meteorology, to Geology, to Botany, and to Zoology, most of the papers which they contain having appeared in the transactions of different societies, generally not easily accessible. The Society is therefore much indebted to authors who thus favour it with copies of their papers. Several complete volumes have also been presented by their authors. Miss Ormerod's 'Cobham Journals of Meteorological and Phenological Phenomena'; the Rev. T. A. Preston's 'Wiltshire Rainfall'; and Dr. Sclater's 'List of Vertebrate Animals in the Gardens of the Zoological Society,' thus presented, are valuable additions to the Library in 1880.

The Society is not only indebted to Mrs. Webb for a valuable collection of botanical books, but also for a collection of plants, the value of which, as containing the actual specimens from which the first flora of the county was compiled, can scarcely be over-rated. The herbarium of the authors of the 'Flora Hertfordiensis' is now the property of the Society, although not yet in its possession, being at present in the hands of Mr. R. A. Pryor, to whom it was lent by Mr. Webb for critical examination in connexion with his preparation of a new 'Flora of Hertfordshire.' As this work is now nearly completed, the Council hopes shortly to be enabled to announce the receipt of the whole of Mrs. Webb's donation.

The Society continues to be in a most satisfactory financial position. The great increase of members in 1879, owing to the extension of the Society in that year from a local to a county institution, coupled with the indefatigable exertions of your President, caused a corresponding increase of income, but it also necessitated a larger expenditure than before, the change of name, revision of rules, etc., being elements of expense. The expenditure in each year, to the present time, may be roughly stated as follows:—in 1875, £64; in 1876, £70; in 1877, £70; in 1878, £90; in 1879,

£130; and in 1880, £100. Although the receipts during the past year were somewhat less than in 1879, the smaller expenditure has enabled your Treasurer, after withdrawing the £52 on deposit at the Bank, to invest £98 15*s.* in the purchase of £100 Consols, and to carry forward a balance of £26 14*s.* 11*d.*, in which sum is included £18 received for subscriptions in advance. The Society now holds Consols to the amount of £203 4*s.* 6*d.* to represent its indebtedness to its 31 Life Members, and there is also a larger balance in hand than before.

The Council has now to announce the expiration, in accordance with the rules, of the term of office of your President, Dr. J. Gwyn Jeffreys, F.R.S. During the two years the Society has had the advantage of his presidency, Dr. Gwyn Jeffreys has presided at nearly every meeting which has been held on either side of the County. He has also been most assiduous in adding to the list of members, and to his influence, exerted at a most important time in the history of the Society, is in a great measure due the large increase in the number of members during the last two years. Though the nett increase in the entire roll of the Society in 1879 and 1880 is exactly 100, during this time 140 ordinary members were elected, nearly one-third of this number having been proposed by your President. While the Society, under its former title of the Watford Natural History Society, was peculiarly fortunate in having such a distinguished scientific man as Mr. John Evans as its first President, it has been equally favoured in having been presided over by Dr. Gwyn Jeffreys in the first stages of its existence as the Hertfordshire Natural History Society.

The Council regrets to have to announce the resignation of your Librarian and your Curator. The former office, the duties of which were previously undertaken by your Secretary, has been held during the past year by Mr. Arthur Cottam, who now finds that other engagements prevent him from retaining it. For a similar reason Mr. W. Lepard Smith now resigns the curatorship, an office which he has filled from the formation of the Society six years ago.

In concluding this report the Council desires to express the obligation the Society is under to the Committee of the Watford Public Library. Although the meetings at Watford are now not nearly so frequent as formerly, the Public Library is still the principal place of meeting, and, as containing your library and museum, is the home of the Society.

INCOME AND EXPENDITURE DURING THE YEAR ENDING 31*st* *DECEMBER*, 1880.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance	20	3	0	By Stationery	2	4	3
,, Subscriptions for 1877	0	10	0	,, Printing 'Transactions'	51	4	6
,, ,, ,, 1878	0	10	0	,, Miscellaneous Printing	9	16	3
,, ,, ,, 1879	4	0	0	,, Rent—Watford Public Library	5	0	0
,, ,, ,, 1880	69	10	0	,, Attendance at ditto	0	15	0
,, ,, ,, 1881	18	0	0	,, Expenses of St. Albans Meeting	1	1	0
,, Entrance Fees	27	10	0	,, ,, Ware Meetings	3	0	0
,, Life Compositions	25	0	0	,, Library	8	3	3
,, Dividend on £103 4*s.* 6*d.* Consols, for 1879 and 1880	6	3	8	,, Museum	0	10	3
,, Interest on Deposit	0	19	4	,, Addressing Notices and 'Transactions'	1	10	0
,, Sale of 'Transactions'	1	7	0	,, Postages	15	11	2
,, Amount from Deposit Account	52	0	0	,, Sundry Small Expenses	1	7	5
				,, Purchase of £100 Consols	98	15	0
				,, Balance	26	14	11
	£225	13	0		£225	13	0

Amount invested in the purchase of £203 4*s.* 6*d.* Consols .... £198 15*s.*

Audited and found correct, 3rd February, 1881. { C. F. HOLLINGSWORTH, WILLIAM VERINI.

Donations to the Library in 1880.

Title.	Donor.
Abernethy, J. Address to the Department of Mechanical Science of the British Association. 8vo. Swansea, 1880	*Mr. J. Hopkinson.*
Adams, Prof. W. G. Address to the Mathematical Section of the British Association. 8vo. Swansea, 1880	,,
Allen, G. A. History of North American Pinnipeds. 8vo. Washington, 1880	*Prof. F. V. Hayden.*
Anon. The Wonders of the Vegetable Kingdom displayed. 12mo. London, 1822	*Mrs. R. H. Webb.*
———. The Botanist's Manual. 12mo. London, n.d.	,,
Babington, Prof. C. C. Manual of British Botany. 2nd ed. 12mo. London, 1847	,,
———. Flora of Cambridgeshire. 12mo. London, 1860	,,
Balfour, Prof. J. H. Syllabus of the Course of Lectures on Botany delivered in the University of Glasgow. 8vo. Glasgow, n.d.	*Mr. J. Hopkinson.*
Carruthers, W. The Cryptogamic Forests of the Coal Period. (*Proc. Royal Institution*, 1869.) . .	,,
Clay, J. T. Observations on the Yorkshire Drift and Gravel. 8vo. Leeds, 1842	,,
Cowell, M. H. A Floral Guide for East Kent. 8vo. Faversham, 1839	*Mrs. R. H. Webb.*
Croll, Dr. J. Mr. Hill on the Cause of the Glacial Epoch. (*Geol. Mag.* 1880.)	*The Author.*
Don, G. A General History of the Dichlamydeous Plants. 4 vols. 4to. London, 1831-38	*Mrs. R. H. Webb.*
Drew, F. On the Succession of Beds in the Hastings Sand in the Northern Portion of the Wealden Area. (*Quart. Journ. Geol. Soc.* 1861)	*Mr. J. Hopkinson.*
Entomologist. Vol. v, Nos. 96, 97 (1871). Vol. vi, Nos. 100, 101, 108-112, 120-124 (1872-73). Vol. vii, Nos. 125, 126, 130, 131, 133, 134, 136, 137 (1874). 8vo. London	*Mr. A. F. Buxton.*
Fawcett, W. Report of the Weald Series of Excursions under the Direction of Mr. J. Logan Lobley. (*Proc. Geol. Assoc.* 1880.)	*Mr. J. L. Lobley.*
Francis, G. W. An Analysis of the British Ferns and their Allies. 8vo. London, 1837	*Mrs. R. H. Webb.*
Geikie, Prof. A. Outlines of Field-Geology. 8vo. London, 1879	*Miss Rose White.*
Goldsmid, Major-General Sir F. J. Eastern Persia. Vol. i, The Geography. Vol. ii, The Zoology and Geology, by W. T. Blanford. 8vo. London, 1876.	*Mr. C. E. D. Black.*
Grevillea. A Journal of Cryptogamic Botany. Vols. i-viii. 8vo. London, 1872-79	*Mrs. John Evans.*
Griffith, W. Notulæ ad Plantas Asiaticas. Part ii, On the Higher Cryptogamic Plants. 8vo. Calcutta, 1849	*Mrs. R. H. Webb.*
———. Icones Plantarum Asiaticarum. Part ii, On the Higher Cryptogamous Plants. Part iii, Monocotyledonous Plants. 4to. Calcutta, 1849, 51. .	,,
———. Palms of British East India. Folio. Calcutta, 1850	,,

Title.	Donor.
Günther, Dr. A. C. L. G. Address to the Biological Section of the British Association. 8vo. Swansea, 1880	*Mr. J. Hopkinson.*
Gurney, J. H., Jun. A Summary of the Occurrences in Great Britain of the Grey Phalarope in the Autumn of 1866. 8vo. London, 1867.	*The Author.*
———. Notes on the Fern Islands and on some of the Birds that are found there. (*Proc. Nat. Hist. Soc. Glasgow*, 1877.)	,,
Hayden, Dr. F. V. The Great West: its Attractions and Resources. 8vo. Philadelphia, 1880 . .	,,
Henry, Dr. J. Aeneidea. Vol. ii, Books 3, 4. 8vo. Dublin, 1879	*Trustees of Author.*
Hicks, Dr. H. On the Classification of the Cambrian and Silurian Rocks. (*Proc. Geol. Assoc.* 1873.) .	*Mr. J. Hopkinson.*
Holgate, B. Presidential Address on the opening of the Fifth Session of the Leeds Geological Association, Oct. 28, 1878	*The Author.*
Hooker, Sir W. J., and G. A. Arnott. British Flora. 6th ed. 12mo. London, 1850	*Mrs. R. H. Webb.*
Horticultural Register and General Magazine of . . . Natural History and Rural Subjects. Vols. i-iv. 8vo. London, 1832-35	,,
Hudson, Guliel. Flora Anglica . . . . Tomus i. 8vo. London, 1778	,,
India, Memoirs of the Geological Survey of. Palæontologia Indica. Series x, vol. i, parts 4, 5. Series xiii, Nos. 1, 2. 4to. Calcutta, 1880 . .	*Mr. C. E. D. Black.*
Jackson, B. D. Libellus de re Herbaria Novus, by William Turner, originally published in 1538, reprinted in facsimile, with notes, modern names, and a life of the author. 4to. London, 1877 . . .	*Mrs. R. H. Webb.*
Johnston, Dr. G. A Flora of Berwick-upon-Tweed. 2 vols. 12mo. Edinburgh and London, 1829-31 .	,,
Jones, Prof. T. Rupert. On the Practical Advantages of Geological Knowledge. (*Proc. Geol. Assoc.* 1880.)	*The Author.*
Lapworth, C. On New British Graptolites. (*Ann. and Mag. Nat. Hist.* 1880.)	,,
———. On the Geological Distribution of the Rhabdophora. (*ib.* 1880.)	,,
Lee, J. An Introduction to Botany. 8vo. London, 1776	*Mrs. R. H. Webb.*
Lefroy, Lieut.-General Sir J. H. Address to the Geographical Section of the British Association. 8vo. Swansea, 1880	*Mr. J. Hopkinson.*
Leidy, Dr. J., The Freshwater Rhizopods of North America. 4to. Washington, 1879	*Prof. F. V. Hayden.*
Lindley, Prof. J. A Key to Structural, Physiological, and Systematic Botany. 8vo. London, 1835 . .	*Mrs. R. H. Webb.*
———. An Introduction to Botany. 2nd ed. 8vo. London, 1835	,,
———. A Natural System of Botany. 2nd ed. 8vo. London, 1836	,,
Linnean Society. Journal. Botany, Vol. xvii, Nos. 101-105. Zoology, Vol. xiv, Nos. 78-81 . .	*Mr. R. B. Croft.*
Loudon, J. C. Hortus Britannicus. New ed. 8vo. London, 1832	*Mrs. R. H. Webb.*
Mouillefert, P. Le Phylloxera. 8vo. Paris, 1876 .	*Mr. R. B. Croft.*

Title.	Donor.
Ormerod, Eleanor A. Notes of Observations of Injurious Insects. Report for 1879. 8vo. London, 1880	*The Authoress.*
———. The Cobham Journals of Meteorological and Phenological Observations made by Miss Caroline Molesworth in the years 1825 to 1850. 8vo. London, 1880	,,
Phytologist, a Popular Botanical Miscellany. Vol. iii. (incomplete). 8vo. London, 1848-50 . . .	*Mrs. R. H. Webb.*
Preston, Rev. T. A. Wiltshire Rainfall, 1879. 8vo. Marlborough, 1880	*The Editor.*
Ramsay, Prof. A. C. [Presidential] Address [to the British Association, Swansea, 1880.] 8vo. . .	*Mr. J. Hopkinson.*
Rea, John. Flora, Ceres, & Pomona. 4to. London, 1665	*Mrs. R. H. Webb.*
Rennie, Prof. James. Alphabet of Botany. 2nd ed 8vo. London, 1833	,,
Roget, Dr. P. M. Animal and Vegetable Physiology . . . . 2 vols. 8vo. London, 1834	,,
Rudler, F. W. Address to the Department of Anthropology (Section of Biology) of the British Association, Swansea, 1880. 8vo.	*Mr. J. Hopkinson.*
Sclater, Dr. P. L. A Monograph of the Birds forming the Tanagrine Genus *Calliste.* 8vo. London, 1857.	*Mr. George Stone.*
——— List of the Vertebrate Animals in the Gardens of the Zoological Society of London. 7th ed. 8vo. London, 1879	*The Author.*
Sorby, H. C. Address to the Geological Section of the British Association. 8vo. Swansea, 1880. . .	*Mr. J. Hopkinson.*
Suffolk, W. T. Presidential Address to the South London Microscopical and Natural History Club, March 16, 1880. 8vo.	*The Author.*
Sweet, R. Hortus Britannicus. 8vo. London, 1830 .	*Mrs. R. H. Webb.*
Symons, G. J. On the Sensitiveness of Thermometers. (*Quart. Journ. Meteorol. Soc.* 1874.)	*The Author.*
———. On a White Rain or Fog Bow. (*ib.* 1875.)	,,
———. Improved form of Thermometer for observing Earth Temperature. (*ib.* 1877.)	,,
———. Report on the Rainfall of the British Isles for the years 1875-76. (*Rep. Brit. Assoc. for* 1876.) .	,,
———. Abstract of Meteorological Observations made at the Gardens of the Royal Botanic Society, Regent's Park. London, 1871-76. 8vo. London. . .	,,
———. Sanitary Institute of Great Britain. Croydon Congress, 1879. [Presidential] Address to Section iii (Meteorology, Geology, and Geography). 8vo. London	,,
———. British Rainfall, 1879. 8vo. London, 1880	*The Editor.*
———. Monthly Meteorological Magazine. Vol. xv. 8vo. London, 1880	,,
Watson, H. C. The New Botanists' Guide to the Localities of the Rarer Plants of Britain. 2 vols. 12mo. London, 1835-37	*Mrs. R. H. Webb.*
———. Cybele Britannica; or British Plants and their Geographical Relations. 4 vols. and Supplement. 8vo. London, 1847-60	,,
Williams, B. S. Hints on the Cultivation of British and Exotic Ferns and Lycopodiums. 8vo. London, 1852	,,

Received in Exchange, 1880.

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Belfast Natural History and Philosophical Society. Proceedings. Sessions 1878-79, 79-80. 8vo. Belfast, 1880.

Belfast Naturalists' Field Club. Proceedings. Series II, Vol. i, parts 5, 6. 8vo. Belfast, 1879.

Boston Society of Natural History. Proceedings. Vol. xix, parts 3, 4. Vol. xx, parts 1-3. 8vo. Boston, 1878-80.

Brighton and Sussex Natural History Society. Annual Report for 1879. 8vo. Brighton, 1880.

Cardiff Naturalists' Society. Transactions. Vol. xi. 8vo. Cardiff, 1880.

Chester Society of Natural Science. Annual Report for 1879-80. 8vo. Chester, 1880.

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Dudley and Midland Geological and Scientific Society and Field Club. Proceedings. Vol. iii, No. 2. 8vo. 1876.

Eastbourne Natural History Society. Papers. Session 1879-80. 4to. Eastbourne, 1880.

Edinburgh Botanical Society. Transactions and Proceedings. Vol. xiii, part 3. 8vo. Edinburgh, 1879.

Edinburgh Geological Society. Transactions. Vol. iii, part 3. 8vo. Edinburgh, 1880.

Epping Forest and County of Essex Naturalists' Field Club. Transactions. Part 1. 8vo. 1880.

Geological Society. Abstracts of the Proceedings. Session 1879-80. 8vo. London, 1879-80.

———. Address delivered at the Anniversary Meeting, February, 1880. By H. C. Sorby, President. 8vo. London, 1880.

Geologists' Association. Proceedings. Vol. vi, Nos. 4-7. 8vo. London, 1880.

———. Annual Report for 1879. *Ib.* 1880.

Glasgow, Geological Society of. Transactions. Vol. v, part 2. Vol. vi, part 1. 8vo. Glasgow, 1877-79.

Glasgow, Natural History Society of. Proceedings. Vol. iv, part 1. 8vo. Glasgow, 1880.

Grevillea. Vol. ix, Nos. 47-50. 8vo. London, 1880.

Irish, Royal, Academy. Proceedings. Science, Series II, Vol. iii, Nos. 2, 4. Polite Literature and Antiquities, Series II, Vol. ii, Nos. 1, 2, 4. 8vo. Dublin, 1878-80.

———. Transactions. Science, Vol. xxvi, No. 22. 4to. Dublin, 1879. Irish Manuscript Series, Vol. i, part 1. 4to. Dublin, 1880.

——— Cunningham Memoirs. No. 1. On Cubic Transformations, by Dr. John Casey. 4to. Dublin, 1880.

Leicester Literary and Philosophical Society. Transactions, 1879-80. 8vo. Leicester, 1880.

Liverpool Geological Society. Proceedings, Vol. iv, part 2. 8vo. Liverpool, 1880.

Manchester Field Naturalists' and Archæologists' Society. Proceedings, 1879. 8vo. Manchester, 1880.

Manchester Geological Society. Transactions. Vol. xv, parts 10-18. Vol. xvi, part 1. 8vo. Manchester, 1880.

Manchester Literary and Philosophical Society. Transactions. Vols. xvi-xix. 8vo. Manchester, 1877-80.

——— Memoirs. Series III, Vol. vi. 8vo. Manchester, 1880.

Meteorological Society. Quarterly Journal. New Series, Vol. vi. 8vo. London. 1880.

Microscopical, Royal, Society. Journal. Vol. iii. 8vo. London, 1880.

Midland Naturalist. Vol. iii. 8vo. London and Birmingham, 1880.

NATURALIST. Vol. v, Nos. 54-60. Vol. vi, Nos. 61-63. 8vo. Huddersfield, 1880.
NEW YORK ACADEMY OF SCIENCES. Annals. Vol. i, Nos. 1-8. 8vo. New York, 1877-78.
NEW YORK LYCEUM OF NATURAL HISTORY. Annals. Vol. xi, Nos. 9-12. 8vo. New York, 1876.
NEW YORK STATE MUSEUM OF NATURAL HISTORY. 20th to 31st Reports. 8vo. Albany, 1867-79.
NEW YORK STATE LIBRARY. Annual Reports of the Trustees for 1875-78. 8vo. Albany, 1876-79.
————. Results of a series of Meteorological Observations made . . . . in the State of New York. 1826-63. Vols. i. ii. 4to. New York, 1855-72.
QUEKETT MICROSCOPICAL CLUB. Journal. Vol. vi, Nos. 42-45. 8vo. London, 1880.
RUGBY SCHOOL NATURAL HISTORY SOCIETY. Report for 1879. 8vo. Rugby, 1880.
SCIENCE GOSSIP. Vol. xvi. 8vo. London, 1880.
SCOTTISH NATURALIST. Vol. vi, Nos. 37-40. 8vo. Edinburgh and London, 1880.
SMITHSONIAN INSTITUTION. Annual Report for 1878. 8vo. Washington (U.S.A.), 1879.
UNITED STATES COMPTROLLER. Reports of the Comptroller of the Currency for 1878-79. 8vo. Washington, 1878-79.
UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES. Bulletin. Vol. v, Nos. 2-4. 8vo. Washington, 1879-80.
————. Eleventh Annual Report (for 1877), embracing Idaho and Wyoming. 8vo. Washington, 1879.
WEST LONDON SCIENTIFIC ASSOCIATION AND FIELD CLUB. Annual Report for 1879-80. 8vo. London, 1880.
WILTSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY. Magazine. Vol. xviii, No. 54. Vol. xix, No. 55. 8vo. Devizes, 1879-80.
WINCHESTER AND HAMPSHIRE SCIENTIFIC AND LITERARY SOCIETY. Journal of Proceedings. Vol. iii, part 2. 8vo. Winchester, 1879.
YORKSHIRE GEOLOGICAL AND POLYTECHNIC SOCIETY. Proceedings. N.S. Vol. vii, part 2. 8vo. Leeds, 1879.
YORKSHIRE NATURALISTS' UNION. Transactions. Parts 1-3. 8vo. Leeds, 1878-80.

ORDINARY MEETING, 22ND FEBRUARY, 1881, AT WARE.

R. B. CROFT, Esq., R.N., F.L.S., in the Chair.

The following papers were read:—

1. "The Life-history of a Monad." By Isaac Robinson.

2. "On the Occurrence of Red Snow in Hertfordshire." By R. B. Croft, R.N., F.L.S., F.R.M.S. (*Transactions*, Vol. I, p. 170.)

Microphotographs illustrative of histology, several of which had been taken with a 1-25th inch object-glass, were exhibited by Mr. George Turner.

ORDINARY MEETING, 15TH MARCH, 1881, AT WATFORD.

ALFRED T. BRETT, Esq., M.D., Vice-President, in the Chair.

Mr. R. C. Allen, Ware; Mr. Richard Ginn, Castle Street, Hertford; and Mr. George Turner, Hoddesdon, were elected Members of the Society.

Mr. Percy F. Fordham, Bank House, Royston, was proposed as a Member.

The following papers were read :—

1. "The Formation and Arrangement of Provincial Museums." By John Hopkinson, F.L.S., F.G.S., etc., Hon. Sec. (*Transactions*, Vol. I, p. 193.)

2. "On Local Museums." By H. George Fordham, F.G.S. (*Transactions*, Vol. I, p. 215.)

ORDINARY MEETING, 22ND MARCH, 1881, AT HERTFORD.

J. GWYN JEFFREYS, Esq., LL.D., F.R.S., etc., Vice-President, in the Chair.

Mr. Thomas Bates Blow, Welwyn, and Mr. Alfred Cox, Presdales, Ware, were proposed as Members of the Society.

The following papers were read :—

1. "Report on the Rainfall in Hertfordshire in 1880." By the Rev. C. W. Harvey, M.A., F.M.S. (*Transactions*, Vol. I, p. 221.)

2. "The Frost of January, 1881, as experienced in Hertfordshire." By the Rev. C. W. Harvey. (*Transactions*, Vol. I, p. 228.)

3. "Meteorological Observations taken at Throcking, Herts, during the year 1880." By the Rev. C. W. Harvey. (*Transactions*, Vol. I, p. 233.)

ORDINARY MEETING, 12TH APRIL, 1881, AT HODDESDON.

R. B. CROFT, Esq., R.N., F.L.S., in the Chair.

Miss Alice Warner, The Woodlands, Hoddesdon, and Mr. Henry Warner, Wormley, were proposed as Members of the Society.

The following paper was read :—

"Notes on Aphides." By F. M. Campbell, F.L.S., F.Z.S., F.R.M.S.

After some introductory remarks on the anatomy, life-history, and habits of the Aphides in general, with more special reference to the rose-aphis, *Siphonophora Rosæ*, and the aphis, *Schizoneura lanigera*, which causes the blight on apple trees, Mr. Campbell gave a detailed account of the vine-aphis, *Phylloxera vastatrix*, which he said was one of the most destructive of the aphides. There seemed to be no doubt as to its having been introduced from America. It was observed there in 1854, but twenty years previously some leaves were collected from the wild vine in Texas the galls on which were now recognised to be those of the *Phylloxera*. It was discovered in France in 1868, and was now found in all wine countries, and in England. Its life-history differed slightly from that of the typical aphides. The eggs, which are laid in the bark of the vine, hatched in the spring, the larvæ becoming active at a temperature of about 52°. Some of them remained on the leaves and formed galls, while others found their way to the roots and attacked the delicate fibres, whose functions are soon destroyed. After moulting three or four times, the larvæ laid about thirty eggs (*parthenogenesis*), and there was no progressive development until about the sixth generation. Towards the end of July the nymph appeared, bearing two dark excrescences which become wings, of which two were formed on each side. The hinder one of each carried on the outer edge hooklets, which caught the back edge of the front wing when engaged in flight. The nymph, which might be carried a considerable distance by a slight breeze, laid four or five eggs from which were hatched perfect males and females. Both sexes were apterous and had no digestive organs. The female laid but one egg, which was almost as large as its own body, so that it resembled a walking egg. Unlike some other aphides, it placed the egg with due regard for the food of the larvæ, choosing a sheltered position on the branches or trunk of the vine, while sometimes, dying before the fulfilment of its maternal duties, its skin afforded additional protection to its progeny. This was the egg which passed through the winter with uninjured vitality and hatched in the spring.

Mr. Campbell illustrated his paper by microscopic preparations of *Phylloxera vastatrix* and other aphides in various stages of their life.

Ova and larvæ of the common frog (*Rana temporaria*) in various stages of development were exhibited by Mr. George Turner and Mr. Croft, and objects illustrating pond-life, by Mr. F. W. Phillips and Mr. Henry Warner, under their microscopes. Mr. Croft also showed the *Podura*-scale under a $\frac{1}{12}$th-inch homogeneous immersion object-glass by Messrs. Powell and Lealand.

Ordinary Meeting, 19th April, 1881, at Watford.

George Rooper, Esq., F.Z.S., President, in the Chair.

Mr. Thomas Bates Blow, Welwyn; Mr. Alfred Cox, Presdales, Ware; Mr. Percy Frederick Fordham, Bank House, Royston; Miss Alice Warner, The Woodlands, Hoddesdon; and Mr. Henry Warner, Wormley, were elected Members of the Society.

The following communications were read:—

1. "Meteorological Observations taken at Wansford House, Watford, during the year 1880." By John Hopkinson, F.L.S., F.M.S., etc., Hon. Sec. (*Transactions*, Vol. I, p. 251.)

2. "Report on Phenological Observations in Hertfordshire in 1880." By John Hopkinson. (*Transactions*, Vol. I, p. 257.)

3. "Notes on Birds observed during the year 1880, and the first three months of 1881." By John E. Littleboy. (*Transactions*, Vol. I, p. 239.)

4. "On the presence of Cilia on the Tadpole of the Common Frog." By R. B. Croft, R.N., F.L.S., F.R.M.S. (*Transactions*, Vol. I, p. 264.)

Field Meeting, 7th May, 1881.

THE BOURNE VALLEY, BOXMOOR.

At the little hamlet of Bourne End, between Boxmoor and Berkhampstead, there occasionally flows under the high road, through a culvert about a foot in diameter, a small stream known as the Hertfordshire Bourne. It is one of those intermittent rivers which only flow after periods of excessive rainfall, usually at intervals of from about three to seven years. Occasionally it fills the culvert and flows over the road, adding a considerable volume of water to the River Bulborne.

There is no historical record of the flowing of the Bourne in olden times. Our county historians, Chauncy, Salmon, and Clutterbuck, do not allude even to the existence of such a stream, nor does Camden or his commentators, although he mentions another intermittent Hertfordshire stream. "*Redborn*," he says, is remarkable "for a brook in its neighbourhood named *Wenmer*, which the common people believe never swells or rises without presaging scarcity or some misfortune."* To this Gough adds: "The brook mentioned by Mr. Camden is called *Womer*, and in Magna Britannia, I. 490, *Woborne Mere*, q.d. the brook or mere of woe, and, like that at N. Tanton, Devon, and that before mentioned in Bedfordshire, presages calamity. It particularly did so," he continues, "in the reign of Edward IV. when it burst out, and run from Feb. 14 to June 14; from which Norden fancies the neighbouring *Market street* hath its name corrupted from *Mer-gate*, q.d. an issue or out-gate of water."†

The earliest notice of the Hertfordshire Bourne appears to be so recent as 1876, when an account of it was given by Mr. John Evans, D.C.L., F.R.S., in a paper read before our Society, in which he records its flowing in that year, in 1873, and in 1853, and says that it also probably flowed in 1860 and 1866.‡

Although historical records thus appear to be wanting, the valley of the Bourne furnishes evidence, in the extensive denudation which has resulted in its formation, of the existence of a stream most probably long before historic times. For five miles from the point where it flows into the Bulborne, this stream, in its occasional appearance above the surface, has cut a valley of considerable depth and at least a mile in width, through the glacial gravel and sand, and the clay-with-flints, into the Chalk which forms its bed. That it ran in olden times is also proved by its now forming a county boundary for a considerable part of its course.

At the time of the present visit the Bourne had been flowing for about two months, and to trace it to its source a large number of members, ladies forming the majority, assembled at Bourne End, and under the guidance of Mr. John Evans followed the course of the stream from its outpour into the Bulborne to its source in a meadow a little to the west of Haresfoot Park, and about two miles from Berkhampstead, Mr. T. A. Dorrien Smith, over whose property it flows, having kindly granted the necessary permission.

It soon became evident that the recent dry weather had materially affected the volume of the stream, and its source was found to have lately receded at least half a mile. Pools of standing water still

* Camden's 'Britannia,' edited by Gough, vol. ii, p. 63. † *Ib.* p. 73.

‡ 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 137. Cussans appears to be our first county historian who refers to the Bourne. 'Hist. Herts, Dacorum Hundred,' p. 48.

remained in portions of the meadow above the Harratt's End Lane, but no current was observable beyond the meadow below.

At its present source, Professor Attfield, who was one of the party, took a sample of the water for analysis. He reports that it was the ordinary chalk-water of the district, for it contained, per gallon, 12 grains of chalk; 4 grains of similar calcareous matter formed of about equal parts of chlorides, nitrates, and sulphates; a little more than a grain of saline substances; and the merest traces of vegetable organic matter. While too hard for economical or serviceable use with soap, it was, he says, of very good quality for drinking purposes.

From the lane just above this spot the course of the Bourne was well seen, and here Mr. Evans explained the distinguishing characteristics of the stream. The Bourne, he said, usually runs about once in seven years, but recently it has flowed about once in three years. Its flow is dependent not on the rainfall at the time, but upon the rain which has fallen six, twelve, or even more months previously. This is to a certain extent the case with every stream flowing through a chalk country; for the ground is so porous that during the summer months it absorbs all the water falling upon it, this being given out again by evaporation or absorbed by vegetation. During the winter months usually 7 or 8 inches of the rain which falls on the surface descends through three feet of soil, but during the summer there is scarcely any percolation to that depth. The surface or gradient of the water in the chalk forms an angle which is determined by the friction of the rock and the amount of the rainfall. In the Upper Chalk this angle is about 12 feet 6 inches to the mile, but in the Lower Chalk it is 19 or 20 feet to the mile. As the actual inclination of the valley of the Bourne is about 20 feet to the mile, it is therefore necessary for a sufficient quantity of rain to fall to cause the angle of the underground reservoir to assume a higher inclination than this, in order that the surface of this reservoir may appear above ground as the Hertfordshire Bourne.

A pleasant walk of about a mile and a half along a stretch of Buckinghamshire lanes brought the party to a once-fortified enclosure within which is a farm-house, at present known as Chesham Grove. It is believed to have been a moated grange of considerable pretensions, and is probably of mediæval date. Mr. Goodson, the occupant of the farm, supplied the party with all the information he possessed respecting his interesting residence, and kindly opened a large barn for inspection. This was evidently a portion of the old mansion, probably the dining-hall, several bricked-up windows and doorways bearing unmistakable testimony to its antiquity. Tradition reports that Protestant worship was performed in this building during the reign of Queen Mary, when no other room could be obtained in the neighbourhood. The octagonal corner towers, the remains of the outer wall, and the deep fosse, were inspected with much interest. The latter, which, completely surrounds the enclosure, is still perfect. The bottom of the moat appears to have been paved with flints, and then puddled with clay in order to retain the water. After leaving these interesting ruins of what must have been a very fine specimen of the old English manor-house, a walk across the fields brought the party to another and yet earlier fortification, a circular camp near Bush Wood, probably British. Mr. Evans stated that it was one of a series of three, the others being situated respectively at Hawridge and Cholesbury. From a field close to one of these he had obtained a bronze sword, and there could be no question as to their very early date.

The route then lay through Bovingdon back to Boxmoor Station.

Field Meeting, 12th May, 1881.

BROXBOURNE AND BRICKENDON.

Leaving Broxbourne Station, the main road from London to Hoddesdon was taken for a short distance, and then a lane to the west brought the party into the fields, the path from which led through a short avenue of beech trees to Baas Hill, from which a fine view of Broxbournebury House and Park was obtained, and proceeding down the hill two old cottages, part of the old manor-house of Baas, were visited.

After collecting microscopic objects in a pond behind these cottages, the party proceeded towards Broxbournebury, and at the farm-entrance the ferns *Asplenium Adiantum-nigrum*, *Scolopendrium vulgare*, and *Polypodium calcareum* were seen. Their spores had probably been brought by the wind from the fernery at the Bury, finding here a favourable situation in which to germinate.

Passing into Pembridge Lane and through a wood to the high-road to Brickendon, Brickendon Grange was soon reached, and here the members were welcomed by Mr. and Mrs. H. Demain Saunders, who kindly provided tea and other refreshments on the lawn.

On the way from Brickendon Grange a pond on the Green was visited, and from it were obtained many species of Entomostraca, *Hydra vulgaris*, *Myriophyllum*, etc. The route then taken was through the "Lights Wood" and down Brickendonbury avenue to Hertford.

The following plants and trees were observed in flower in the course of the walk:—

Ranunculus hederaceus.	*Potentilla reptans.*
R. reptans.	*Pyrus malus*, v. *acerba.*
R. scleratus.	*Ajuga reptans.*
Cardamine sylvatica.	*Myosotis versicolor.*
Viola odorata.	*Primula veris.*
Lychnis dioica.	*Quercus pedunculata.*
Vicia sepium.	*Orchis mascula.*
Lathyrus tuberosus.	*O. Morio.*

The meeting was under the direction of Mr. R. T. Andrews, from whose account this report has been compiled.

Field Meeting, 19th May, 1881.

BUNTINGFORD.

Heavy rain-squalls prevented a large gathering of members, but at half-past two a fair number assembled at the Buntingford railway-station, and under the guidance of the Rev. J. A. Ewing started on their walk to Braughing.

Leaving the high-road the members went along the valley of the Rib to Westmill, and were shown the beautiful little church by their guide the Rector. Shortly after leaving the church, the members were made aware that they had no longitude, being on the meridian of Greenwich.

Near Westmill station a slight detour was made to examine a chalk-pit, and then, following the line of railway, many specimens of the large edible snail, *Helix Pomatia*, were seen, and speculation hazarded as to whether they were true natives or descendants of escapes from the neighbouring Roman camp.

Before arriving at Braughing station the rain began to come down in earnest, and the party had to take refuge in the goods-shed and reluctantly give up their visit to the encampment and the rich botanical hunting-ground near Up Hall.

The following plants in the Meteorological Society's list were observed in flower:—

Ranunculus Ficaria.
R. acris.
Caltha palustris.
Cardamine pratensis.
Stellaria Holostea.
Geranium Robertianum.
Lotus corniculatus.
Vicia sepium.
Potentilla anserina.
Anthriscus sylvestris.
Galium aparine.
Petasites vulgaris.
Symphytum officinale.
Veronica Chamædrys.
Nepeta Glechoma.
Ajuga reptans.
Primula veris.
Plantago lanceolata.
Mercurialis perennis.
Endymion nutans.

Field Meeting, 28th May, 1881.

STANMORE COMMON.

Assembling on the Common at about half-past three, the members, including a large number of ladies, were soon scattered in various directions, microscopists visiting the ponds at the further extremity of the Common, while those interested in botany wandered over the "gorse-clad moor" diligently searching for botanical treasures. Amongst the "finds" may be mentioned the following:—*Carduus pratensis, Polygala depressa, Genista anglica, Veronica scutellata,* and a beautiful grass, *Aira flexuosa.*

The party re-assembled at "The Grove," the delightfully-situated residence of Mr. George Brightwen, and, after partaking of tea, spent a very pleasant time in inspecting the museum and examining interesting objects in Natural History. Amongst these a series of designs in feathers, some representing the birds from which the feathers had been derived, artistically executed by Mrs. Brightwen, deserve special notice.*

Field Meeting, 2nd June, 1881.

PANSHANGER, HERTFORD.

The members and their friends assembled at Cole Green railway station, and, entering the park by the Cole Green lodge, walked to the bridge over the Mimram, near which a lady espied the first yellow iris of the season (*Iris Pseudacorus*).

After lingering in the welcome shade of the trees by the river, the party proceeded to the Panshanger Oak, mentioned in Canon Gee's paper on "Famous Trees in Hertfordshire,"† and from thence to the beautiful gardens of Panshanger, which were kindly thrown open by their noble owner, Earl Cowper.

On the way to the Hertingfordbury lodge a solitary blossom of the wild rose (*Rosa canina*) was found, and on leaving the park a poppy (*Papaver Rhœas*) was seen in bloom. From here some of the members went direct to Hertford along the road, while the remainder branched off by a footpath to the left, and, after going through two or three fields, one was reached which was quite ablaze with poppies, which had evidently been out for two or three days, although during a walk of some miles only one poppy had previously been seen. This was considered a striking proof of the necessity of having many phenological observers.

The meeting was under the direction of Mr. Henry Warner.

Field Meeting, 8th June, 1881.

MUNDEN PARK, WATFORD.

From the place of meeting, Watford Station, the members walked a short distance along the St. Albans road, and then across the fields and by Bushey Mill to Otterspool, the residence of Mr. S. T Holland.

A chalk- and gravel-pit was first visited, and then, entering the gardens opposite this pit, the springs from which Otterspool takes its name were soon reached. Here the origin of the springs, the position of which in the picturesque pool was distinctly seen, formed a subject of discussion, and that the crevices in the chalk from which they arise communicate with swallow-holes in the neighbourhood of Aldenham or Batler's Green, was considered to be the most probable supposition. For various points of interet, connected with this pool and the chalk-pit near, reference masy however, be made to the reports of former visits.‡

* Report by Mr. Littleboy.

† 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 9.

‡ See 'Proc. Geol. Assoc.,' vol. ii, p. 44, and 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. xvi.

Leaving Otterspool, a path by the side of the Colne was taken to Munden House, the residence of Mr. A. H. Holland Hibbert, who met the members in his grounds and pointed out the finest and most notable trees and other objects of interest. A fine example of *Salisburia adiantifolia*, the maiden-hair tree, the foliage of which resembles that of the fern of this name, a silver chestnut, a tulip tree, hemlock spruces, yews, etc., all of very luxuriant growth, were specially noticed, and Mr. Hibbert pointed out a splendid *Abies Douglassi*, planted from a pot thirty-six years ago by a gardener still at Munden.

In the house, after partaking of tea, kindly provided by Mr. Hibbert, a large collection of birds shot on the estate was inspected,* and some time was spent in the library, which contains many valuable books, etchings, and engravings.

The meeting was under the direction of Mr. F. W. Silvester.

Field Meeting, 18th June, 1881.

HODDESDON.

Several members and their friends, with about fifteen members of the Quekett Microscopical Club, left Broxbourne railway-station under the guidance of Mr. Henry Warner and of Miss Warner, and, passing through the pleasant village of Broxbourne and through Broxbournebury Park, several of the oak trees in which were much admired, explored the tumulus locally known as Hod's Barrow, which is supposed to have been erected by, or to the memory of, one Hodo, a Danish prince, who also gave his name to the neighbouring hamlet of Hoddesdon.

This barrow is mentioned by Salmon,† but all traces of it had been lost sight of and its existence forgotten till some years ago, when Mr. Whitley determined to endeavour to re-discover it, which he did after much search. As Mr. Whitley was present with the party, the interest in this part of the day's proceedings was much enhanced by his descriptions, etc.

A short walk brought the party to the Ermine Street, of which the portion between Broxbournebury and Goose Green was then explored, and the fine forest scenery on either side of the ancient way was greatly admired.

From Goose Green the party returned through the woods towards Hoddesdon, and, entering the beautiful grounds of "Woodlands," the microscopists were soon busily employed fishing in the ornamental water, which is well known to be rich in minute organisms.

Mrs. Warner then most kindly entertained the members of the two societies at tea, after which the party separated.

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 32, for a complete list of this collection.

† Hoddesdon "might be named from *Oddo*, or *Otto*, some *Danish* Commander, whose *Tumulus* was here."—'Hist. Herts,' p. 21.

Field Meeting, 25th June, 1881.

TOTTERNHOE, KENSWORTH, AND LUTON.

The Dunstable Downs form the most elevated tract of country north of London within the area of the Chalk formation, in the trough of which lies the London Tertiary Basin, their highest point, Kensworth Hill, being at least 800 feet above sea-level. The Chalk here forms two escarpments, but the higher beds of the Upper Chalk are not represented, the main escarpment exposing the outcrop of the Lower Chalk and the lower beds of the Upper Chalk, and the secondary escarpment the lower beds of the Lower Chalk and the upper portion of the Chalk Marl, with the Totternhoe Stone forming its highest bed.

To gain a knowledge of the physical features of the Dunstable Downs and surrounding country, and to examine the Totternhoe Stone, which only occurs on the north-west outcrop of the Chalk Marl, the members of the Geologists' Association, the Hertfordshire Natural History Society, and the Luton Natural History Society, assembled at Stanbridgeford Station at about half-past 11, and at once proceeded, some in carriages and some on foot, to the Totternhoe quarries, where a good section of the Totternhoe Stone is exposed.

Mr. Saunders here said that this bed usually occurred in two seams, each about three feet thick, and consisted of a compact arenaceous limestone, which, in working, separated into massive blocks. Its sandy nature suggested a break in the continuity of the physical conditions which accompanied the deposition of the other beds of the Chalk formation, which were almost purely calcareous. The Totternhoe Stone played an important part in modifying the physical features of the district. At its junction with the overlying bed many springs took their rise, the long-continued action of which had been the primary agent in excavating those coombs or valleys which were so characteristic of chalk escarpments. Of these escarpments examples might be seen at Ivinghoe, Barton, Ravensbury Castle, and Pegsdon Barns. Of the rarer fossils found in this bed, Mr. Saunders mentioned that he had discovered part of the jaw, with teeth, of *Ichthyosaurus campylodon*, and a crustacean, *Palæga Carteri*, the first of its kind which exhibited the caudal appendages by which Dr. Henry Woodward was enabled to determine the affinities of the species.

Rain had fallen heavily in the morning, and now it again descended, rendering fossil-collecting not such a pleasant occupation as it would otherwise have been. A good many fossils were, however, found, including *Rhynchonella plicatula* and *R. octoplicata*, *Terebratulæ*, *Inocerami*, etc., teeth of *Ptychodus*, and a fragment of a large dorsal spine of a sauroid fish, the only important find. Some nodules of chert were also obtained.

The party then walked across the fields to Totternhoe Knoll, on the summit of which Professor Morris gave an address on the physiography of the district, explaining how some of the Chalk beds were more or less indurated than others, and how the varying degree of hardness and softness rendered them more or less liable to the effects of subaërial denudation, thus determining the physical features of the country. The Chalk, he said, once extended over a wide area in a north-westerly direction, and had been subsequently removed by denudation. Chalk escarpments, as thus left, which formed such a prominent feature in English scenery, had been inferred to be sea-cliffs, but that could not be the case, for the sea cuts indiscriminately through all classes of rocks, and would have left water-worn flints, pebbles, and sand at the base of the escarpment, instead of the unrolled and unbroken flints here seen. After alluding in succession to the most interesting points connected with the physical character and extent of the contiguous underlying strata, the Gault, Lower Greensand, and Purbeck beds, Professor Morris referred more particularly to the influence of the range of the Lower Greensand on the physical features and water-supply of the neighbourhood, illustrating his remarks with a geological map, which, however, was partially sheltered from observation and rain by an umbrella. Before he could finish, heavy rain and a gale of wind drove the party down the hill and into the village inn below for shelter and refreshment.

The rain soon ceasing, Totternhoe was left for Kensworth Hill. At the foot of the hill a spring was examined, and a discussion ensued as to the stratum which retained and threw out the water on the hill-side, for its position appeared to be above the line of junction of the Chalk Marl (or its highest bed the Totternhoe Stone), with the more porous chalk overlying it. The water from the spring had carved out for itself a valley in the chalk, affording an example of the mode of formation of the coombs which are so characteristic of chalk escarpments.

A steep climb soon brought the party to the summit of Kensworth Hill. Here a splendid view of the surrounding country was obtained. On the south the ground was seen to slope gently in the direction of Kensworth, while to the north was the steep escarpment which had just been climbed, with the lesser, Lower Chalk escarpment of Totternhoe Knoll and the Maiden's Bower below it, and here and there an outlier of the Chalk might be seen forming a slight elevation on the Gault plain beyond. The height of this hill is generally given on maps of the district, etc., as 904ft. above the sea-level, but Mr. Hopkinson stated that, from aneroid measurements he had made from bench-marks on the Dunstable road, he believed the summit was about 810 ft. above Ordnance-datum.

The route now lay by Kensworth Green, through Kensworth churchyard, and across the St. Albans and Dunstable road, to Caddington. Here the carriages were waiting to convey the party to Farley Hill, Luton, where Mr. Henry Brown, President of the Luton Natural History Society, had kindly offered to provide tea at his residence, "Highfields."

After a substantial meal had been partaken of, in a marquee erected for the purpose, Mr. Hudleston, as President of the Geologists' Association, proposed a vote of thanks to Mr. and Mrs. Brown, which was seconded by Mr. Hopkinson, as Secretary of the Hertfordshire Natural History Society, and heartily carried. Professor P. Martin Duncan, F.R.S., then expressed the thanks of the party to the Directors, specially mentioning the wide extent of knowledge of the local geology of England possessed by Professor Morris.

Before separating, the members of the three Societies had an opportunity of inspecting a fine collection of local fossils made by Mr. Saunders, and some artistically-executed diagrams, illustrating the geology of the district, prepared by Mr. A. Ewen.

Mr. Saunders reports the following plants as seen in flower in the course of the day.

On the hills near Totternhoe:—*Galium sexatile, Campanula glomerata, Polygala vulgaris* (of various colours).

Near the village of Totternhoe:—*Verbena officinalis.*

In the hedges near Totternhoe:—*Bryonia dioica, Rhamnus catharticus, Cornus sanguinea.*

Approaching the Dunstable Downs:—*Orchis maculata.*

On the Downs:—*Carex præcox.*

In the woods near Whipsnade:—*Helleborus viridis, Prunus institia, Carex remota* and *C. sylvatica.*

In deserted pits:—*Echium vulgare, Reseda lutea.*

Field Meeting, 9th July, 1881.

HUNTON BRIDGE AND WATFORD.

Members and their friends assembled at Hunton Bridge at about half-past three and walked across the meadows in the direction of the Haggery Farm. A pond on the Langleybury estate offered an enticing hunting-ground for microscopists, nets and small bottles being quickly brought into requisition.

The Grove Park, with its splendid beech trees and picturesque slopes, was next crossed, and those who had known the Grove longest agreed in the conclusion that they had never before seen it to greater advantage.

The wood-walks which bound the Cassiobury Park on its eastern side were then traversed, and here several interesting botanical specimens were obtained, including *Impatiens parviflora* and several orchids. The members then entered the private grounds of Cassiobury, where they were received by the Earl of Essex, and they strolled about here for some time inspecting the many fine trees which grace these picturesque grounds.

Leaving Cassiobury by the Nascott gate, the members adjourned to Watford House, where they were kindly entertained by Dr. Brett. The many objects of interest contained in Dr. Brett's museum were then inspected, and a large oak, the girth of which entitled it, according to Canon Gee's definition, to be classed amongst the famous trees of Hertfordshire, was also examined.

The meeting was under the direction of Mr. Littleboy, who furnished this report.

Field Meeting, 21st July, 1881.

EPPING FOREST.

This meeting was held in conjunction with the Epping Forest and County of Essex Naturalists' Field Club, the two societies meeting at the Wake Arms in the centre of the forest, for which the members of the Hertfordshire Society had taken a coach from Waltham.

The members of the two societies, under the guidance of Mr. Cole, the Honorary Secretary of the Essex Club, walked through Great and Little Monk's woods to High Beech, from which there is an extensive view over the valley of the Lea into Hertfordshire and Middlesex. A pleasant ramble brought the party to the ancient British Camp, where Mr. Cole pointed out the recent excavations and explained their results, and a return was then made to the Wake Arms, where tea was ready for the party.

After tea the Rev. W. Linton Wilson, M.A., took the chair at an ordinary meeting of the Essex Field Club, and in a genial speech cordially welcomed the Hertfordshire Society, on whose behalf Mr. Croft briefly responded. The Hertfordshire contingent then mounted their coach for the return journey to Waltham, and the members of the local society wandered through the woodlands to Loughton and Theydon Bois.

TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

I.

ADDRESS.

By the PRESIDENT, J. GWYN JEFFREYS, LL.D., F.R.S., F.L.S., F.G.S., etc.

Delivered at Hertford, 2nd October, 1879.

LADIES AND GENTLEMEN,—

When both our excellent Secretaries asked me to "say a few words" on the occasion of opening the session of the Hertfordshire Natural History Society and Field Club, I certainly was not prepared to deliver an address, as announced in the notice of this meeting, because the usual anniversary address is to be given in February next; so that I hope you will not be disappointed if I do not make a long and elaborate discourse, especially as your time will be more agreeably occupied in examining various interesting objects under the microscopes which have been so plentifully and so kindly supplied for your instruction and amusement.

After this apologetic preface I beg to propose our mutual congratulations on the Society, under its new name, meeting for the first time, and at Hertford. I may explain to such of my audience as have not yet enjoyed the privilege of being members, that the original title of the Society was the "Watford Natural History Society and Hertfordshire Field Club," and that the name has this year been changed to that which it now bears. This change of name has already caused a considerable accession of members; and I hope it will produce an increased crop of scientific work, in consequence of the area of our observations being enlarged, and of the enrolment of new workers.

Societies of our kind are becoming very numerous and useful in this country. My friend Sir Walter Elliot has kindly sent me extracts from his opening address as President of the Botanical Society of Edinburgh in 1870, the appendix to which contains a list of provincial societies and field clubs then existing in Great Britain and Ireland, with full particulars. In England there were 95, of which 51 published periodical transactions and proceedings, or occasional scientific papers. The oldest of these societies (the Literary and Philosophical Society of Manchester) was founded in 1781, and in 1870 consisted of 1513 members. The Rev. Henry H. Higgins, the President of the Liverpool Naturalists' Field Club, informs me that his society has over 500 members, in about equal proportions of the sexes. Mr. Henry Brady, a well-known zoologist, and a Fellow of the Royal Society, writes me word that the Tyneside Naturalists' Field Club has nearly 700 members. This and the Berwickshire Naturalists' Field Club, which was founded in 1831, are celebrated for their valuable publications. I took much interest in the formation and establishment of the Royal Institution of South Wales, having been, in 1835, the first honorary secretary, and afterwards president. My old Swansea schoolfellows, Mr. Justice Grove and Lord Aberdare, were also presidents in other years. The Royal Institution of South Wales has now 348 members. The Birmingham Natural History and Microscopical Society has a peculiar feature—viz. in not confining its field excursions to its own district, but in making expeditions once a year to distant places, such as South Devon, the Clyde, or Falmouth, for dredging and other natural-history work. Many ladies take part in these expeditions. Scotland, in 1870, had 19 societies, of which 11 were publishing; the oldest was the Perth Literary and Antiquarian Society, and dated from 1784. The Glasgow Philosophical Society had the greatest number of members, 540. In Ireland were 7 societies, 5 publishing; the oldest was the Belfast Literary Society, and dated from 1801. The Belfast Naturalists' Field Club was the most numerous, and had 232 members.

Lancashire and Yorkshire Field Clubs can boast at present of being the most active; and they comprise a great many working naturalists—workmen in every sense of the word. I have been much and often gratified by receiving specimens of land and freshwater shells for my opinion from men who were evidently common artisans in the principal northern towns; and I valued their communications not less than those which I had from my own colleagues. I shall not forget the pleasure with which I welcomed the communications of the Banff shoemaker, Thomas Edward, the history of whose life and career has been so admirably written by Mr. Smiles. Other naturalists of the same class have not been inferior to Edward in zeal and energy; but they wanted a biographer to make them famous. The knowledge of natural history cannot be greater in those who are "in populous cities pent" than in country folk. Even the farm-labourer, who is usually, but wrongly, despised for what is called his Bœotian stupidity, could tell us much more than town folk about wild animals and plants. Such studies offer just now an especial attraction by diverting men's minds from the cares and worries incident to the "bad times." A similar remedy—that of literary work—was prescribed long ago by Cicero in his oration for the poet Archias. But I venture to give a gentle hint to the ladies also. Don't ignore knowledge, nor be ashamed of using the intellect and faculties which God has entrusted to you. Don't be "know nothings," or thus adopt the name of that dangerous and troublesome sect in the United States, although you may be plotters in some harmless way. Don't say, "Oh! I am not scientific," either from horror at being considered a "blue-stocking," or from hugging yourself with the consciousness of possessing some recondite virtue.

I hope I shall not be thought very fanciful if I advise my brother-naturalists to be moderate in their captures of animals and plants. Shakspere's poetical idea of the pang felt by the poor beetle when trodden on, may, after all, be founded in truth, notwithstanding the opinion of the late George Henry Lewes that animals having a low degree of organization do not suffer pain. And we are not quite sure that the beautiful myth of the ancient Greeks, ever sympathising with external nature, as to the Hamadryads, or wood-nymphs, who were united so closely, each to her tree, that they sprung up and died with it, may not have had a similar foundation. We know that the sarcode of animals and the parenchyma of plants (both now called protoplasm), form the basis or substructure of all animal and vegetable organisms, and are of the same nature; and as most organisms have nerves, it is not unreasonable to suppose that they feel some kind of physical pain like that which is apparently exhibited by insects and the sensitive plant. We cannot ascertain this for a certainty by making our own metamorphosis and turning into other animals, or becoming trees, whatever may have been our descent or the original course of our evolution.

It now only remains for me to mention that the number of our members was at the close of last year 170, and is now 210;* and

* Viz. honorary members 12, and ordinary members 198, of whom 32 are ladies. Of the ordinary members 23, including 3 ladies, are life members.

I would remind you that the objects of this Society are,—the investigation of the Meteorology, Geology, Botany, and Zoology of the county of Hertford; the publication of the results of such investigation; and the dissemination amongst its members of information on Natural History and Microscopical Science. Anthropology is, of course, included in the scheme. You all know that Pope said—

> "The proper study of mankind is man;"

but Wordsworth, who was a more philosophic poet, albeit perhaps sometimes verbose, tells us—

> "Happy is he who lives to understand
> Not human nature only, but explores
> All natures,—to the end that he may find
> The law that governs each; and where begins
> The union, the partition where, that makes
> Kind and degree, among all visible beings;
> The constitutions, powers, and faculties
> Which they inherit—cannot step beyond—
> And cannot fall beneath; that do assign
> To every class its station and its office,
> Through all the mighty commonwealth of things;
> Up from the creeping plant to sovereign Man.
> Such converse, if directed by a meek,
> Sincere, and humble spirit, teaches love:
> For knowledge is delight; and such delight
> Breeds love: yet, suited as it rather is
> To thought and to the climbing intellect,
> It teaches less to love, than to adore;
> If that be not indeed the highest love!"

II.

ANIMALS WHICH HAVE BECOME EXTINCT IN BRITAIN WITHIN HISTORIC TIMES.

By J. E. Harting, F.L.S., F.Z.S.

Read at Watford, 21st October, 1879.

It is a curious reflection at the present day, as we pass over some of the wilder parts of the country, that at one time these same moors and woods and glens, which we now traverse so securely, were infested to such an extent with ferocious animals that a journey of any length was, on that account, attended with considerable danger. Droves of wolves, which usually issued forth at night to ravage the herdsman's flocks, were ever ready to attack the solitary horseman or unwary traveller on foot who might venture to pass within reach of their hiding-places. In the oak-woods and amongst the reed-beds which fringed the meres, wild boars lurked, while munching their rich store of acorns, or wallowing as is their wont in lacustrine mire while they searched for the palatable roots of aquatic plants. Many a traveller then had cause to rue the sudden and unexpected rush of some grand old patriarch of the "sownder," who with gnashing tusks charged out upon the invader of his domain, occasionally unhorsing him, and not unfrequently inflicting severe injuries upon his steed.

In the wilder recesses of the forests, and amongst the caves and boulders of the mountain-side, the bear, too, had his stronghold, and though exterminated at a much earlier period, long co-existed with the animals we have named; while in a few favoured localities in the west and north, the harmless inoffensive beaver built its dam, and dived in timid haste at the approach of an intruder.

In the present day it is difficult to realize such a state of things, unless we consider at the same time the aspect and condition of the country in which these animals lived. and the remarkable physical changes which have since taken place.

Nothing we have now left can give us any idea of the state of things then: not the moors of North Derbyshire, West Yorkshire, and Lancashire, the wild wastes of Westmoreland, Cumberland, and Northumberland, nor even the extensive deer-forests and moors of the Scottish Highlands; for the pathless woods which then covered a great part of these districts are all gone, and so also are the thick forests which outside of, but connected with them, skirted these higher grounds. The advance of man and the progress of cultivation has destroyed most of these wild woods; but it was not so in late Saxon, or in early Norman, times. Even in the less hilly districts more than half the country was one vast forest, and in the north at least these forests flanked the mountain-ranges, extending their wild influence, and at the same time rendering them more inaccessible and wilder still. Between the tenth and twelfth centuries great forests came up almost to the gates of London. In a curious tract entitled 'Descriptio nobilissimæ civitatis Londoniæ,' written by Fitzstephen, a monk of Canterbury, in 1174, it is stated that there were open meadows of pasture-lands on the north side of the city, and that beyond these was a great forest in whose woody coverts lurked the stag, the hind, the wild boar, and the bull. Two-thirds or nearly of the county of Stafford was, even in relatively modern times, either moorland or woodland. The northern part, going nearly up to Buxton, was moorland; the central and eastern part, forest. Harwood, in his edition of Erdeswick's 'Survey of Staffordshire,' quoting Sir Simon Degge, says: "The moorlands are the more northerly mountainous part of the county lying betwixt Dove and Trent; the woodlands are the more southerly level part of the county. Between the aforesaid rivers, including Needwood Forest, with all its parks, are also the parks of Wichnor, Chartley, Horecross, Bagots, Loxley, and Paynesley, which anciently were all but as one wood, that gave it the name of Woodlands." Leland, about 1536, though he speaks of the woods being then much reduced, confirms this, and even carries this country of woods farther south. He says: "Of ancient tyme all the quarters of the country about Lichefeild were forrest and wild ground." That would bring the Staffordshire woodlands close up to the purlieus of Charnwood Forest, in Leicestershire. Nor is this all; for about three miles north-west of Lichfield commences Cannock Chase, with its parks as numerous and extensive as those of Needwood, from which it was separated only by the river Trent. This chase even at a comparatively recent period was "said to contain 36,000 acres;" while "in Queen Elizabeth's time Needwood Forest was twenty-four miles in circumference." From the Peak northwards, throughout West Yorkshire and East Lancashire, the forests, moors, and mosses connected with this mountain-range were immense.

Some idea of their extent may be gathered from the remarks of the learned Dr. Whitaker, who, describing Whalley in Lancashire in late Saxon and early Norman times, says: "If, excluding the forest of Bowland, we take the parish of Whalley as a square of 161 miles, from this sum at least 70 miles, or 27,657 acres, must be deducted for the four forests or chases of Blackburnshire, which belonged to no township or manor, but were at that time mere derelicts, and therefore claimed, as heretofore unappropriated, by the first Norman lords. There will therefore remain for the different manors and townships 36,000 acres or thereabouts, of which 3,520, or not quite a tenth part, was in a state of cultivation; while the vast *residuum* stretched far and wide, like an ocean of waste interspersed with a few inhabited islands." * Let us try to realize the state of things, when out of 63,657 acres of land, over 60,000 were either forest or waste, nearly half of that amount being unclaimed

* Whitaker's 'Whalley,' p. 171.—1818.

and unappropriated; while close at hand towards the north was the still larger and wilder forest of Bowland, and towards the South that of Rosendale, with an amazing range of moors beyond it. But this only shows how the great central range was covered and fringed with wastes and forests on its western side. On the eastern side in the same neighbourhood, the country of Craven, it was just the same even as lately as the reign of Henry the Eighth. Leland says: "The forest from a mile beneath Gnaresburgh to very nigh Bolton yn Craven is about a twenty miles in length, and in bredeth it is in sum places an viij miles," the whole intermediate district between Bolton and Bowland Forest, or between it and Whalley, being about as wild as anything can be.*

In the north of England the same state of things prevailed, often on an even larger scale; one forest alone in Cumberland, and that not in its wildest part, being described in 'The Chartulary of Lanercost Priory' as extending at the time of the Norman Conquest from Carlisle to Penrith, a distance of eighteen miles, and as "a goodly forest, full of woods, red deer and fallow, wild swine, and all manner of wild beasts." As for Scotland, we can scarcely over-estimate the wildness that everywhere prevailed, when in the south a vast forest filled the intervening space between Chillingham and Hamilton, a distance as the crow flies of about 80 miles, including within it Ettrick and numerous other forests, and further north the great Caledonian forest, known even at Rome, covered the greater part of both Lowlands and Highlands.

But enough has been said to show how favourable was the condition of the country for the preservation of aboriginal wild animals. Let us now look into the evidence which can be adduced of their former existence.

The Bear.

To treat first of the earliest historic species which has died out, no doubt can exist that the brown bear inhabited Britain in times of which history takes cognizance, the few written records which have come down to us of its former existence here being supplemented by the best of all evidence, the discovery of its bones. Remains have been found in the most recent formations throughout England which can scarcely be regarded as fossil, and if not absolutely identical with the bear which still exists in Northern Europe, appertain only to a variety. From the variation in size which has been observed in the skeletons of animals apparently adult, there is reason to believe in the former existence in Great Britain of at least two, if not three, species of bear.

Our illustrious countryman, John Ray, in his 'Synopsis Methodica Animalium' (a small octavo volume published in 1693), tells us (pp. 213-214) that his friend, Mr. Edward Llwyd, in an old Welsh MS. on British Laws and Customs, discovered certain statutes and regulations relating to hunting, from which it appeared

* Storer, 'Wild White Cattle of Great Britain,' p. 67.

that the bear was formerly reckoned amongst the beasts of the chase, and that its flesh was esteemed equally with that of the hare and the wild boar.—"*Summam seu præcipuæ æstimationis ferinam esse, ursi, leporis, et apri.*"

Many places in Wales, says Pennant, still retain the name of Penarth, or "the bear's head," another evidence of their existence in our country.

But so far as history informs us, it would seem that Scotland, and more particularly the Caledonian forest, was the great stronghold of our British bears. Bishop Leslie says that that great wood was once "*refertissimam*"—full of them.

Camden, too, writing of Perthshire, observes: "This Athole . . . . is a country fruitful enough, having woody vallies, where once the Caledonian forest (dreadful for its dark intricate windings and for its dens of bears, and its huge wild, thick-maned bulls) . . extended itself far and near in these parts."

After the occupation of Britain by the Romans, Caledonian bears seem to have been perfectly well known in Rome. We learn from Martial that they were used for the purpose of tormenting malefactors, of which we have an instance in the fate of Laureolus:—

> "Nuda Caledonio sic pectora præbuit urso
> Non falsa pendens in cruce Laureolus,"—

which may be Englished:—

> "Thus Laureolus on no ideal cross suspended
> Presents his nude body to the Caledonian bear."

Plutarch, too, assures us "that they transported bears from Britain to Rome, where they held them in great admiration." How these bears were captured, and in what way they were transported to the coast and shipped on board the Roman galleys, must, we fear, for ever remain matters for speculation. We do not even know the precise period at which these very hazardous consignments were made, but it may be assumed to have been probably somewhat before the time that wolf-dogs were being exported to Rome, which we know was about the latter end of the fourth century. A Roman consul of that day, Symmachus by name, writing to his brother Flavianus over here, thanks him for a present which he had made him of some dogs which he calls *Canes Scotici*, and which were shown at the Circensian games to the great astonishment of the people, who could not believe it possible to bring them to Rome otherwise than in iron cages. It was no doubt in iron cages that the bears were transported.

When this animal became extinct in Britain is uncertain. Professor Boyd Dawkins thinks it must have been extirpated probably before the tenth century. The story quoted by Pennant from a history of the Gordons, to the effect that in 1057 a Gordon, in reward for his valour in killing a fierce bear, was directed by the King to carry three bears' heads on his banner, seems to be altogether a fallacy, being unsupported by any documentary evidence. Moreover, the arms of the Gordons happen to be boars' not bears' heads. The difference of one letter only in the name might easily account for a mistake, which has been since blindly copied by many writers.

When native bears no longer existed, our ancestors imported foreign ones, for a purpose that does no credit to the manners and customs of the times: "bear-baiting," in all its cruelty, was a favourite pastime with our forefathers. In Queen Elizabeth's time it was reckoned a fitting entertainment for an ambassador, and the Queen herself was amused in this way, amongst others, when she visited Kenilworth. Our nobility also kept their "bear-ward," who was paid so much a year, like a keeper, falconer, or other retainer. Twenty shillings was the payment made in 1512 to the "bear-ward" of the fifth Earl of Northumberland, "when he comyth to my lorde in Cristmas with his lordshippes beests for makynge of his lordship pastyme the said xij days."

A travelling "bear-ward" depended entirely on his patrons. In the "household book" kept by the steward of Squire Kitson, of Hengrave, Suffolk, and commenced in 1572, we find under date July, 1572, the entry, "To a bearman for bringing his bears to Hengrave, ijs. vjd."

Happily in this more enlightened age such pastimes have been discontinued.

THE BEAVER.

There is no reason to doubt that within historic times the beaver was an inhabitant of Britain, although, like the bear, the wolf, and the wild boar, it has been exterminated before the advance of civilization.

The earliest notice we find of it is contained in the code of Welsh Laws made by Howel Dha in the ninth century, and which, unlike the ancient Saxon codes and the Irish Senchus Mor, contains many quaint laws relating to hunting and fishing. It is there laid down that the King is to have the worth of beavers, martens, and ermines, in whatsoever spot they shall be killed, because from them the borders of the King's garments are made.

The price of a beaver's skin, termed *Croen Llostlydan*, at that time, was fixed at 120 pence, while the skin of a marten was only 24 pence, and that of an ermine, fox, and otter, 12 pence. This shows that even at that period the beaver was a rare animal in Wales. The otter is there styled *dyfrgi*, but the name *afangc* (beaver) nowhere appears, though the skins then in use are particularly enumerated.

Giraldus de Barri, or, as he is generally styled, Giraldus Cambrensis, in his quaint account of the journey he made through Wales in 1188 in company with Baldwin, Archbishop of Canterbury (who afterwards fell before Acre in the train of Richard Cœur de Lion), tells us that in his day the beaver was found in the river Teivi in Cardiganshire, and gives a curious account of its habits, apparently derived in some part from his own observation.*

* Giraldus Cambrensis, 'Itinerary,' ed. Hoare, vol. ii, p. 49.

Harrison, in his 'Description of England,' prefixed to Holinshed's 'Chronicles,' remarks, "For to saie the truth we have not manie beavers, but onelie in the Teifie in Wales." * The precise spot on the river appears to have been Killgarran, which is situated on the summit of a rock at a place called Carnach Mawr (now Kenarth), where there is a salmon-leap.

Drayton, in his 'Polyolbion' (Song vi.), thus versifies the tradition :—

> "More famous long agone than for the salmon's leap,
> For beavers Teivi was, in his strong banks that bred,
> Which else no other brook of Britain nourished :
> Where nature in the shape of this now perish'd beast
> Her property did seem to have wondrously exprest."

There is some reason for supposing, however, that there were other rivers in Wales besides the Teivi which were frequented by these animals. "In the Conway," says Camden, "is the beaver's pool," and a portion of the river above Llanwrst is supposed to have been a beaver's dam.

Sir Richard Colt Hoare, in his edition of the 'Itinerary' of Giraldus, remarks: "If the *Castor* of Giraldus and the *Avanc* of Humphrey Llwyd and of the Welsh dictionaries be really the same animal, it certainly is not peculiar to the Teivi, but was equally known in North Wales, as the names of places testify. A small lake in Montgomeryshire is called *Llyn yr Afange*; a pool in the river Conway, not far from Bettws, bears the same name (the beaver's pool); and the name of the vale called *Nant Ffrancon*, upon the river Ogwen in Caernarvonshire, is supposed by the natives to be a corruption from *Nant yr afancwm* or the Vale of the Beavers."

Owen, in his 'Welsh Dictionary' (1801), says that it has been "seen in this valley within the memory of man;" but, says Sir Richard Hoare, "I am much inclined to think that *Avanc* or *Afange* is nothing more than an obsolete or perhaps a local name for the common otter, an animal exceedingly well-known in all our lakes and rivers, and the recognition of it by Mr. Owen considerably strengthens my supposition. *Afangcwm* is evidently the plural *Afangi*, composed of the words *Afan*, a corrupt pronunciation of *Afon*, 'a river,' and *Ci*, 'a dog,' synonymous, as I conceive, with *Dyfrgi*, 'the water-dog,' which is the common appellation of the otter among the Welsh. The term *Llostlydan* or 'broad-tail,' from *Llost*, tail, and *Llydan*, broad, appears to be more immediately applicable to the character of the beaver as described by naturalists, and is equally authorised by the Welsh dictionaries, though not so often used as *Afange*." †

Upon this we would remark that while it is pretty certain that the animal seen according to Owen, "within the memory of man,"

* Holinshed's 'Chronicles,' vol. i, p. 379 (1587).
† 'Itinerary,' ed. Hoare, vol. ii, pp. 56, 57.

was the otter, the minute description given by Giraldus shows that the animal to which *he* referred was the beaver.

After stating that the Teivi was the only river in Wales or even in England that had beavers, he adds, "in Scotland they are said to be found in one river, but are very scarce."

Hector Boece (or Boethius), that shrewd old father of Scottish historians, writing in 1526, enumerates the *fibri*,* or beavers, with perfect confidence, amongst the *feræ naturæ* of Loch Ness, whose fur was in request for exportation towards the end of the fifteenth century; and he even speaks of "an incomparable number," though perhaps he may be only availing himself of a privilege which moderns have taken the liberty of granting to mediæval authors when dealing with curious facts. Bellenden, in his vernacular translation of Boethius' 'Croniklis of Scotland,' which he undertook at royal request in 1536, while omitting stags, roedeer, and even otters, in his anxiety for accuracy, mentions "beavers" without the slightest hesitation; and though exception may be taken to the first clause of the sentence, yet the passage is worth quoting. "Mony wyld hors and among yame are mony martrikis [pine-martens], *beavers*, quhitredis [weasels], and toddis [foxes], the furrings and skynnis of yame are coft [bought] with great price amang uncouth [foreign] merchandis."

More than a century later Sir Robert Sibbald was unable to say that the beaver still existed in Scotland. In his 'Scotia Illustrata,' published in 1684, he remarks (pars iii. cap. v.): "*Boethius dicit Fibrum seu Castorem in Scotia reperiri, an nunc reperiatur nescio.*"

It is more than probable, says Dr. Robert Brown, that these worthy historians were influenced by a little of the pride of country—the *perferridum ingenium Scotorum*—when they recorded the beaver as an inhabitant of Loch Ness in the fifteenth century, since no mention is made of it in an Act of Parliament dated June, 1424, although "mertricks, foumartes, otters, and toddis" are specified. They were perhaps so strongly impressed by the wide-spread tradition of its existence in former days as to lead them to enumerate it among the animals of Scotland, and it may be observed that the authors quoted boast immoderately of the productions of their country.

At the beginning of the century (at least) the Highlanders had a peculiar name for the animal—*Losleathan* or *Dobhran losleathan*, the broad-tailed otter,† and according to Dr. Stewart, of Luss, in a letter to the late Dr. Patrick Neill, Secretary of the Wernerian Society of Natural History, a tradition used to exist that the beaver, or broad-tailed otter, once lived in Lochaber.

It must be confessed that the written records we have of its occurrence are very fragmentary, and not wholly satisfactory, but abundant evidence of its former existence in this country, at a date anterior to these historical notices, is supplied by the remains of

* *Fibri* from *fiber*, denoting an animal that is fond of the *fibrum*, or edge of the water.

† Compare the Welsh *Llostlydan*.

the animal which have been dug up in various places both in England and Scotland.

In the 'Memoirs of the Wernerian Natural History Society' * will be found an account by the late Dr. Neill, of some fossil remains of beavers found in Perthshire and Berwickshire.† Skulls of this animal exhumed in Roxburgh are preserved in the Natural History Museum at Kelso. Other remains of beavers, considered to be identical with the species found in North America at the present day, have been discovered in the fluvio-marine Crag near Southwold, Suffolk.

The species has occurred in a fossil state in Cambridgeshire,‡ and at one time, it would seem, this animal must have been pretty common in the eastern counties of England. Mr. Skertchly, in his remarks on the prehistoric fauna of the fens,§ says: "The remains of the beaver are tolerably abundant in the fens," and further on, "So far as my observation goes, the beaver did not build dams in the fens, owing, in all probability, to the abundance of still water. The late J. K. Lord, himself an experienced trapper, informed me that in North America the beaver only constructs dams in running streams, and chooses still waters where possible to save the labour of architecture." Mr. F. Buckland has a fine specimen of a beaver's jaw, not fossil, which was dug up in a fen in Lincolnshire, and other remains of this animal have been exhumed from the peat near Newbury, Berks,‖ and at Crossness Point on the south side of the Thames, near Erith.¶ Pennant refers to a complete head of a beaver, with the teeth entire, which was found in the peat at Romsey, Hants,** and various portions of the skeleton have been discovered in Kent's Hole, Devonshire, the only British cave which has hitherto yielded the remains of beavers.††

Fossil remains of an extinct beaver closely allied to, but much larger than, the existing species, have been found in the Norwich Crag at Cromer. Professor Owen has described it under the name *Trogontherium Cuvieri*.

The town of Beverley, in Yorkshire, is said to have derived its name from the number of beavers found in the vicinity, when, in the eighth century (about 710), St. John of Beverley built his hermitage there, the foundation of the town. The stream on which the town was built was then called in Anglo-Saxon *Beofor-leag*, or "the beaver's lea," but this has become softened down into its present pronunciation and spelling. "The town," says Leland, "hath yn

* Vol. iii, p. 207 (1821).

† See also Dr. C. Wilson, "On the Prior Existence of the *Castor fiber* in Scotland," 'Edinb. New Phil. Journal,' 1858, N.S. vol. vii.

‡ Jenyns, 'British Vertebrate Animals,' p. 34.

§ 'The Fenland, Past and Present,' p. 348.

‖ Elliot, 'Phil. Trans.' 1757, p. 112.

¶ Boyd Dawkins, 'Popular Science Review,' 1868, p. 39.

** 'British Zoology,' vol. i, p. 60, note (ed. 1812).

†† Pengelly, "On the Ossiferous Caverns of Devonshire," 'Report Brit. Assoc.' 1869 and 1877.

theyr common seal the figure of a bever." Other places in England also seem to indicate by their names the ancient haunts of this animal, as Beverege and Bevere Island (Worcestershire), Bevercoates (Nottinghamshire), Beverstone (Gloucestershire), and Beversbrook (Wiltshire).

The lately attempted re-introduction of the beaver into Scotland by the Marquis of Bute deserves here a passing notice.

In a solitary pine-wood near Rothesay, in the Isle of Bute, a space of ground has been walled in, so that the beavers cannot escape, and through this park runs a mountain stream. Left to themselves, they have quite altered the appearance of this stream, for they have built no fewer than three dams across it; the lowest is the largest and most firmly constructed, as it would seem the beavers were fully aware that it would have to bear the greatest pressure of water. In order to strengthen this dam, these intelligent animals have supported the down-stream surface of it with props of strong boughs, as artfully secured as though a human engineer had been at work. Immediately above this the beavers have constructed their hut or home, consisting apparently of a large heap of drift-wood. Upon examination, however, it appears that the sticks have been placed with regularity and order, so that the general appearance of the hut is not unlike a bird's nest turned upside down. The beavers have cut down a good many trees in their park, gnawing a wedge-shaped gap into one side of the tree until it totters, and then going round to the other side and gnawing the only portion of wood which prevents it from falling. If the felled log is too heavy for transport, they cut it into pieces, which they roll away separately. Although there have been one or two deaths, it is satisfactory to learn that these beavers have bred in the island since their introduction. In December, 1877, there were twelve known to be alive. They were reported to be very shy, retiring into their hut, or into the water, at the least alarm. Besides what vegetable food they pick up, they are fed principally with willow boughs, the bark of which they strip off with the neatness of a basket-maker.

This is not the only experiment, however, which has been made of late years in regard to the re-introduction of beavers into this country. A similar attempt has been made in Suffolk. Some beavers were turned down by Mr. Barnes, of Sotterley Park, Wangford, and on their dams being destroyed as an eyesore, they strayed further down the stream which runs through the park. They were there two winters, and bred, having three or four young ones. Two of these which strayed were killed at Benacre in the spring of 1872, and one was captured. They began to build a lodge in the West Bush, against Benacre Broad, did no damage to trees, but destroyed some underwood. This third beaver seems to have been killed, as two of the three were sent to London to be stuffed for Lady Gooch, and the head-keeper took the skin of the third.

It is interesting to find that, but for the interference of man, beavers would still thrive in our climate, as we learn from geology and history they formerly did.

The Reindeer.

About the time that the beaver was building its dams in Britain there was fast becoming extinct another animal whose singular form is well known to all of us, and has been so from infancy, when we took up our first zoological picture-book—I mean the reindeer.

This animal was one of the earliest arrivals on British soil after the ice and snow of the Glacial epoch began to disappear, and it is in caverns and river-gravels and sands of post-glacial age that we first meet with its remains. Its abundance in British deposits of this date is very remarkable. Professor Boyd Dawkins has found portions of its bones and horns in no less than thirteen out of twenty-one caverns examined by him, while the red-deer was only found in seven; thus, contrary to what is generally assumed to be the case, the reindeer predominated in numbers over the red-deer at the time the British bone-caverns were being filled.

In the post-glacial river-deposits the same numerical preponderance of the reindeer is observed. Altogether it has been determined in ten out of eighteen river-deposits which have furnished fossil mammals, while the red-deer has been found only in nine. During the arctic severity of the post-glacial climate the remains of the red-deer were rare, while those of the reindeer were most abundant.

During the pre-historic period the red-deer gradually increased in numbers until the reindeer at last became extinct. In its rarity in the latter epoch we have a proof of the great climatal change that had taken place in France and Britain.

Professor Owen figures in his 'British Fossil Mammals' (fig. 197) a skull with antlers found in a peat-moss on Bilney Moor, near East Dereham in Norfolk. He also gives a figure of a metatarsal bone from the fens of Cambridgeshire. A third case was afforded during the excavation at Crossness Point, on the south side of the Thames, near Erith, which was made for the reservoir of the southern outfall of the Metropolitan sewage. A fine antler was obtained from the bottom of a layer of peat varying from five to fifteen feet in thickness, along with the remains of a beaver and a human skull. Another antler was found in a shell-marl underlying the peat near Whittington Hall, Lancashire.

As regards its occurrence in Scotland we may learn almost all there is to be said on the subject from an important memoir by Dr. John Alexander Smith, published in the 'Proceedings of the Society of Antiquaries of Scotland,' which deserves to be read in its entirety.*

In Ireland Dr. Carte has noticed three antlers found at Coonagh, on the south side of the Shannon, county Clare. A large number of remains representing at least thirty fine individuals were found in Shanday Lane, near Dungarvan, associated with the bones of other

* 'Proc. Soc. Antiq. Scotl.,' vol. viii, pp. 186-223.

animals. These specimens have all been preserved either in the Museum of Trinity College, or in the Museum of Science and Art, Dublin. A noteworthy character of the horns is the uniformity of the beam, which is slender and round as in English specimens, and the existing reindeer of Norway, and unlike the flattened antlers of the Siberian stock.

Having seen what geology teaches with regard to the former existence of the reindeer in this country, we have now to inquire whether there is any historical evidence of its survival in Britain. There is no record of its having lived in historic times in England and Wales, but in Scotland the case is otherwise. Its last home was in Caithness, and in the '*Orkneyinga Saga*' it is related that the Jarls of Orkney were in the habit of crossing over to Caithness every summer, and there hunting in the wilds the red-deer and the reindeer. The passage is thus translated by a learned Icelander, Jonas Jonæus:—

"*Solebant Comites quaris fere æstate in Katenesum transire, ibique in desertis feras rubras et rangiferos venari.*"

Torfæus, writing at the end of the seventeenth century, says that the animals hunted were roedeer and reindeer, and renders the passage thus:—"*Consuererant Comites in Catenesiam indeque ad montana ad venatum Caprearum Rangiferorum quæ quotannis proficisci.*"*

Dr. Hibbert, who has written an elaborate critique on this passage,† agrees with Jonæus in believing that the reindeer was hunted in Scotland by the Jarls of Orkney in the twelfth century. Of the same opinion also is Professor Brandt.

The authors of the '*Saga*,' says Prof. Boyd Dawkins, must have been well acquainted with the animal in Norway, Sweden, and Iceland; and there seems nothing improbable in the natural inference that the animal they called reindeer was undoubtedly one. The inclement hills of Caithness lie in the same parallel of latitude as the south of Norway and Sweden, in which the animal was living at the time; reindeer-moss is abundant there, and the only condition of life which is wanting to make that country still habitable by it is a greater severity of cold. He is disposed, therefore, to admit the fact that the reindeer lived in Caithness at the time that Henry the Second occupied the throne of England, and Alexander Neckham was writing his Natural History. There is another point which is well worthy of notice. The animal is mentioned in the '*Saga*' along with the red-deer. At the present day they occupy different zoological provinces, so that the fact of their association in Caithness would show that in the twelfth century the red-deer had already appropriated the pastures of the reindeer, which could not retreat further north on account of the sea, and was verging on extinction. From Linnæus' time down to the present day, even in Sweden and Norway, it has been retreating further and further north.

* 'Rerum Orcadensium Historiæ,' lib. i, cap. xxvi.
† Brewster's 'Edinb. Journ. Science,' N.S. vol. v, p. 50.

The Wild Boar.

The wild boar is one of the oldest forest animals in Britain, and one of those of which we find the earliest mention in history. Characteristic figures of it appear on ancient British coins,* and it is one of the earliest animals figured in Celtic works of art.† Britons, Romans, Saxons, and Normans, all hunted it here in turns.

Figures of the wild boar are found on Roman monuments in England. Pennant has noticed one such at Ribchester, formerly a famous Roman station.‡ "It is supposed," he says, "to have been an honorary inscription to Severus and Caracalla by the repetition of the address. It was done by a *Vexillatio* of one of the Legions quartered here. A stone fixed in the wall of a small house near the church gives room to suppose that it belonged to the twentieth. The inscription is LEG. XX. V.V. FEC. and on one side is the sculpture of a boar, an animal I have in two other instances observed attendant upon the inscriptions made by the famous *Legio vicesima valens victrix.*"

Nor should we forget the Roman altar which was found at Weardale, dedicated by a grateful Roman Prefect to the god Silvanus, for the capture of an enormous boar which *multi antecessores ejus* had in vain attempted to destroy.§ A similar altar, also dedicated to Sylvanus by the hunters of Banna, was found at Birdoswald.

Edward the Confessor (A.D. 1042) had a royal palace at Brill or Brehull, Bucks, to which he often repaired for the pleasure of hunting in his forest of Bernwood. This forest, it is said, was much infested by a wild boar, which was at last slain by one Nigell, a huntsman, who presented the boar's head to the king; and for a reward the king gave him one hide of arable land called "Derehyde," and a wood called "Hulewood," with the custody of the forest of Bernwood, to hold to him and his heirs by a horn, which is the charter of the aforesaid forest. Upon this land Nigell built a lodge, or mansion-house, called Borestall, in memory of the slain boar. For proof of this in a large folio vellum book containing transcripts of charters and evidences relating to this estate (supposed to have been written in or before the reign of Henry the Sixth) is a rude delineation of the site of Borestall House and manor, and under it the figure of a man presenting on his knees to the King the head of a boar on the point of a sword, and the King returning to him a coat of arms, argent, a fesse, gules, between two crescents and a horn, vert. The same figure of a boar's head was carved on the head of an old bedstead now remaining in the tower

* Evans, 'British Coins,' plates vi, viii, xi, xii, and xiii.

† 'Horæ Ferales,' p. 185, plate xiv; Montellier, 'Memoires sur les Bronzes Antiques,' Paris, 1865; and Stephens' 'Literature of Kymry,' p. 250.

‡ 'Tour to Alston Moor,' 1801, p. 93. See also Horsley, 'Britannia Romana, or the Roman Antiquities of Britain,' folio, 1732.

§ See the inscription given from Camden in Wright's 'The Celt, the Roman, and the Saxon,' 1852, p. 207.

or lodge of that ancient house or castle, and the arms are now to be seen in the windows, and in other parts. And, what is of greatest authority, the original horn tipped at each end with silver gilt, fitted with wreaths of leather to hang about the neck, with an old brass seal-ring, a plate of brass with the sculpture of a horn and several lesser plates of silver gilt, with *fleur de lys*, has been all along preserved by the Lords of Borestall, under the name of Nigell's horn, and was in the year 1773 in the possession of John Aubrey, Esq. (son and heir of Sir Thomas Aubrey, Bart.), to whom this estate descended, without alienation or forfeiture, from before the Conquest, by several heirs female from the family of Nigell to that of Aubrey.*

At the Conquest, Inglewood Forest was held by the Scots, from whom it was taken by the Conqueror and given to Ranulph de Meschines, who made a survey of the whole country, and gave his followers all the frontiers bordering on Scotland and Northumberland, retaining to himself the central part between the east and west mountains, described as a goodly great forest, full of woods, red-deer and fallow, wild boars, and all manner of wild beasts.†

Henry the First was especially fond of boar-hunting, as we learn from Holinshed, who stigmatises it as "a verie dangerous exercise"; and Edward the First made several grants of land which was held by the serjeanty of keeping or providing boar-hounds. The boar was a badge of Edward the Third,‡ and might therefore have been borne by any of his descendants, but Richard the Third is the only one to whom we can trace its adoption.§

To notice all the localities where remains of this animal have been discovered would be unnecessary, but we may mention the ossiferous caverns of Derbyshire and Devonshire, the peat-mosses of Northumberland and Westmoreland, and the peat at Newbury, Berks, and Romsey, Hants. Some remarkably fine tusks of the boar found in Cresswell Moss are preserved at Middleton Hall, near Wooler, the seat of Mr. G. H. Hughes.

To judge by the remains of the animal which have been found in various parts of the British Islands, wild boars at one time must have completely over-run the country. They were hunted in all the great forests, and in ancient surveys they are often mentioned amongst the wild animals of the district surveyed.

Swindon, Swinford, Swinfield, Swindale in Westmoreland, Wild Boar Fell in the same county, particularly described by Pennant,|| and Wild Boar Clough in Cheshire, are names all equally suggestive of the ancient haunts of this animal; as also are Eversham and Eversley, from *eofer*, a boar.

On the west side of Benin-glo, Perthshire, are two places called

* 'Archæologia,' vol. iii, pp. 3, 15; Kennett, 'Paroch. Antiq.;' and Blount, 'Ancient Tenures,' p. 243.

† Longstaffe, 'Durham before the Conquest.'

‡ 'Archæologia,' vol. v, p. 17.

§ Hawkins, 'English Silver Coins,' p. 278.

|| 'Tour to Alston Moor,' p. 134.

"Carn-torey" and "Coire-torey," *i.e.* the hill and the hollow of boars; in the same county is the boar's loch, "Loch-an-tuire."*

In Ireland wild boars were at one time common, but have long been extinct there. According to Giraldus Cambrensis† they existed in vast numbers, but were a small, deformed, and cowardly race. Dr. Scouler asserts that they continued to be plentiful in Ireland down to the seventeenth century, but the exact date of their extinction he was unable to ascertain.

Tusks of wild boars dug up in Ireland, according to Thompson, are often of goodly dimensions.

Several attempts have been made to re-introduce wild boars for the purpose of hunting; but from various causes none of the experiments proved very successful. In some instances the animals throve well and increased, but the opposition of those whose crops they damaged was fatal to their existence for any length of time. Charles the First imported wild boars from Germany and turned them out in the New Forest. At a later period, as recorded by Gilbert White, General Howe turned out some German wild boars in the forest of Wolmer and Alice Holt, of which he had a grant from the crown, but, as White says, "the country rose upon them and destroyed them."‡ The late Earl of Fife, who tried many experiments in introducing different animals into the Forest of Mar, turned out some wild boars by the advice of the Margrave of Anspach while at Mar Lodge on a visit, but the experiment in this case did not answer for want of acorns, their principal food.§ Forty years ago Mr. Drax, of Charborough Park, Dorsetshire, made a similar experiment. Writing in Sept. 1879, he says: "I fenced them in with a wood paling in the wood where I built the present tower, and used to shoot them. The latter part of the time I kept them at Morden Park, and bred a lot of them, feeding them on turnips and corn. They were very savage and troublesome, however, to keep within bounds, and I was therefore obliged to kill them. They were good eating when fed upon corn."‖

At Chartley Park, Staffordshire, where, 300 years ago, as we learn from Erdeswick, wild swine roamed at large, an attempt was made by the present Earl Ferrers to reintroduce these animals, for which purpose he imported a boar and sow. The experiment, however, unluckily failed, since both the animals died soon after their arrival.

The exact date of the extinction of the wild boar in Britain is uncertain. It has been fixed at 1620,¶ but the authority for the statement is not furnished, and there is evidence of its having existed in Staffordshire, as we shall presently show, at least fifty years later. In 1617 it was still to be found in Lancashire, for

* 'Old Statistical Acct. of Scotland,' vol. ii, p. 478.

† 'Topographia Hiberniæ.'

‡ 'Nat. Hist. Selborne,' Letter ix to Pennant.

§ Scrope's 'Art of Deer-stalking,' p. 406.

‖ Letter to Mr. J. C. Mansel-Pleydell. See also Blaine's 'Rural Sports,' p. 406 (ed. 1858).

¶ Boyd Dawkins, 'Cave Hunting,' pp. 76, 78.

when James the First in that year visited Sir Richard Hoghton, at Hoghton Tower, near Whalley, one of the dishes with which the royal banquet was more than once supplied was "wild-boar pye."*

In the same year the King hunted the boar at Windsor. Adam Newton, in a letter to Sir Thomas Puckering, Bart., dated Deptford, Sept. 28, 1617, writes: "I was at Hampton Court on Sunday last, where the court was indeed very full; King, Queen, and Prince all residing there for the time. The King and Prince, after their coming from Theobalds this day se'nnight, went to Windsor *to the hunting of the wild boar*, and came back on Saturday."†

The latest date at which we have been able to find any mention of this animal in England occurs in an old "Account Book of the Steward of the Manor of Chartley: Preses. Com: Ferrers," which contains the following entry:—

"1683—Feb. Paid the cooper for a paile for ye wild swine . 0 2 0"

This shows that the wild boar was not extinct in England so early as has been supposed, that is, previously to Charles the First's abortive attempt to reintroduce it into the New Forest.

The Wolf.

Of the five species which come within the scope of the present essay, the wolf was the last to disappear. On this account, partly, the materials for its history as a British animal are more complete than is the case with any of the others.

To judge by the osteological remains which the researches of geologists have brought to light, there was perhaps scarcely a county in England or Wales, in which at one time or another wolves did not abound, while in Scotland or Ireland they must have been even still more numerous.

The vast tracts of unreclaimed forest land which formerly existed in these realms, the magnificent remnants of which in many parts still strike the beholder with awe and admiration, afforded for centuries an impenetrable retreat for these animals, from which it was almost impossible to drive them. It was not indeed until all legitimate modes of hunting and trapping had proved in vain, until large prices set upon the heads of old and young had alike failed to compass their entire destruction, that, by cutting down or burning whole tracts of the forests which harboured them, they were at length effectually extirpated.

Hunting the wolf was a favourite pursuit with the ancient Britons. Memprys, one of the immediate descendants of Brutus, about the year 980 B.C. fell a victim to the wolves which he delighted to pursue, and was unfortunately devoured by them.

Blaiddyd, another British monarch (B.C. 863), who seems to have been learned in chemistry, is said to have discovered the medicinal properties of the Bath mineral waters, by observing that

* Nichols, 'Progresses, etc., of James I.,' vol. iii, p. 402.

† 'The Court and Times of James I.,' vol. ii, p. 34.

cattle when attacked and wounded by the wolves went and stood in these waters, and were then healed much sooner than they would have been by any other means.

Such ravages did the wolves commit during winter, particularly in January, when the cold was severest, that the Saxons distinguished that month by the name of "wolf-month." They also called an outlaw "wolf's-head" (A.S. *wulresheofod*), as being out of the protection of the law, proscribed, and as liable to be killed as that destructive beast.

It is to the terror which the wolf inspired among our forefathers, that we are to ascribe the fact of kings and rulers in a barbarous age feeling proud of bearing the name of this animal as an attribute of courage and ferocity. Brute power was then considered the highest distinction of man, and the sentiment was not mitigated by those requirements of modern life which conceal but do not destroy it. We thus find amongst our Anglo-Saxon kings and great men, such names as Ethelwulf, "the noble wolf"; Berthwulf, "the illustrious wolf"; Earlwulf, "the prosperous wolf"; Ealdwulf, "the old wolf," etc.

In Athelstan's reign, wolves abounded so in Yorkshire, that a retreat was built by one Acehorn, at Flixton, near Filey in that county, wherein travellers might seek refuge if attacked by them.

When Athelstan, in 938, obtained a signal victory at Brunanburgh over Constantine, King of Wales, he imposed upon him a yearly tribute of gold, silver, and cattle, to which was also added a certain number of "hawks and sharp-scented dogs fit for the hunting of wild beasts."* His successor, Edgar, remitted the pecuniary payment on condition of receiving annually from Ludwall, the successor of Constantine, the skins, some say the heads, of three hundred wolves. It is generally admitted that he adopted this course, because, say the historians, the extensive woodlands and coverts, abounding at that time in Britain, afforded shelter for the wolves, which were exceedingly numerous, especially in the districts bordering upon Wales. By this prudent expedient, it is said, in less than four years the whole island was cleared of these ferocious animals, without putting his subjects to the least expense.

But this statement must be taken to refer only to Wales, for, in the first place, it can hardly be supposed that the Welsh chieftain would be permitted to hunt out of his own dominions, and, in the next place, there is abundant documentary evidence to prove the existence of wolves in England for many centuries later.

The wolf is expressly mentioned in the forest laws of Canute, promulgated in 1016; and Liulphus, a Dean of Whalley at that time, was celebrated as a wolf-hunter at Rossendale, Lancashire.† Matthew Paris, in his 'Lives of the Abbots of St. Albans,' mentions a grant of church lands by Abbot Leofstan (the twelfth Abbot of that Monastery) to Thurnoth and others, in consideration of

* William of Malmsbury, 'Hist. Reg. Anglorum,' lib. ii, c. 6.

† Whitaker, 'History of Whalley,' p. 222.

their keeping the woods between the Chiltern Hundreds and London free from wolves and other wild beasts.

Longstaffe, in his account of 'Durham before the Conquest,' states that a great increase of wolves took place in Richmondshire during this century, and the early Norman kings must have had a fine time of it hunting these animals by turns with the deer and the wild boar.

In Henry the Second's time the Sheriff of Hants had an allowance made to him in the Exchequer for several sums by him disbursed for the King's wolf-hunters, hawkers, falconers, and others. From a charter of liberties granted by King John, when Earl of Morton, to the inhabitants of Devonshire, the original of which is in the custody of the Dean and Chapter of Exeter, it appears that the wolf was at that time included amongst the beasts of venery in that county. Indeed throughout the southern forests at that time it could not have been very uncommon, for we find entries in the Rolls of payments made to the slayers of them. Thus in 1212, "On Thursday next, in the octave of the Holy Trinity [May 12], for a wolf captured at Freemantle [Surrey], by the dogs of Master Ernald de Auclent, 5*s*." "Item [at Hereford], Thursday next following the feast of St. Martin [Nov. 22], to Norman the Keeper of the Veltrars,* and to Wilkin Doggett, his associate, for two wolves captured in the forest of Irwell, 10*s*., by the King's command."

We shall see later how the reward increased in value, until in Cromwell's time as many pounds were paid for a wolf's head as John had given shillings.

In the reign of Henry the Third, these beasts were still sufficiently numerous in some parts of the country to induce the King to make grants of land to various individuals upon the express condition of their taking measures to destroy them wherever they could be found.† The same may be said of the reign of Edward the First,‡ who in 1281 appointed one Peter Corbet to the office of wolf-hunter general, commissioning him to destroy all he could find in the counties of Gloucester, Worcester, Hereford, Salop, and Stafford, and the bailiffs in the several counties were directed to be ready to assist him.§

In the accounts of Bolton Priory, quoted in Whitaker's 'History of Craven' (p. 331), occur entries in the years 1306-1307, of payments made in reward for the slaughter of wolves, as "*Cuidam qui occidit lupum*," but the price paid to the slayer is not stated. In 1320 lands were held at Wormhill in the county of Derby, by the service of hunting and taking wolves, from whence they were called

* *Veltrarius* or *Vautrarius*, from the French *vaultre*, was a mongrel hound for the chase of the wild boar.—Blount, 'Ancient Tenures,' p. 233.

† Dugdale's 'Baronage,' vol. i, p. 466; and Selden, notes to Drayton's 'Polyolbion' (ix, 76).

‡ Camden, 'Britannia,' p. 525; Blount, 'Ancient Tenures,' pp. 230, 236, 257.

§ Rymer's 'Fœdera,' vol. i, pt. 2, p. 192; vol. ii, p. 168.

"Wolf-hunt" or "Wolve-hunt.'* In Edward the Third's time much the same state of things prevailed,† and in the reign of Henry the Fourth lands were held by the serjeanty of destroying wolves and other wild animals in certain counties.‡ In the eleventh year of Henry the Sixth (1433), Sir Robert Plumpton was seised of land in the county of Nottingham called "Wolf-hunt land," which he held by the service of winding a horn, and chasing or frightening the wolves in the forest of Shirewood.§ Six years afterwards, namely, in 1439, Robert de Umfraville held the Castle of Herbotell and Manor of Otterburn of the King, *in capite* by the service of keeping the valley and liberty of Riddesdale, where the said castle and manor are situated, free from wolves and robbers.‖

The latest period at which I have been able to find mention of the destruction of wolves in England is the reign of Henry the Seventh (1485–1509). In Longstaffe's 'Memoirs of the Life of Ambrose Barnes,' it is stated that his immediate ancestors held an estate of £500 a year of the Earl of Rutland and Belvoir, one of whom (a Barnes, of Hatford, near Barnard Castle) was commonly called Ambrose "Roast-Wolf," from the many wolves which he hunted down and destroyed in the time of Henry the Seventh.

Many names of places compounded with 'wolf' still remain to attest probably the former existence of this animal in the neighbourhood. Wolmer, *i.e.* Wolf-mere or Wolve-mere, is an instance of this, Wolferton is another. Wolfenden in Rossendale, and Wolfstones in Cliviger (Lancashire), both attest the existence of this animal there when those names were imposed.

In Scotland the wolf survived much later than it did in England, owing to the wild, unsettled state of the country, and the well-nigh impenetrable forests and rugged moors with which the greater portion of it was still clothed. John Taylor, the water-poet, who, in 1618, travelled on foot from London to Edinburgh, when visiting Braemar, wrote: "I was the space of twelve days before I saw either house, cornfield, or habitation of any creature, but deer, wild horses, wolves, and such-like creatures, which made me doubt that I should never have seen a house again."

The history of the wolf in Scotland has been so fully dealt with in my former essay¶ (in which numerous historical notices concerning it will be found), that it will be unnecessary for me here to do more than briefly refer to the period at which it is believed to have become extinct there. The same remark will apply to Ireland. So far as can now be ascertained, it appears that the wolf became extinct in England during the reign of Henry the Seventh; that it survived in Scotland until 1743; and that the last of these

* "The Local Laws, Courts and Customs of Derbyshire," 'Journ. Brit. Archæol. Assoc.,' vol. vii, p. 197.

† Burton, 'Monasticon Eboracense,' p. 370.

‡ Blount, 'Ancient Tenures,' p. 260.

§ Escaet. 11 Hen. VI. n. 5. Blount, *op. cit.* p. 312, and Pegge, 'Archæologia,' vol. iii, p. 3. See also Thoroton, 'Antiq. Nottingham,' p. 373.

‖ Madox, 'Baronia Anglica,' p. 244.

¶ 'Popular Science Review,' 1878, pp. 53, 141, 251, and 396.

animals was killed in Ireland, according to Richardson, in 1770, or according to Sir James Emmerson Tennent, subsequently to 1766.

Conclusion.

In considering the causes, besides those already referred to, which have led to their extinction, it should be borne in mind that for some centuries after the Norman Conquest these wild animals were not hunted down and destroyed by everybody and anybody, as they would be if they existed at the present day, but were strictly preserved, under very severe penalties, by the kings and powerful noblemen of the day for their own particular sport and recreation. William the Conqueror punished with the loss of eyes those convicted of killing a wild boar, stag, or roebuck; and wolves and foxes, although reckoned neither as beasts of the forest nor of venery, could not be killed within the limits of the forest without a breach of the royal chase, for which offenders had to yield a recompense.*

The inveterate love of the chase possessed by William Rufus, which prompted him to enforce during his tragical reign the most stringent and cruel forest laws, is too well known to readers of history to require comment.

In his passion for hunting wild animals Henry the First excelled even his brother William, and, not content with encountering and slaying those which, like the wolf and the wild boar, were at that time indigenous to this country, he "cherished of set purpose sundrie kinds of wild beasts, as bears, libards, ounces, lions, at Woodstocke and one or two other places in England, which he walled about with hard stone, An. 1120, and where he would often fight with some one of them hand to hand." †

Henry the Second, and John, were both great preservers of wild animals, and monopolised large tracts of country wherein to indulge their passion for hunting. Ferocious animals were in consequence long suffered to remain at large against the will of the people, and hence survived to a much later period in this country than would have been the case had the subjects of these monarchs dared sooner to assert their independence. But at length came the repeal of the forest laws. The operation of the Charter of the Forests, which was signed by John at the same time with Magna Charta, restrained the worst abuses of the feudal tenure; all lands which had been converted into woods or parks since the commencement of this reign were disafforested, and the tenants bordering on the royal forests secured against spoliation; in a word, the laws made for the protection of the game and wild animals were either repealed or considerably mitigated.

From this time it may be said that the presence of ferocious animals in the country was no longer tolerated. They were slain

* Manwood's 'Forest Laws,' § 27.

† Harrison's "Description of England," prefixed to Holinshed's 'Chronicles,' p. 226.

wherever and whenever they could be found, and only managed to survive in reduced numbers for some few centuries longer in consequence of the utter impossibility of dislodging them from the almost impenetrable forests and mountain-fastnesses to which they were driven. Later on, when large tracts of forest were purposely cut down or burned for the purpose of expelling these animals, and statutes were put in force which rewarded the slayers of them, their extermination was finally accomplished.

To the naturalist it is a somewhat sad reflection, that animals of the forest and the chase, now only known by name as the inhabitants of other countries, were once as familiar to our ancestors as they are at present to the people of the remote kingdoms which they frequent. Man has been warring against these forest-denizens, and as tract after tract which they once claimed as their own has been brought under the ploughshare, they have been driven further and further back, until the last of them has been blotted out from our fauna.

Lake and moor have become fields of yellow grain; forest has been changed into morass, morass into moor, and moor again into forest, until, finding nowhere to rest in peace, the bear, the beaver, the reindeer, the wild boar, and the wolf, have become in Britain amongst the things that were.

III.

OUR BRITISH BEETLES: NOTES ON THEIR CLASSIFICATION AND COLLECTION.

By Arthur Cottam, F.R.A.S.

Read at Watford 18th November, 1879.

Beetles are so retiring in their habits, that to casual observers very few are known. To make a collection of our butterflies and moths is a common thing, and in consequence nearly every one (of the Macro-lepidoptera at all events) has an English name. The beetles that have English names can almost be counted on the fingers, in itself a proof how few are commonly known; yet there are over 3,000 species inhabiting Great Britain, half as many again as the species of moths.

The common idea that beetles are ugly and offensive creatures is probably one reason why they are so little studied and collected; but this idea is very far from being generally true. There are some that may perhaps be called ugly, and a few have the power of exuding offensive odours or juices in self-defence, but by far the larger number will be found to be more or less beautiful, and many, even in our temperate climate, are really splendid.

The notion—I am sorry to say, a very common one indeed—that the cockroach, a very offensive creature in every way, is a typical specimen of a beetle, has, I fear, something to do with the prejudice against collecting or studying them. But a cockroach is not a beetle at all. It belongs to an entirely distinct order of insects—the *Orthoptera*—of which the grasshoppers and crickets are other equally well-known examples.

Most of you will no doubt recollect a clever sketch that appeared in 'Punch' a year or two ago, of a child and her governess. The child remarked upon the number of "blackbeetles" in the kitchen. The governess reproved her for calling them "blackbeetles," and told her to call them "cockroaches," giving as the reason why they should not be called "blackbeetles," that they are *not* beetles, and they are *not* black. The child's reply was, "Certainly I will call them cockroaches if you wish it, though they are *not* roaches and they are *not* cocks." The child's reply was as true as the governess's reproof; both names are inappropriate, but the remark of the governess was a scientific truth that ought to be generally known and remembered.

The Coleoptera, or beetles, are almost universally admitted to take precedence of all other orders of insects, on account of their complete metamorphosis, their highly-developed organs, and the great number of their species.

The name *Coleoptera* means "sheath-winged." In all insects the normal number of wings is four. In the beetles two of these become horny or leathery wing-cases or *elytra*, which cover the true (membranous) wings. In many species the true wings are absent, and when this is the case the *elytra* are usually soldered together.

The classification of the beetles is based upon their external anatomy; and although, within the limits of this paper, it will be impossible to do more than give the merest outline of the differences in structure by which the system of classification is carried out, I hope to be able to convey a general idea of the system.

I can claim no originality for these notes. I am myself but a novice in the study of this branch of entomology, but it is so interesting, and so little seems to be commonly known about it, that I am glad of the opportunity to endeavour to arouse an interest in an order of insects that is very little studied. I take it that in such societies as ours it should be an object to get workers in every branch of Natural History, and as little or nothing seems yet to have been done in working out the entomology of our county (with the exception of the butterflies), there is a large and most interesting field of work, in which I am anxious to find among our members some fellow-explorers.

Mr. Sydney Humbert and I have been doing what has lain in our power during the last two years to work out something as to our Coleopterous fauna, but we have not yet got very far. Indeed I feel sure that it will take a good many years' work before we shall be able to record even a fair number of our indigenous beetles, for even my short experience in collecting has proved to me that in any given neighbourhood species that may be taken in numbers in one year will apparently disappear altogether for a time. In my first year's collecting here I turned up some species in numbers that I have not seen here since, while I am constantly taking fresh species in places that I have worked repeatedly year after year. So that I expect to record the capture of fresh species after every year's collecting for some time to come.

To those who are inclined to take an interest in our beetles I can confidently recommend Mr. Rye's most excellent 'Introduction to the study of our British Coleoptera,' published by Lovell, Reeve, and Co. To that little book I am indebted for the greater part of the information contained in these notes, and it is from that book that I have taken the "sections" into which I have described the British beetles as being divided.

Insects—from the Latin *insecta*, "divided"—are so called because their bodies are formed of three distinct portions.

1. The head, which bears the organs of sensation, the *antennæ*, *eyes*, and *mouth*;
2. The thorax, which bears the organs of locomotion, the *wings* and *legs*; and
3. The abdomen, containing the vital organs of *respiration* and *digestion*, and the organs of *generation*.

In the beetles, the position and shape of the eyes, the position, structure, and number of joints of the antennæ, the structure of the mouth with its mandibles, maxillæ, and palpi, the structure of the legs, and the number and structure of the joints of the tarsi or feet, are among the most important characters employed in their classification; but besides these many other points have to be noticed, such as the outline of the thorax and elytra, the presence or absence of punctation and striation, and of pubescence, and many other minute details.

Our beetles are divided, according to Mr. Rye, into eleven great sections.

1. The Adephaga, or carnivorous beetles, which are again divided into two sub-sections;
   a. Geodephaga, ground-beetles; and
   b. Hydradephaga, the aquatic species.
2. The Brachelytra, or rove-beetles.
3. The Necrophaga, or carrion-feeders.
4. The Lamellicornes, or chafers.
5. The Sternoxi, or skipjacks and their allies.
6. The Malacodermi, which have soft integuments.
7. The Heteromera.
8. The Rhynchophora, or weevils.
9. The Longicornes.
10. The Eupoda or Phytophaga; and
11. The Pseudo-trimera.

In most of these sections there are species that are more or less well known and that have English names, and I shall endeavour, by referring to these better-known insects as types, to make the subject clearer and more generally interesting.

1*a*. The Geodephaga.

The predatory ground-beetles are easily recognized by their active habits, and thin legs and antennæ. Many are metallic and bright-coloured, especially those that appear in the day-time. Some of these, which belong to two large genera, *Pterostichus* and *Amara*, commonly called "sunshiners," may be often seen running rapidly across roads and footpaths in the hottest weather. But the majority of species are dark and dull in colour, and are nocturnal feeders.

The tiger-beetles (*Cicindela*), of which we have five species, are exceedingly active and rapacious, running and flying alternately in the hottest sunshine. They are very elegant in form, exquisitely coloured, with long metallic legs and prominent eyes. The Cicindelidæ form one family of our Geodephaga, and are separated from the other family, the Carabidæ, by their maxillæ having a small movable hook at the end, while those of the Carabidæ are without the hook. The common tiger-beetle (*C. Campestris*) is found in sandy and gravelly places, and is common in the neighbourhood of London. I possess two or three specimens from Harrow Weald Common.

The *Carabi*, specimens of the common species of which may often be seen dead upon footpaths, where they have been trodden upon during their nocturnal explorations in search of food, are among the largest and most elegant of our ground-beetles. I have taken several specimens of the three common species (*C. violaceus*, *nemoralis*, and *monilis*) in the cellar of my house. Most of the *Carabi*, and many others among the night-feeders, have no wings, and the elytra are soldered together.

One large and very handsome species of this genus (*Carabus auratus*) is very common on the Continent in vegetable-gardens, and is there called the "Jardinière." There appears to be no reason why it should not live in England, but it is doubtful whether it ever breeds here. Mr. Rye has a specimen found alive in a bunch of radishes which were stated to have been gathered in a garden at New Cross. Three were recently found in the Borough Market, and last summer one was found in Watford in a bunch of radishes which were stated to have come from France. Mr. Jonathan Chater had this specimen alive, and he very kindly gave it to me. The bombadier beetle (*Brachinus crepitans*), of which I have taken several specimens in this neighbourhood, has acquired its English name from its power of emitting an acid secretion with a slight explosion. This secretion, which is exceedingly volatile, is converted into vapour the moment it comes into contact with the air, and under cover of this little cloud of smoke the insect escapes, or endeavours to do so.

Many of the ground-beetles are very small, and the species of this section are exceedingly puzzling, requiring careful examination and comparison of the various portions of the mouth.

We have about 300 species of ground-beetles inhabiting Great Britain.

In this section the tarsi are all five-jointed, and in the males the basal joints of the front tarsi are nearly always widened. The antennæ are long and slender.

1*b*. The Hydradephaga.

Our carnivorous water-beetles number about 120 species. In most of these the antennæ are tolerably long and exceedingly delicate; the hind legs are adapted for swimming; and in some of the Dytiscidæ the males have the lower joints of the tarsi of the anterior legs formed into broad suckers, with which they can hold their prey securely.

The large water-beetles often put into aquaria are species of the genus *Dytiscus*. They should, however, be kept in an aquarium by themselves, as they devour all other aquatic creatures that may be with them.

Most of the water-beetles have ample wings, and at night make free use of them, flying from one piece of water to another. If in a room they will often fly at the lamp-globes, and they have been known to alight on greenhouses, no doubt mistaking the light reflected from the glass for water.

The Gyrindæ, commonly called "whirlwig" or "whirligig" beetles, may often be seen in the sunshine swimming on the surface of the water, sometimes a number together, with a rapid gyratory motion. They differ in many respects from any other of our water-beetles; the antennæ are shorter and thick, and they have four eyes, two above and two below the surface of the water. They are very rapid in their movements, and so wary that it is not an easy matter to catch them.

2. The Brachelytra.

The Brachelytra are so called on account of their elytra being very short, leaving the greater part of the abdomen exposed. Their English names are "rove-beetles," "turnuptails," or "cocktails," and one large and common one (*Ocypus olens*) is known as the "Devil's coachhorse." All the larger Brachelytra are predaceous, and are very fearless. The whole of the beetles forming this section are furnished with large wings, which they use very readily; and it is curious to see how they use their flexible tails to fold their wings up under the small elytra. Many of this section, which numbers about 700 species in Britain, are exceedingly minute, and these small species are very fond of flying into people's eyes in the summer. Most of the "flies" that get into the eyes are in reality minute beetles.

The rove-beetles are among the most puzzling to identify, and a large number, on account of their extremely diminutive size, are exceedingly troublesome to set. One of the principal characters by which the species in this section are separated is the position of the antennæ with reference to the eyes, and another is the notching of the penultimate joint of the abdomen on the underside. The relative length and width of the joints of the antennæ and tarsi, and the degree of punctation and pubescence, have also to be observed.

3. The Necrophaga.

The word *Necrophaga* literally means carrion-feeders, and the appellation is well applied to a large number of this section, which feed upon decaying animal or vegetable substances. Another name for this section is Clavicornes, which means "club-horned," the antennæ ending in a club. The French naturalists divide them into two sections, Clavicornes and Palpicornes. The latter name is given to several genera in which the palpi are as long as, or longer than, the antennæ. They are also sometimes called Phyllhydrida, as most of the species are aquatic, and they are by some authors put after the Hydradephaga, I suppose in order to have all the water-beetles together, but their proper place is undoubtedly with the Clavicornes, their antennæ, although inconspicuous, being clubbed; and they appear to be out of place if interposed between the Hydradephaga and the Brachelytra, two sections of carnivorous beetles.

The best known of the Necrophaga or Clavicornes are the so-called "burying" beetles (*Necrophorus*). We have seven species of these useful little scavengers. Instinct impels them to bury any dead animal that they find, for the purpose of providing food for their offspring. Having excavated the ground round the carcase, till it gradually sinks below the surface, the female lays her eggs in it, and the grubs when hatched feed on the dead body, which by being buried is preserved much longer than if it had been left on the surface. Another common species in this section is the "bacon-beetle" (*Dermestes lardarius*).

Among the water-beetles included in this section is one often known as the "harmless water-beetle" (*Hydrous piceus*), and therefore in some demand for aquaria. It is by no means the *only* harmless water-beetle, as none of the Palpicornes are predaceous. But this one is so conspicuous—it is the largest of all our British beetles, the only one that comes near it in size being the "stag-beetle"—that it is really a striking creature in an aquarium, especially as the water magnifies it and makes it look larger even than it really is.

4. The Lamellicornes.

We now come to the Lamellicornes or chafers. In this section the structure of the antennæ is (as in the Clavicornes, Palpicornes, and Longicornes) the character from which the name is derived. The club of the antennæ in this section is formed of lamellæ or plates, something like the leaves of a book, varying from three to seven in number, and in some of the genera movable. Every species in this section may be at once known by this peculiarity of structure. Why they should be called "chafers" I do not know.

The British species are not numerous—under 90; but many of them are common, some among the commonest of our beetles, and in consequence, a larger number have English names than in any other section. The most common of all is perhaps the "cockchafer" (*Melolontha vulgaris*). This insect in some years is excessively abundant, and great damage is then done to meadows, the grub feeding in the roots of the grass. In this species the antennæ of the male have seven and those of the female six plates. The smaller "summer chafer" (*Rhizotrogus solstitialis*) has only three plates to the club of the antennæ.

In the eastern and south-eastern counties of England two species of Lamellicornes are common that are hardly found elsewhere in this country. The "June bug" (*Phyllopertha horticola*), a small chafer with a green thorax, is one of these, and the "stag-beetle" (*Lucanus Cervus*) is another. This large beetle (with the exception of the large water-beetle before mentioned), our largest indigenous species, has acquired its English name from the enormous development of the mandibles in the male. In the female they are much smaller. I have two specimens of the male taken in Watford.

One of our commonest chafers is the "clock" or "dumble-dor" (*Geotrupes stercorarius*). There are half a dozen species of the genus, and two or three are common. One or other of them may be seen flying at dusk, or walking slowly on the ground by day, almost all the year through, except of course in quite the winter weather. Mr. Rye suggests that the name "dumble-dor" is possibly an inflection of the American "tumble-dung," a name given to some of the species which roll along the ground pellets of dung in which they deposit their eggs. Our species may be found in, or in the ground under, the excrement of cattle. Their legs are fossorial, and their muscles so strong that it is no easy matter to hold one in the hand. I have heard, and can quite believe that, in proportion to their size, they are eight times as strong as a horse. Another well-known chafer is the "rose-beetle" (*Cetonia aurata*), one of the most brilliantly coloured of all our common beetles. Another found in Perthshire is there known as the "bee-beetle" (*Trichius fasciatus*). It is banded with yellow and black down, and flies round thistle-tops in the hot sunshine.

There are at least four genera in this section, the larvæ of which are dung-feeders, *Geotrupes*, *Copris*, *Aphodius*, and *Onthophagus*. Of *Aphodius* there are about forty species. It is remarkable that all these seem to contract no contamination from the excrement in which they are found, but emerge with their armour and limbs perfectly bright and unsoiled.

5. The Sternoxi.

Some common species of one of the families composing this section—the Elaterides—have acquired the English name of "skip-jacks" or "click-beetles," from a power they have when they fall on their backs, which they do pretty frequently, of jumping some height into the air with a peculiar clicking sound. Their legs are very short, and if they had not this saltatorial power it would be impossible for them to right themselves when they fall on their backs. If in the first jump they fail to fall on their feet, they continue jumping until they succeed. They have a long projection of the prothorax, which fits into a groove between the middle legs. In arching itself preparatory to jumping, the beetle lifts this projection out of its groove, and in the act of jumping it is re-inserted with a click.

Our British representatives of this section are neither striking in appearance, nor numerous (about seventy), and only a few are common. In the tropics they are among the most numerous and most gorgeously brilliant of all the beetles. One species (*Athous hæmorrhoidalis*) is very common with us in the spring, but it has no English name. This and one or two smaller species may frequently be seen flying in the hot sunshine.

These beetles are vegetable- or wood-feeders. They are long and narrow, with hard integuments. The antennæ are either serrated, flabellated, or filiform. Their larvæ are exceedingly destructive, the "wire-worm," one of them, is only too well known.

6. The Malacodermi.

The beetles forming this section are a complete contrast to the last, in respect of their outer covering, having, as their name implies, soft integuments. They are, for this reason, very difficult to preserve satisfactorily, having a tendency to shrivel and become distorted. Some of the species of one family (the Telephoridæ), commonly called "soldiers" and "sailors," are known to every one.

It is remarkable that beetles with so little defensive armour should be warriors, but it is the fact that there are no such determined biters as these soft-bodied species. A single malacoderm placed in the same bottle with other beetles will attack and maim them all, even species double its own size. The collector is therefore obliged to be very careful to isolate or to kill at once specimens of this section.

Perhaps one of the best known of all our British beetles—although not generally suspected of being a member of the order—belongs to this section. I mean the "glow-worm" (*Lampyris noctiluca*). The insect which we call the "glow-worm" is an apterous female beetle, the male of which is much smaller, and is provided with ample wings. It is supposed that the female is provided with her light to enable the male to find his mate. The male will sometimes fly into a room at night attracted by lights that may be burning there.

Another species (*Drilus flavescens*), similar to the glow-worm in that the male is winged and the female worm-like and apterous, is to be found in grassy places at Dover, Darenth Wood, etc., especially where snails abound, upon which the beetle is supposed to feed. In this species the male is, where found, often abundant, but the female is one of our greatest rarities.

We have about 150 species of Malacodermi in Great Britain, very various in form and size. The antennæ of the majority of the species included in this section are long, filiform or serrate, and generally with eleven joints, though the number varies from ten to twelve. The tarsi are five-jointed, though with only four joints in the front legs of the males of certain species.

Some of the species cannot be strictly called malacoderms, their integuments being more or less horny.

7. The Heteromera.

All the insects in this section have five joints to the tarsi of the front and middle pairs of legs, and only four joints to those of the hinder pair. Other pretty-constant features are kidney-shaped eyes, exserted and clavate maxillary palpi, bifid mandibles, and moniliform unelbowed antennæ. The number of British species included in it rather exceeds 100, and among them are insects very dissimilar in external appearance.

The "cellar" or "churchyard beetle" (*Blaps mucronata*) is one well-known species. It is one of the slowest-moving insects I know. Another of this section is well known in the larval state as the "mealworm," a favourite food for singing birds, but perhaps the beetle (*Tenebrio*) is not so well known except to millers.

The "cardinal beetle" (*Pyrochroa coccinea*) is not uncommon in woods, and the "oil beetle" (*Meloe proscarabæus*) is probably known to almost every one.

One species of this section, the well-known "Spanish fly" or "blister beetle" (*Lytta* or *Cantharis vesicatoria*), is occasionally taken in the south of England, but is doubtfully indigenous.

8. The Rhynchophora.

The beetles forming this section are at once distinguished by the head being elongated into a beak, sometimes long and thin as in the *Balanini*, or short and thick as in *Otiorhynchus*, bearing the organs of the mouth at the apex. The antennæ are generally inserted on the rostrum, and in by far the larger number they are elbowed, having a long basal joint, called the "scape," the other joints forming the "funiculus" and "club." The number of joints varies from eight to twelve. The tarsi have five joints in this and in the two following sections, but the fourth joint is so small that for a long time it was overlooked.

The weevils, as the Rhynchophora are called, are all vegetable-feeders, and their larvæ often do great damage.

The "corn weevil" (*Calandra granaria*) is frequently spoken of by farmers as "the" weevil, as if there were no other, but we have very nearly 500 indigenous species.

One of the best known is perhaps the "nut weevil" (*Balaninus Nucum*); but the grub of this, which is often found devouring the kernel of a nut when we crack it, is better known than the perfect insect. The beetle has a very long thin rostrum, and is altogether a remarkable-looking creature. The genus *Balaninus* contains seven species, all more or less elegantly coloured.

Three genera—*Cœliodes*, *Ceuthorhynchus*, and *Ceuthorhynchideus*—including among them a large number of species, are odd-looking insects that a young collector is very apt to overlook in his net. Their bodies are more or less round, and they have a habit of folding up their rather long straggling legs and by no means short rostrum close to their bodies; they then roll about in the net and look very like the seeds of certain plants. It is surprising how much larger they appear when they unpack their limbs and begin to walk. The only difference between the species of the two genera *Ceuthorhynchus* and *Ceuthorhynchideus* is, that in the first the funiculus of the antennæ has seven, and in the latter six joints.

Among the species of two genera—*Phyllobius* and *Polydrosus*—there are some very common in the spring, which are clothed with brilliant metallic scales, red or green. *Polydrosus pterygomalis*, one of these, is a favourite low-power object for the microscope, and a very beautiful one.

9. The Longicornes.

The tropical species of this section are both large and numerous, but the British representatives number under 60 species. They are comparatively moderate in size, and few are common. Nevertheless, three at least have English names.

One of these (*Astynomus ædilis*) is the best example we have of a "longhorn." It is only found at Rannoch in Perthshire. From its habit of settling on pine-logs with its antennæ spread out like a pair of compasses as if measuring the timber, the Highlanders have given it the name of the "timberman," a name, as Mr. Rye remarks, "curiously enough, also applied to it in Lapland and Sweden, where it is common."

One of our commonest longhorns is the "musk beetle" (*Aromia moschata*), so called from its exuding a delicious odour of musk, even for some time after its death. Another, called the "wasp beetle" (*Clytus Arietis*), is a tolerably common insect.

All the Longicornes are wood-feeders, and are consequently more or less difficult to find, and variable in size.

In this section the antennæ are long, never clubbed, and generally filiform or setaceous, with a long basal joint. The eyes are more or less kidney-shaped. The legs are long, the tibiæ without external spines but spurred at the apex. The tarsi have the three basal joints silky or spongy beneath, the first and second widened, the third bilobed, and the fourth either obsolete or hidden between the lobes of the third, the apical joint being long, slender, and strongly clawed.

10. The Phytophaga or Eupoda.

The name *Phytophaga* means "plant-feeders," a name which would be equally applicable to the two preceding sections, the Rhynchophora and the Longicornes. The insects included in this section are very distinct in form from those of either of the two before mentioned. There are very few even moderately large ones, most are more or less convex in form, diurnal, and of bright metallic colours. The antennæ are straight, never elbowed, either filiform, moniliform, or serrate.

One of the largest of them is commonly known as the "bloody-nosed beetle," from a habit it has when handled of exuding from the mouth a drop of clear red fluid. This is the first of the Chrysomelidæ or "golden-apple" beetles, a family containing some of the most gorgeous and brilliant of our beetles.

Most members of this section are very slow-moving insects, but one family, the Halticidæ, have the hinder thighs thickened, and are very active jumpers. The best known, although one of the smaller of the family, is the "turnip fly or flea" (*Philotreta nemorum*). It is often very abundant, and in every stage is most destructive to the turnip-crop.

In this section is included a family, the species of which hardly look like beetles,—the back is a nearly flat shield, under which the beetle is hidden, head, legs, and all. One species, *Cassida viridis*, is very common on thistles. The section contains about 230 British species.

11. The Pseudotrimera.

The beetles forming this section are very dissimilar, families of very various structure being included in it. Many of the species are exceedingly minute, and with the exception of the "lady-birds" (*Coccinella*), are quite unknown to casual observers. There are, however, over 170 species included in this section.

The genus *Coccinella* contains eighteen or nineteen species, some of which, like the common lady-bird (*C. septempunctata*), hardly vary at all; while others, *C. bipunctata, variabilis, ocellata,* and *hieroglyphica,* vary in the most extraordinary way.

Having now given an outline of the various sections into which our indigenous Coleoptera are generally divided, it only remains for me to add a few notes as to their collection.

The *Geodephaga* require searching for as a rule; they hide, sometimes underground, more often under stones or bits of wood, and in fact to collect them successfully it is necessary to know something of the habits of the particular species you are in search of.

The *Hydradephaga* must be fished for with a water-net. Some inhabit ponds, some running streams, while others are only to be found in brackish water.

The *Brachelytra* must be sought for in various places. Some feed on carrion and must be looked for on and under dead animals; others will be found in dung; others in fungi in the autumn; and many can be caught flying in the hot sunshine.

All the members of these three sections, as well as the *Malacodermi,* should be put as soon as caught into a bottle full of young laurel-leaves, which have been picked when quite dry, and then pounded and cut up into small pieces. Beetles so killed are very stiff at first, and require to be kept in laurel for two or three days, when they become relaxed and fit for setting.

The other sections are best caught either by beating or sweeping. In beating, an umbrella opened and held under the herbage or tree to be beaten is as good an implement as I know; the foliage should be beaten with a stick, taking care to strike *downwards,* and the beetles will fall off into the umbrella, and can then be easily bottled.

A sweeping-net is made of some strong material, canvas or calico, and is swept about amongst the herbage with a backwards and forwards motion.

Beetles simply bottled should be killed by immersion in *quite* boiling water; this kills them instantly, and they are at once ready for setting. Those that cannot be set at once should be kept in the laurel-bottle, which will keep them relaxed for some time.

The best collectors are those who, knowing the habits of the insects they are in search of, turn that knowledge to account, and examine likely spots. If you are seeking *Geodephaga* or *Brachelytra* it is good advice to search under stones, and to "leave no stone unturned"—an expression that I have often thought must have originated in beetle-collecting—but even in this matter experience is a great help. For instance, stones lying on grass have hardly ever insects under them, and it will be found that those stones harbour most specimens that have laid on the ground long enough to kill the herbage under them, and especially those that are on moist ground; for beetles love a certain amount of moisture, although most of them dislike actual wet.

Many of the vegetable-feeders are often to be found sheltering under stones, and it seems often that they are the bait that tempts the carnivorous beetles into the same places.

Of course the best way to collect the plant-feeding species is to sweep or beat the particular plants or trees they are known to affect, and some knowledge of botany is invaluable in collecting these sections If the plant can be ascertained upon which any particular beetle has been caught, it is often a guide to the acquisition of a good series of specimens, and where the food-plant is not known previously, this should be noted for future guidance. The majority of the plant-feeding beetles are named specifically after their food-plants; for instance, *Apion Limonii* is only to be found on the sea lavender, *Statice Limonium*; but it does not always follow that the perfect insect is to be found on the food-plant. The "nut-weevil" is, I believe, most frequently beaten out of oak trees, and there are other similar cases.

It is impossible, within the limits of such a paper as this, to give more than a mere outline of the methods adopted for collecting. There is a capital little book recently published by David Bogue, called 'Notes on Preserving and Collecting Natural History Objects,' being a collection of papers by various authors, that I can strongly recommend, and one of those papers, by Mr. Rye, goes very fully into the subject of beetle-collecting.

I will only add that mere chance collecting will produce no good results, and that patience, perseverance, and thoughtful application of experience—needful in all natural-history collecting—are especially so where beetles are concerned.

IV.

GENERAL OBSERVATIONS ON SPIDERS.

By F. M. Campbell, F.L.S., F.Z.S., F.R.M.S.

Read at Hertford, 2nd December, 1879.

There is probably no subject in Natural History which has been so much neglected as that of spiders, and this may account for the few species favoured with popular names. As far as I know, these are "the money-spinner," "the harvest spider," "the Hertfordshire spider," "the garden spider," "the house spider," "the cellar spider," "the trap-door spider." Of these, the "money-spinner" and the "harvest spider," although of the class Arachnidæ, belong respectively to the orders Acarinæ and Adelarthrosomatæ, whereas all true spiders are embraced in the Araneidæ. As respects the "Hertfordshire spider," I have been unable to discover the particular species to which the name refers. Various specimens have been sent me, but there was nothing common to all except large size. There were more of the "house spider" (*Tegenaria domestica*) than of any other, but although this species has not been found in some localities, it is generally common in the London district, and widely distributed on the Continent.

Systematic Arrangement.

Mr. Blackwall* separated spiders into tribes according to the number of their eyes. In England there are only those with six eyes (Senoculina) and eight eyes (Octonoculina), while in other parts of the world there are spiders with two and four eyes. The same araneologist divided the "Octonoculina" into ten families, and the "Senoculina" into two, the distinctive characters being the position and comparative size of the eyes, the shape of the palpi, maxillæ, falces, labium, cephalothorax, sternum (breast-plate), and abdomen, and the proportionate length of the legs.

The general arrangement is however open to much objection. It is "too artificial, and based on insufficient (though in some respects convenient) characters, and moreover" has not "found favour with other araneologists."

The above quotation is from a paper by the Rev. O. P. Cambridge, entitled "Systematic List of the Spiders at present known to inhabit Great Britain and Ireland,"† which gives the names, and synonyms where necessary, of 457 species. Since then (1874) the number has been increased to about 520. Sooner or later Mr. Blackwall's classification will have to be abandoned for one more in accord with other authorities; but the proposal to employ as a basis the form of the webs can never be accepted, as the

* 'A History of the Spiders of Great Britain and Ireland.'—1859-64.

† 'Trans. Linnean Society,' vol. xxx.

effect would be to place in the same genus spiders which are utterly dissimilar.

General Anatomical Structure.

Spiders chiefly differ from insects in the following respects. The head and chest are amalgamated (cephalothorax), they have eight legs, and no antennæ.

Respiration is only partly tracheal. The stigmata vary in position and number. In the garden spider (*Epeira diadema*) there is but one stigma, which is just in front of the spinnerets. The chief organs of respiration are pulmonary sacs, which are never less than two, nor more than four. These are easily discernible, and are situated under two (generally) smooth pieces of skin near the base of the abdomen on its under side. They contain, with their ends free, a number of membranous sacs, arranged side by side in the form of thin plates (laminæ), through which the blood passes. The heart is a muscular tube running along the dorsal part of the abdomen. Blood is admitted by means of openings on each of its sides, and then forced through communicating arteries to different parts of the body. The vascular system is not complete. According to Prof. Huxley,* the principal nerve-centres are "a supra-œsophageal ganglion and a single post-œsophageal mass." These are in communication, and from the former run branches to the eyes, while the latter are in connexion with the limbs and abdomen. There are also some free ganglia. The eyes are always simple, with a lens and retinal expansion. Under the eyes, attached to the front portion of the cephalothorax, are two "mandibles," which are the homologues of antennæ, and for this reason the name "falces" is applied to them. The first or basal joint is generally stout and strong, while the terminal consists of a sharp claw, which when at rest closes on the basal joint as a blade of a pocket-knife on the handle. At the end of the claw is the opening of the duct of the poison-gland, which runs into the cephalothorax. Its largest portion, which appears to act as a reservoir, is surrounded by an irregular but closely arranged spiral muscle. The function of the falces is to seize and kill the prey, and to bring it within reach of the maxillæ. The mouth is just under the attachment of the falces to the cephalothorax. There is an upper and under lip (labrum and labium), to each of which is attached a rough plate, generally somewhat lanceolate, in the centre of which runs a groove terminating in a point.† When the mouth is closed, the two grooves form a tube which opens into the gullet or œsophagus, and that expands into the sucking-stomach.

At the top of the latter are muscles attached to the cephalothorax, and at the bottom are others fastened between the legs. It would seem that by the alternate contraction and expansion of the sucking-stomach the liquid food is removed from the mouth and driven

* 'The Anatomy of Invertebrate Animals.'

† Either of these plates is the so-called "spider's tongue," sold by microscopic-object dealers.

backwards to the abdominal intestine. Behind the sucking-stomach the intestine sends forward two branches, from each of which run downwards four others (cæca). These vary in different species.

On each side of, and attached to, the two lips, is a maxilla, which, however, is but the basal joint of a six-jointed palpus. Part of the external edges of the maxillæ is strongly dentated. The maxillæ have a lateral motion, and their function is to press the prey, thus causing its juices to exude, while they also bring the parts so treated within reach of the lips.

The external spinning organs, or spinnerets, are situated at the extremity of the abdomen. They consist of two, four, six, seven, or eight jointed protuberances,* on which are numerous horny tubes in communication with glands. These secrete a viscid fluid, which, when exposed to the atmosphere, quickly dries. Mr. Meade, in a paper read before the British Association,† describes these glands in detail, and holds that spiders may have the power of throwing out threads without the assistance of any external force. From a variety of experiments I am inclined to think that this is not the case.

The simplest method employed by a spider to draw out its thread is to fasten it to some fixed object and then to move away. If one be led to do this on a piece of glass, and the attachment be microscopically examined from the inverted side, it will be found to consist of many shreds, which at a little distance become united.‡ As the spinnerets are jointed, a spider is enabled to direct them in such a manner as to enable the liquid passing from each to dry at different points, so that it can spin more than one thread at the same time. The horny tubes vary in size, form, and arrangement in different species, and their number with age.

Life-History.

Spiders are oviparous, and there is no metamorphosis. They cast their skins from time to time as they grow, and each whole exuvium carries with it that of the two plates (which have already been mentioned as being attached to the lips), the œsophagus, with sucking-stomach, the spinnerets with tubes, and the pulmonary sacs with laminæ. Blackwall observed nine moults in a *Tegenaria civilis*; and a *T. domestica* (house spider) which I had in confinement went through this process on the following dates this year, 15th May, 9th June, 1st August, 21st September. On each occasion it was completely exhausted after leaving the exuvium, and remained for about twenty-five minutes hanging motionless, although it was touched. Eggs are only laid by spiders when full grown, and the age to which they live varies in different species, some dying the autumn after they are hatched, and others not for several years.

* British spiders have not less than six, in front of which in some families is the seventh, in the form of a narrow band. This in some species is divided by a line, thus making the eighth.

† 'Report of the Twenty-eighth Meeting,' 1858, p. 157.

‡ I refer to another plan under the heading of "Habits."

I have had in confinement for twenty-seven months an adult *Tegenaria domestica*, and she is still alive. On the 13th of last May she laid about 150 eggs, and on returning nine weeks afterwards, I found most of them hatched.* The young ones remained in the loose sac which surrounded the eggs until they had cast their first skin, which they did on the third day. I allowed them to be with the mother until September, and never had reason to accuse her of making a meal off any of them, but I cannot acquit her children of this cannabalism.

SENSES.

The mother-sense, namely, touch, is well developed in spiders. The limbs which are more specially susceptible are the feet and palpi. I have frequently placed a wood-louse (*Oniscus*) in a bottle, with a *Tegenaria civilis* or *domestica*, and with few exceptions the spider has first struck it with the fore-legs or palpi, and for the time abandoned the prey as if from the knowledge of its being a tough morsel. In all cases, however, the fate of the wood-louse was only a question of time, either from the vigour of the attack, or the entanglement of its legs in the web, which prevented its assuming its usual protective attitude. Spiders are, moreover, well provided with the means of feeling the slightest movement of their webs or other objects. On their legs and palpi are long slender simple hairs, which differ from others in that they are attached to a small disc on the integument. They are numerous on the *Epeira diadema* (garden spider), and are unusually long on the palpi of the *Pholcus phalangioides* (cellar spider). In web-spinning species they appear to rest on the snare, and this may account for the accuracy with which these spiders estimate the strength of their victim, while it also enables them to avoid risking an encounter of doubtful result. A violent agitation of the threads would at once show them they had no easy victory before them. It is also quite possible that these hairs are affected by the vibrations of sound; but as the organs of a special sense are always localised, it is unlikely that the sensation a spider receives by such means is anything more than one of disturbed stability. We ourselves, whose sense of touch has not been especially developed in this direction, can, by placing our hands, for instance, on a wooden structure near an organ, experience the vibrations of sound in the form of a gentle tremor, which is different to all other sensations. In a similar way some deaf people are enabled to enjoy music, and as there has as yet been nothing found on spiders which can be called an ear, we may not be wrong in attributing the undoubted effect on spiders of sound-vibration to the presence of the hairs which here I have briefly described.

* As I send this paper for publication (May 13th), I notice that early this morning the same spider has spun a shaft $3\frac{1}{2}$ inches in height, $1\frac{1}{2}$ inches in diameter, from the bottom of her bottle, and has supported it with side attachments. On the top she has laid one egg only, and covered it with a close-spun sheet an inch in diameter. The coincidence of the dates is strange.

Notwithstanding the discovery of Prof. Westring,* that some spiders (Theridiidæ) possess stridulating organs on the cephalothorax and the base of the abdomen, and the subsequent account of a stridulating mygale † found in Assam, I resolved to try a few experiments with the view of testing how far spiders could be affected by sound and music.

Walckenær ‡ writes that Gretry relates in his memoirs, that a spider came to a piano as soon as it was played. D'Oliver, in the 'Histoire de l'Académie Française,' tells the romantic story of Pellisson, who, when imprisoned, fed a spider which had spun its web in the air-hole of his dungeon, and after a few months trained it to run up as high as his knees to be fed at the sound of a Basque bagpipe.

The first experiment I tried was with a tuning-fork (C) in a small out-house where there were many spiders. Only one was attracted, and it followed the vibrating fork from place to place, but having allowed it to approach close to the open side of the sounding-box, it ran away as fast as it could for some little distance, and then remained stationary. The following day the note produced no visible effect on the same spider,—indeed, I have found that I could not always rely on constant results from these experiments. The tamest spider I had (*Tegenaria domestica*) was unfortunately allowed to escape. At a tune from a musical box she would open her spinnerets—an act which is common to spiders when expectant of food—and go to the centre of her web, where she used to be fed. It took me some weeks thus to train her, and the first sign of reconciliation to her imprisonment was an angry movement of the falces when I touched her, whereas previously she used to run away. On one occasion I placed a few feet from a *T. domestica* a vessel into which I had swept a mass of gnats from an out-house in winter. There must have been at least a hundred, and the "piping" was great. The spider became violently excited long before he could have seen them, and when he *did* see them was shortly so surrounded that he struck at them indiscriminately with his legs, reminding one of a young sportsman shooting at a large covey of birds. He succeeded in bringing down several. I have often startled spiders some distance off by the banging of a door, and their agitation could not be explained by supposing any current of air to have disturbed either *them* or their webs. The above are only a few of many experiments.

I have but little to say on the sense of sight. It would appear from the movements of spiders while spinning their webs that

* 'Natur-historisk Tidskrift,' vol. iv, 1842-3, p. 349, and vol. ii, 1846-9, p. 342; and 'Araniæ Suecicæ,' p. 184. Since the above was written I find that the females of *Theridion guttatum* have these organs as well as the males. Westring states males only. I have also discovered what appear to be undoubted organs of a similar function on the palpi and falces in *Linyphia tenebricola*, a spider $\frac{1}{11}$ of an inch in length, and have read a paper before the Linnean Society on both subjects.

† Wood-Mason, in 'Trans. Entomological Soc.' 1877.

‡ 'Histoire des Aptéres,' vol. i, p. 110.

they are more dependent upon touch. Many species are more active by night than by day, and the most intricate and symmetrical snares can be made in the dark. Whatever deduction we may make from this must, however, be subject to the consideration that *our* visual range lies between a minimum and maximum number of vibrations in a second, which exclude the less recurrent waves of radiant heat. These latter, for anything we know, may cause a luminous sensation in other creatures, in the same manner as sound-vibrations outside our auditory range produce on them an appreciable effect.

That spiders are capable of a delicate judgment of distance is evidenced by the *Salticus scenicus* (a small common species, readily recognised by its zebra markings), which springs some little space to seize its prey. The same spider will often turn round as it is running down the perpendicular side of a wall, and look upwards, if a little sand be dropped so as to fall about six inches from it.

From the nature of the external integument, the eyes of spiders would seem to be fixed in one direction, yet microscopic examination of them when alive leads me to think that the spiders not only have an adjusting power over the lenses, but that they also can move the eye itself within the cavity covered by the transparent cuticle. This is the only way in which I can account for the frequent changes of colour, as well as of the form and position of the colour, which take place in their eyes, and which resembles that of a moving liquid globule.

Spiders are generally not dainty in their food, but they have their strong aversions. They will reject the caterpillars of the currant moth (*Abraxas Grossulariata*) and of the "V" moth (*Halia wavaria*), while they generally discard the Ichneumonidæ, if I may judge of experiments made on *Tegenaria domestica* in confinement. Mr. Moggridge* relates how he guided a beetle (*Chrysomela Banksii*) to the nest of a trap-door spider, how it was seized and forcibly rejected, and how immediately afterwards a wood-louse was retained.

Habits.

The eggs of spiders are enveloped in a cocoon, and the young remain together a few days after they are hatched, when, if prevented from separating, they attack one another. A common practice employed by these young spiders to avoid their hungry relatives, and one which does not seem at this early age to be peculiar to any one species, is to stand rather higher than usual and raise the end of the abdomen, like an angry bee, while the viscid fluid before referred to is allowed to flow through the spinnerets, and form on their surface a loose entanglement of silk. In this position they will remain until a current of air (even a gentle human expiration is sufficient) draws away this rough parachute, and with it a thread in communication with the spider. The

* 'Trap-door Spiders,' Supplement, p. 40.

aeronaut soon seizes this with its fore-legs, runs up the thread, and is wafted away to a fresh hunting-ground.* The distance to which they are carried varies much, and Darwin† mentions that the rigging of the "Beagle," when sixty miles from land, was one morning covered with thousands of young and old spiders of both sexes. It is owing to such aerial excursions, and also to the practice of some spiders always to trail a thread after them, that at certain seasons of the year, when the weather is favourable, we see so much gossamer.

As soon as the young spiders are separated from the rest of the brood, they commence to obtain their food according to the habits of their species, whether by webs, as the Epeiridæ, Theridiidæ, etc., or by fleetness of foot, or ambuscade, as the Lycosidæ, Drassidæ, Dysderidæ, and Salticidæ, etc. *Salticus scenicus* has already been mentioned as springing on its prey, but before doing so it attaches its thread to the place from which it starts, thus making a careful provision against a fall. Under its feet, as is the case with many spiders, are pads of stiff bristles which end in a bulbous point. These must be of great service in its spring.

There is an almost endless variety of webs, from that of the so-called cobwebs in our houses to the beautiful regular snare of the Epeiridæ (garden spiders). The former, if preserved from dust and smoke, retain for years their original pearly lustre. The first more or less horizontal line which forms the foundation of the web of the *Epeira diadema* is drawn from the spinnerets by a light current of air as just described, the spider remaining motionless, apparently waiting to feel the decreased tension as the thread becomes entangled with some fixed object, when it securely fastens the ends.‡ More or less parallel to this it similarly obtains another. Walking then to some point on the upper thread, it there fixes a third thread, and drops down to the second, and securely attaches the two. It then proceeds to about the centre of the last thread and there fastens another, which it trails along until it reaches some point on the first, to the right or left of the perpendicular thread. There the spider draws the loose thread tight, and fastens it. It is thus that all the radii are spun, care being taken that they are arranged so as to keep the whole structure compact and tight. The spider then commences from the centre of its snare to trail a spiral, the lines of which are much farther apart than those seen in the finished web. If we touch this thread we find it is non-adhesive. On reaching the circumference, the spider spins the permanent spiral, making use of the first as a bridge over the distances between the radii, and bites away those parts of it which are no longer required for this purpose. The spider thus continues, until it is not far from the centre, when it leaves un-

* This habit is persistent in some small species.

† 'Naturalist's Voyage round the World.'

‡ This can easily be seen by placing an *Epeira* on a stick, standing perpendicularly in a pail of water, and opening the door and window of the room so as to cause a draught.

touched the first spiral. The web is now finished,* unless, as is often the case, a thread is carried from its centre to a leaf or other fixed object, concealed in which the owner may wait in ease, with one foot on the communicating line, ready to run out on its slightest movement. If now we touch the permanent spiral, we find it very adhesive and elastic, which is not the case with the radii and the other supports of the web. The difference between the two on microscopic examination is seen to be the presence in the former of many small globules, which are found to be very viscid. The spider invariably runs along the radii to its prey, and the cause of its leaving in the centre of the web a few turns of the first spiral, which is non-adhesive, seems to be that it makes that part a general resting-place, and does not wish to be hampered in its movements. In some cases the spiral, as it approaches the circumference, is much more open than at other parts, and this occurs more often in large webs. It would appear that this is an error, for it occurs where the radii are the farthest apart, and at the weakest points of the whole structure. This objection is however removed if we consider that it would be to the advantage of the spider to allow a powerful insect to break through the web rather than it should be destroyed by the captive's struggles for freedom, and, were it stronger at the circumference, such would be the result in a shorter time than would allow the spider a chance of a personal encounter. If large insects are caught, it is only near the centre, within easy striking distance, and even then the Epeiridæ will sometimes bite asunder the threads which hold them rather than expose their web to any risk.

Adhesiveness is, however, not a property of the webs of all genera. In these cases the prey is secured by entanglement and immediate attack. The snares of the Ciniflonidæ, which have on the metatarsal joint of each posterior leg two rows of curved movable spines, with which they crimp the thread as they leave the spinnerets (calamistrum), are adhesive when newly made, and there are none of the viscid globules already referred to. Mr. Blackwall has treated of the matter,† and points out that the application of a polished surface does not derange the web. This, as well as other considerations, leads to the conjecture that the detention of insects is due to some of the threads of the webs of this genus being fibrous. Many spiders' webs are in connexion with holes and crevices in the earth, and there the spiders hybernate. Some of the Lycosidæ dig an irregular oval cavity (about one inch by half an inch), close it with their thread, and earth, and remain there with a cocoon. I kept one in confinement, and twice destroyed her retreat, only to find another made the following morning. The top was covered with granular pieces of earth, such as might be surmised to have been raked over the silken lining with her feet. A similar burrowing habit, but one that is

* For the sake of brevity I omit here the very many stays and side-threads of the web.

† 'Trans. Linnean Society,' vol. xvi.

persistent in all seasons, is found in the genus *Atypus*, of which we have two recognized species, *piceus* and *affinis* *), which are the so-called "English trap-door spiders." This term is, however, incorrect, for although they dig a hole in the ground, which, in the case of adult females, measures ten inches in length and five-eighths of an inch in width, there is no attempt to make a door such as is seen in the true trap-door spiders' nests of the Continent, which are to be found readily about Bordeaux and the Riviera.† *Atypus piceus* and *affinis* spin a much stronger lining to their nest, and carry it about two inches beyond the ground, upon which the prolongation rests. When the spiders are at home, the tubes are invariably closed and fully extended; the end being brought to a point, and so well woven, that even on close examination there is no trace of a seam. They feed by night.

One of the most interesting of our indigenous spiders on account of its habitat is *Argyroneta aquatica*, which is born and lives *in* pools and ditches. It is easily kept in confinement for some time, and is procurable from the Cambridgeshire fens, where it is common, but it is not to be confounded with some species which hunt for their prey *on* the water, nor with those which only occasionally take a plunge (*Lycosa piratica* and *Dolomedes fimbriatus*). It constructs a dome-shaped cell in the water in the following manner. Entangling a bubble of air in its spinnerets, it descends, and attaches it to a weed, then it rises to the surface, procures another, which it adds to the first, covering both with its thread. This it will repeat as many as twenty times, until the cell is large enough, when it enters from below, having previously taken care to attach lines in communication with different points. Here it lives and hybernates, occasionally making a foraging excursion. It is the only English species in which the male is larger than the female.

Many of the female hunting spiders (Lycosidæ, etc.), rather than desert their cocoon, carry or draw it after them, and defend it to the last; and Bonnet ‡ relates how a *Dolomedes mirabilis* preferred to remain in the hole of an ant-lion to abandoning its eggs. This species, as the hatching-time approaches, weaves a sheet upon blades of grass, and remains with her young for some days, only leaving them to procure food. Spiders which spin snares generally place their cocoons in close proximity, and some, like *Tegenaria domestica*, are to be continually found sitting § on the sac which incloses their eggs.

The strategy of spiders is not confined to the construction of their webs. The Epeiridæ will at times shake them so violently as to make the outline of their bodies invisible, while the cellar spider

* Blackwall's synonym for both is *Sulzeri*.

† Mr. Moggridge's book, 'Harvesting Ants and Trap-door Spiders,' goes fully into their habits and the construction of their nests.

‡ 'Traité d'Insectologie,' vol. i, p. 547 (4to.).

§ Such is the position at the present moment of the *T. domestica*, mentioned already as having laid one egg.

(*Pholcus phalangioides*) will if disturbed spin round and round so rapidly, that it only gives the visual impression of an indistinct circle of some light substance suspended from its web. These simple habits become more complex in the triangle spider of America (genus *Hyptiotes*, Walck.). The net is in the form of a triangle, divided by two lines from the apex to the base, more or less parallel to which run nine others. The apex is attached to a twig by a thread, which the spider seizes, and then moves her hinder feet backward. The effect is to put the whole net on the stretch. Thus it will remain until an insect strikes it, when the spider relaxes the hold of the hinder legs, and the net springs back to its original position, entangling the prey.*

In common with many other creatures, spiders "sham death" an expression which I think is open to much objection, as it suggests a complex cause for a phenomenon, whereas a simple one will suffice. Dr. Preyer, of Jena,† has published his experiments on animals while under the influence of sudden fright. He shows them to be unconscious, and our general experience is confirmatory. A child falls, and though not hurt loses himself for a few seconds; when regaining consciousness, he bursts out into a loud roar. Rabbits appear powerless when weasels approach them. Birds and hares will sometimes remain motionless on our sudden appearance. Many moths never attempt flight when touched, and the white ermine, the satin, the swallow-tail, and the male ghost moth will fall as if paralysed when a net is swooped under them at night while on the wing. The clouded-yellow butterfly will drop as if lifeless, when closely pursued, and I would add to this incomplete list of the results of fright the so-called "shamming death" of spiders. The *Epeira diadema* gives almost a constant result if it be suddenly touched, but it is strange to see it afterwards, as is often the case, pursuing its way mindless of any further disturbance. The most natural explanation of this apparent contradiction is, that the phenomenon is dependent on fright, which is greater if unexpected. Dr. Preyer found it difficult to produce satisfactory results on the young of some animals, and not long since at Mentone, while digging out a trap-door spider (*Nemesia Moggridgii*), I was struck at seeing some of her progeny running about as if nothing was happening, while others remained with their mother motionless. On touching them with chloroform, the young died at once, but the old one was quiet for thirty seconds or more, and then moved but little. It would seem that she was unconscious even of pain, for the application of this agent of death to large spiders is generally followed by resistance. A parallel case to this is the well-known death-watch beetle, which is said to submit to any amount of torture without movement, after it has once drawn its head into its monk-like hood and folded its legs. That this resignation to all consequences would be the case if it were con-

* See Mr. Wilder's paper in 'Proceedings of the American Association,' August, 1873.

† 'Sammlung Physiologischer Abhandlungen,' Zweite Reihe, Erster Heft, 1878.

scious, would imply that it preferred to continue to play a part at the expense of its life, when the object of that part was preservation. Notwithstanding the above remarks, I do not think that all creatures which remain motionless under circumstances likely to frighten them, are unconscious. I refer to those animals, etc., such as the hedgehog, armadillo, wood-louse, snail, and parasitic Chrysididæ, which, having some parts of their body harder than the rest, use them as a shield. In such cases immobility may be regarded as a necessity of their attitude of protection.

In connexion with this subject the question naturally arises as to whether insects show any sign of fear in the presence of spiders. Experience acquired from the observation of animals given to reptiles for food would lead one to think this would rarely be the case. Birds and mammals fly and run against the heads of snakes, and even rest there, frightening *them* much more than they do themselves, and the same is true of flies and spiders. I have only once observed an attitude in a fly which might be taken as coincident with kataplexy, which is Dr. Preyer's term for the paralysis caused by fright. The fly was about an inch and a half from a *Tegenaria domestica*, and was busily cleaning itself, when suddenly it stood motionless in the very act of rubbing its crossed legs together, and remained so until it was shortly afterwards seized. This could not be explained by the spider having previously struck it with its fangs, palpi, or legs, for such was not the case. Mr. Belt states that he has seen cockroaches retreat in full haste when they had accidentally approached a large spider.*

General Remarks.

Spiders have enemies also. They often fall victims to members of their own order, and to "harvest-spiders" (Phalangidæ), wasps, hornets, lizards, toads, centipedes, squirrels, etc. Several of the Pompilidæ prey upon them, and convey them, when paralysed by a sting, to their burrows, where they are stored as food for the young brood. Some of the Ichneumonidæ lay their eggs in the cocoons, the puncture presenting the appearance of the prick of a pin. This seems to be very common, if I may judge from the number of instances which I have met with. Ants will quickly seize a disabled spider, and the Rev. O. P. Cambridge writes: † "The large red ant of our woods, *Formica rufa*, destroys them so completely that in those localities thickly inhabited by the ant I have generally found it almost useless to search for spiders."

In winter spiders are to be found under all kinds of cover, whether it be a brick, a long tuft of grass, an untidy side of a haystack, moss, or a collection of leaves. A careful shaking of these over a square yard of calico will soon reveal their contents. In spring, summer, and autumn they are also to be sought for on their webs, on railings, and on the ground, basking in the sun,

* 'The Naturalist in Nicaragua,' p. 110.
† 'Spiders of Dorset,' vol. i, p. xxxi.

while in dry weather many species are to be obtained by carefully searching the grass growing by the water-side. As a rule those frequenting damp places soon die in confinement, while others have been known to live some months without water or even food.

Spiders are best caught in a glass tube (about $2\frac{1}{2}$ inches by $\frac{1}{2}$ an inch), and the small species by applying to them a wetted finger. A knowledge of their habits, a quick eye, and a ready hand, are required, especially for some fast runners, but it is astonishing how soon even these become tired out. They are all best preserved in spirit (about 40 per cent. over proof).

It is interesting to observe the difference between the spinning organs of the larvæ of Lepidoptera and those of spiders. The comparatively large single opening of the former causes the viscid fluid to dry but slowly, thus preventing the silk from being employed in connexion with any rapid movement, while the spider with its number of tubes (already described), exposes to the atmosphere as many minute liquid jets. These almost instantaneously solidify as they unite, thus permitting that immediate use of the thread which is so necessary to the spider for its safety or means of subsistence.

The thread varies in thickness from $\frac{1}{1000}$ to $\frac{1}{4000}$ of an inch in diameter, and yet will sustain a weight of from 56 to 60 grains. Many have been the attempts to use it in manufacture. The first was by Bon, who wove gloves made from the silk of cocoons at the commencement of the last century,* and in 1710 the Academy of Sciences in Paris charged Réaumur to investigate the subject. His report was unfavourable.† Eighty years afterwards Tremeyer (in Italy) drew the silk straight from the *Epeira diadema*, with which he also made gloves, and about the beginning of this century Troughton employed it in scientific instruments, instead of silver wire. Further experiments have within the last few years been made by Dr. Wilder, who gives their result in the 'Galaxy' (July, 1869). He shows that it is quite possible to obtain sufficient spiders' thread or silk for it to become a material of general manufacture. He reeled 150 yards from a *Nephila plumipes*, on twenty occasions within a month, and he calculates that it would require a similar produce, from 450 of this species, that is, 1,350,000 yards, to make a yard of silk such as would be used in a dress. Greater labour is however required than in the case of the silk from the *Bombyx*, and this, notwithstanding a finer texture, is an insuperable objection to its use.

* Bon, 'Dissertation sur l'Araignée.'—1710.

† "Examen sur les Araignés," in the 'Report of the Academy of Sciences.' —1710.

V.

HOMOLOGY AND ANALOGY OF PLANT ORGANS.

By the Rev. George Henslow, M.A., F.L.S., F.G.S.

A Lecture delivered at St. Albans, 16th December, 1879.

Homology between any plant organs may be defined as an identity of morphological origin with a difference of function: while *Analogy* signifies a similarity of function in different organs, whether there be a difference in their morphological origin or not.

Thus, a leaf-tendril is homologous with a leaf-blade, since they are the same organ fundamentally and morphologically; but each in its development has become adapted to its own special function.

The tendril of a vine, however, is *not* homologous with a leaf, because it is a metamorphosed flowering branch, with which it is, of course, homologous. On the other hand, it is analogous to the tendril of the pea, for its function is the same. In this case, therefore, there is no common morphological origin between the tendril of a pea and that of a vine.

Again, recognising a green bract as an organ distinct, say, from a petal; though they are morphologically of the same nature, both being referable to the leaf-type; yet when a bract becomes coloured, it is then analogous to a petal; for its function is now the same, viz to attract insects. On the other hand, whenever a bract is green, it is, at one and the same time, both analogous and homologous with a true leaf.

It is the object of this paper to illustrate these principles as applied to the Vegetable Kingdom.

HOMOLOGY.

A few preliminary facts must be stated.

Every part of a plant to which some definite function can be assigned is called an *organ;* and all organs of a flowering plant are grouped under the two heads, *vegetative* and *reproductive.*

Under the former term are included roots, stems, stipules, leaves, leaf-scales, and green bracts. Under the latter term are inflorescences, coloured bracts, flowers, and their resulting fruits.

All these organs may be otherwise classified under the terms *axes* and *appendages;* the former being "caulomes" or stem-structures, the latter "phyllomes" or leaf-structures and "trichomes" or epidermal outgrowths.

Roots and rootlets are called descending root-axes. These bear no phyllomes, but only trichomes, as root-hairs for absorption.

Stems may be (1) subterranean stem-axes or (2) aerial and ascending stem- and branch-axes.

Omitting hairs and other trichomes, stem- and branch-axes only bear phyllomes or foliar appendages.

The term *leaf* may be used in a wide sense for any phyllome or appendage, not including trichomes. Hence we may recognise phyllomes as occupying (1) the leaf-scale and bud-scale regions, (2) the true leaf region, (3) the bract* region, and (4) the floral region.

Homology asserts, *first*, that root- and stem-axes are fundamentally the same; *secondly*, that all leaf-appendages or phyllomes are fundamentally the same; and *thirdly*, that even caulomes and phyllomes must be regarded as being fundamentally the same; though in each case their normal functions may be very different, respectively.

In comparing these several organs, we must first consider their normal differences, and secondly look for their fundamental agreements.

I. Axial Structures—Vegetative.

The following comparisons may be made between root- and stem-axes. Roots differ from stems,—1, in their order of *branching;* 2, in their *anatomy;* 3, in their *physiology;* and 4, in the *absence* of *buds* and *appendages*, excepting epidermal root-hairs.

1. *Branching of Roots.*—The branching of stem-axes being mainly determined by the position of the leaves, and these being more or less arranged according to phyllotactical laws, the branching becomes more or less symmetrical, or at least is originally so, but the regularity is often marred by the arrest of buds and by their displacement, etc. In roots, there is, except at first, no such apparent regularity. As examples of certain regular distributions the following may be noticed: the rootlets of *Cruciferæ*, *Papaveraceæ*, *Resedaceæ*, and *Geraniaceæ* are in two lines; several *Leguminosæ* in three lines; *Malvaceæ*, *Euphorbiaceæ*, *Umbelliferæ*, *Labiatæ*, and *Verbenaceæ* in four lines; and *Compositæ* and *Solaneæ* in five lines. The arrangement in two and four lines is the commonest. This disposition is generally in accordance and in connexion with the fibro-vascular bundles.

2. *Anatomy of roots.*—This is in some respects very different from that of stems. A young root consists of epidermis with or without root-hairs and with no stomata. Beneath it is the cellular cortical layer; then the cylinder of cells called the protecting sheath which includes the root-forming pericambium, and lastly the central fibro-vascular column usually without a distinct medulla or pith. The apex is protected by a special root-cap or pileorhiza, wanting in Gymnosperms. Old woody roots as compared with similar stems have mostly no pith, and the medullary rays are less numerous and less developed. The wood is very irregular. There is much interlacing of parts, causing the wood to be *knotty*. There is a similar cambium layer. The cortex or cork is mostly thicker (as in the thick cellular layer in herbaceous rhizomes). There is less liber or none.

* Bracts may be regarded as transitional organs between the vegetative and reproductive.

3. *Physiology of roots.*—(1) The elongation of roots is confined to a space of about one line in length at a distance of half a line from the actual apex; a growing stem on the other hand appears to elongate by growing throughout its whole length. (2) New rootlets are always endogenous. Arising from the pericambium, they burst through the tissue, raising the cortical layer into a "coleorhiza" round the base of the emerging rootlet. Regularly formed buds, on the other hand, are exogenous and form superficial papillæ near the *punctum vegetationis* of a stem. Adventitious buds, however, are endogenous. (3) The functions of roots are (i) to fix the plant to its site in the earth, or as an epiphyte on other plants; or on rocks, etc., in water or air; unless the plant float freely on or is suspended in water; (ii) to absorb water with mineral and organic matters in solution: the modifications being (*a*) normal, in soils and water, (*b*) absorbents of organised matter, as in *Neottia Nidus-avis* and "saprophytes," (*c*) aerial absorbents, as in orchids, (*d*) parasitic, either subterranean, as in *Orobanche*, or aerial, as in *Cuscuta*; (iii) to act as *props* for climbing, as on ivy and orchids; (iv) to form reservoirs of nutriment, as tuberous roots; (v) to act as propagating instruments, whenever buds are produced on roots, as in *Anemone Japonica*; while *Ranunculus Ficaria* and terrestrial orchids propagate by the production of adventitious tuberous roots, each being terminated above by a bud. (4) The vitality of roots is generally very great as compared with that of stems and any other part of the plant. Lindley* mentions live roots having been found in land many years after the trunks to which they belonged had been destroyed, as of white thorn. Knight found evidence of the same fact in fruit trees.

Roots *agree* with stems in forming similar concentric woody layers with cambium and bark, and having the individual cells of the different layers of the same nature as, but larger in many cases than, the cells in the stems: thus the wood-cells of the root of *Pinus* have two to four rows of disks, whereas they are in a single row on the wood-cells of the stems. Roots can produce buds. Many plants habitually do so, as *Anemone Japonica*, *Pyrus Japonica*, peach and plum trees. The roots of *Neottia* are said to bear leaves,† and when roots of trees, as elm, horse-chestnut, etc., become exposed, they then will produce buds freely. An adventitious root proceeding from the upper part of a decorticated spot on a *Robinia* (false acacia) penetrated the soil at a distance of five feet. Being detached above, it threw out leaf-buds and now forms a small tree, the true root assuming the character and functions of an aerial trunk.‡

On the other hand, exogenous stem-structures differ from roots in having, if complete, the following elements:—medulla or pith, regular medullary rays, wood in regular concentric cylinders, a cambium layer, liber and soft bark, a green layer, liber and epidermis with stomata, and no apical cap. In its method of growth,

* 'Theory of Horticulture,' p. 31.
† Perhaps these are stem-structures.
‡ This is growing in the Rectory garden at Ealing.

the apex elongates, and the internode *stretches* by interstitial growth throughout its whole length.

Conversely, stems can resemble roots in developing adventitious roots; and in absorbing moisture throughout their whole surface, as long as it is only covered by a delicate epidermis and but a thin cuticular layer.

Normal instances of roots arising from stems occur in all monocotyledons.

As abnormal instances,—Exogens when decorticated often produce them from the living edges of the part; all "cuts" and "slips" are thus made to form independent plants by the facility with which they will strike root. Adventitious buds are endogenous, as are all new rootlets.

Roots and stems can, *both alike*, be modified as reservoirs of nourishment; thus are tuberous roots of *Ranunculus Ficaria*, *Orchis*, *Pæonia*, *Dahlia*, etc. Stem-structures having this function are seen in rhizomes, corms, tubers, etc. Lastly both stems (radicle) and root (axial, primary, or tap) may be together concerned in the act, as in biennial roots of turnip, carrot, etc.

Some plants have no roots when the stem supplies their functions of fixing the plant to its site, as in *Epipogon Gmelini*, *Corallorhiza innata*, and some Bromeliads, as well as the cryptogamous bog-moss *Sphagnum*, and *Psilophyton*. *Utricularia* has also no roots but is simply suspended in water. In some of these cases the stems would seem to act as absorbents of nutriment, as in the above-mentioned orchids; so too similar (root?) structures in *Neottia* probably absorb organic matter as saprophytes.

An interchange of functions can be brought about artificially. Thus Duhamel caused the boughs of a willow to be bent down to the ground, buried, and to strike root. When these were well rooted, he extracted the original roots and elevated them, so that the tree became inverted; the roots now threw out leafy shoots.

The functions of stems, as compared with roots, may be classified as follows:—(i) to fix the plant to its site when it has no roots; (ii) to absorb water through its epidermis, and other food as in saprophytes; or to act parasitically, as in *Viscum*, etc.; (iii) as climbing instruments in stem-twiners; (iv) as reservoirs of nutriment, as in tubers, etc.; (v) as propagating instruments, as by bulbs, tubers, the aerial *corms* of *Ranunculus Ficaria*, and the swollen disarticulated *branches* of *Vitis gongyloides*; (vi) as extending the individual, as by creeping stems of grasses, rhizomes, etc.

II. Appendicular Structures—Vegetative.

1. *The Leaf-scale Regions.* Leaf-scales.—The first modifications of phyllome to be considered are *Leaf-* and *Bud-scales*. These occur in two regions, (1) on underground stems, as well as on the basal parts of aerial stem-axes, and (2) as aerial buds.

Leaf-scales of the first kind appear to have only two origins. They are either homologous with the basal or petiolar portion of the leaf or else are stipules. The former are by far the most numerous; such as bulb-scales, sheathing scales of creeping grass-stems, and the rudimentary scales of the "eyes" of potatoes. But the violet and strawberry furnish illustrations of stipules forming scales on rhizomes.

With reference to their functions, they may be (1) rudimentary and presumably useless as on potatoes; (2) protecting the bud included within them; and (3) reservoirs of nutriment as on bulbs.

Bud-scales are homologous with several structures; they may be:—

1. *Stipular*, as in the lime, elm, oak, and beech.
2. *Laminar*, as in the lilac and willow.
3. *Petiolar*, as in the horse-chestnut and currant.
4. *Petiolar* and *stipular*, by cohesion, as in the plum.
5. *Laminar* and *stipular*, but free, as in the hawthorn.

The functions of bud-scales are mostly the same, whatever be their origin; namely to protect the delicate parts within. To enhance this function they are often provided with hair, either *silky*, as in the beech and willow, or *woolly*, as in the apple. The hair may either densely clothe the leaf, as in the apple, or else the stipules may be hairy as in the willow. The hair acting as a non-conductor enables the heat due to respiration to be retained. Externally they may be resinous, as in the horse-chestnut.

The only additional function they may assume is that of storing up nourishment for the bud, when it can become detached and maintain an independent existence, as in *Lilium bulbiferum*, *Dentaria bulbifera*, etc.

2. *The true Leaf Region.* STIPULES.—The true origin of stipules has not yet been satisfactorily or definitely determined in every case. That they are foliar or phyllomes is generally admitted, but whether they are in all cases *organically* one with the leaf, or totally independent of it, in many cases is not yet decided.*

With reference to the *duration* of stipules, they are persistent or deciduous; and with regard to their *character*, they may be (when persistent) as follows:—

1. Foliaceous and	lateral in position,	*e.g.*	*Pisum.*
,,	axillary ,,	,,	*Melianthus.*
,,	interpetiolar ,,	,,	*Galium.*
2. Membranous	. . . .	,,	*Pelargonium.*
3. Scarious	. . . .	,,	*Illecebraceæ.*
4. Spinescent	. . . .	,,	*Acacia* (species).
5. Cirrhose	. . . .	,,	*Smilax.*
6. Bracteiform	. . . .	,,	*Viola*, *Fragraria.*

* According to Griffith ('Notulæ') stipules are (1) petiolar or "extensions of the petiole," as in *Nandina domestica* (Part I, p. 226) and in the *Ochrea* of *Polygonaceæ*, such being, according to him, "a mere dilatation of the petiole, the margins of the dilated part cohering and forming a sheath;" but it is otherwise regarded as *axillary* by cohesion of two stipules between the leaf and the stem, and cohering on the further side of the stem as well, so forming a tubular sheath. Again, stipules may be (2) "considered as the lowermost pair of pinnules," as in *Bauhinia* and other leguminous plants (p. 228). Lastly, they may be (3) "nothing but the lowermost lobes of the leaves," as in *Passiflora* (p. 229)

Of deciduous stipules there may be the following kinds :—

1. Bud-scales	. . . . .	*e.g.*	*Quercus*, *Tilia*.
2. Bud-sheath	. . . . .	,,	*Magnolia*.
3. Glandular	. . . . .	,,	*Reseda*.

By position stipules may be petiolar (*Rosa*), interpetiolar (*Galium*), oppositifoliar (*Astragalus*), axillary (*Melianthus*), ochreate (*Polygonum*).

Lastly, with reference to their functions, stipules may be as follows :—

1. Foliar, or with true leaf-functions,	*e.g.*	*Pisum*.
2. Protective, as bud-scales .	,,	*Tilia*.
,, as bud-sheath .	,,	*Magnolia*.
3. Defensive, as spines . .	,,	*Acacia*.
4. Scandent, by tendrils . .	,,	*Smilax*.
5. Secretive, by glands . .	,,	*Faba*.
6. Furnishing a domicile for ants .	,,	*Acacia sphærocephala*.*

LEAVES.—Regarding a leaf as the type of all phyllomes, we may recognise the following modifications of the two parts—stalk or *petiole*, and blade or *lamina*.

Petiolar Metamorphoses.—The leaf-stalk or petiole may assume any of the following characters :—

1. Foliaceous (phyllodes) . .	*e.g.*	*Acacia* (species of).
2. Spinescent	,,	*Astragalus gummifer*.
3. Protective (of buds)—		
(1) Sheathing	,,	*Heracleum*.
(2) By a groove	,,	*Aucuba japonica*.
(3) Pileiform	,,	*Platanus*.
(4) Squamiform	,,	*Æsculus*, *Ribes*.
,, with stipules	,,	*Rosa*, *Prunus*.
4. Leaf-supporting sheath—		
(1) Entire and investing the stem	,,	*Palmæ*, *Cyperaceæ*.
(2) Split on opposite side .	,,	*Gramineæ*.
5. Glandular	,,	*Acacia sphærocephala*.
6. Scandent	,,	*Clematis*.
7. Nutritive	,,	*Lilium* (bulb-scales).
8. Vibratory	,,	*Populus*.

Laminar Metamorphoses.—The following are the characters which may be assumed by the blade or lamina :—

1. Petaloid, (1) normal . .	*e.g.*	*Poinsettia*.
,, (2) abnormal . .	,,	*Tulipa*.
2. Protective (of buds). . .	,,	*Syringa*.
3. Scandent (by tendril) . .	,,	*Gloriosa*, *Pisum*.
4. Carnivorous	,,	*Sarracenia*, etc.
5. Glandular	,,	*Aroids*, *Nepenthes*, etc.†
6. Propagative, (1) normal . .	,,	*Bryophyllum*.
,, (2) artificial. .	,,	*Begonia*, etc.

and in *Cissi*. They may take the form of "ciliolar outgrowths developed from the base of the leaves towards the centre of the *interfolium*, as in *Apocyneæ*" (p. 230). Interpetiolar stipules Griffith regards as "rudimentary leaves of independent origin, as in the *Rubiaceæ*" (p. 230).

* See Belt's 'Naturalist in Nicaragua,' p. 219; and 'Journal of Linnean Society,' Botany, vol. xv, p. 398.

† The Pitchers are metamorphosed glands.—'Trans. Linnean Soc.,' vol. xxii, p. 415.

7. "Food-bodies" (bearer of)	.	,,	*Acacia sphærocephala.*
8. Nutritive	.	,,	*Cotyledons.*
9. Water-carriers . . .	.	,,	*Dipsacus.*
10. Defensive, (1) spinescent .	.	,,	*Ilex, Aloë.*
,, (2) stings .	.	,,	*Loasa, Urtica.*
,, (3) serratures .	.	,,	*Pandanus.*
11. Arrested	.	,,	*Acacia* (phyllodinous sp.).

3. *The Bract Region.* BRACTS.—These organs may be regarded as intermediate between the vegetative and reproductive; being assimilated to the former whenever they are green, and more or less foliaceous; but allied to the latter, when petaloid in character.

The homology of bracts and bracteoles is various. In the first place, they may be *stipular*, as in *Magnolia*, strawberry, *Herniaria*, and violet, for the two minute bracteoles on the peduncle of the violet would seem to correspond in their acuminate and dentate characters with the stipules found on the rhizome, the leaf belonging to them having been suppressed. Another case is seen in *Amelanchier*, as figured in De Candolle's 'Organ. Vég.,'* in which the ciliated bracts beneath the flower are similar in every respect to some of the stipules, of which the author observes:† "On y voit en *s* les stipules, qui en *s′* prennent une forme semblable aux bractéoles *bb*." The stipules being dimorphic, the outer stipular bud-scales (alluded to as *s*) being lanceolate and glabrous, the bracteiform stipules (*s′*) as well as the bracteoles (*b*), being almost acicular and ciliate. The epicalyx of *Fragaria* appears to be due to ten stipules coherent in five pairs.‡

More frequently bracts are petiolar, as is so well seen in *Helleborus viridis*, which affords a completely graduated series, from the true pedate leaf to an oval acute bract, by gradual suppression of the segments, and a dilatation coupled with a shortening of the petiole.

On the other hand, it may be the leaf-blade more or less reduced in size which constitutes the bract. Such is the case with *Geranium*, as *e.g.* *G. lucidum*, in which the radical leaves have long petioles, the cauline being much shorter, while the bracts have none, but retain the sub-orbicular form of the lamina. In species of *Ranunculus* with divided laminæ the bracts have the appearance of sessile segments gradually reduced in dimensions and number as the flowers are approached.

Lastly, the bract may be the whole leaf, whether the latter be normally sessile or petiolate, according to the species, but simply reduced in size. When this is the case, the transition from leaves to bracts is usually so gradual that it is impossible to draw any line of demarcation. The shortly petiolate leaves of species of *Epilobium* and of *Pedicularis racemosa*, and the subsessile foliage of *Echium vulgare* and *Beta*, will illustrate this.

Anemone furnishes three conditions. In *A. nemorosa* the involucre is formed by three complete petiolate leaves; in *A. Pulsatilla*

* Vol. ii, pl. 21, figs. 4–6. † p. 271.
‡ Payer, 'Eléments de Botanique,' p. 90, fig. 144.

the segmented laminæ are alone present; while in *A. hepatica* it appears to be the homologue of the petiole alone which constitutes the calyciform involucre.

Bracteoles would seem to be little else than *mid-ribs* invested by parenchyma, like an ultimate segment of fennel, and might thus be called *costal.*

On the other hand, bracts may abnormally *revert* to true but small leaves. Such is not unfrequently the case in species of *Plantago*, in the involucres of *Compositæ* and *Umbelliferæ*, and at the base of the umbells of *Primula.*

Classifying bracts homologically, we may group them as follows:—

1. Stipular . . .	*e.g.*	*Viola, Amelanchier, Magnolia.*
2. Petiolar . . .	,,	*Helleborus.*
3. Laminar . . .	,,	*Ranunculus, Geranium.*
4. Foliar	,,	*Epilobium, Echium.*
5. Costal	,,	Bracteoles.

Recognising bracts as homologous with or issuing from some one of the above sources, they may assume a diversity of forms and characters adapting them for diverse characters.

1. *Foliaceous.* If bracts are of a green colour and herbaceous texture, whatever be their homology, they may justly be presumed to have leaf-functions; and the cases mentioned above will illustrate this condition, which is extremely common.

2. *Petaloid.* This state of bracts and bracteoles is very frequent. Petaloid bracts may be grouped conveniently under three heads.

(1) Assisting in the colorisation of the inflorescence, such being mainly effected otherwise by the floral whorls, the bracts themselves not resembling flowers.

(2) A number of coloured bracts may *together* mimic a flower, the true floral perianth being insignificant or wanting.

(3) Bracts may pass by insensible graduation into the true floral whorls, there being no *break* between true bracts on the exterior and true petals within the flower.

As examples of the first case there are species of *Monarda* and *Salvia*, such as *S. splendens* and *S. Bruantii*, in which the calyx is scarlet as well as the bracts. *Leycesteria*, *Bougainvillia spectabilis*, *Musa coccinea*, *Bromelia*, *Tillandsea*, and *Euphorbia* furnish others, while *Anthurium*, *Richardia*, and other Aroids, have brightly-coloured or white spathes.

As examples of involucrate bracts simulating flowers, there are *Hederoma* (*Darwinia*) *tulipifera*, species of *Cornus*, *Xanthosia*, *Rhodanthe*, *Helichrysum*, and other kinds of the so-called "Everlastings" of *Compositæ*, *Euphorbia jacquineæflora*, and other species of that genus.

Instances of complete graduation from small exterior-coloured bracts up to the petals with no distinct intermediate calycine whorl, may be seen in *Cactus Jenkinsonii* and other members of that order, such as *Epiphyllum splendidum;* as also in *Calycanthus* and *Chimonanthus.*

As an abnormal instance may be mentioned a seedling *Begonia*, described and figured in the 'Gardeners' Chronicle' (1877, p. 488), in which not only the bracts but also the upper leaves were brilliantly coloured.

3. *Squamiform*. In this state bracts protect the flower-bud or essential organs, if they be alone present; they may be membranous, or herbaceous and green, when they have leaf-functions as well, such as the scales of the male catkins of the *Cupuliferæ*, of the female inflorescence of the hop, of the cupules of nut and hornbeam. They may be woody and protective, as in the cups of oak, beech, and chestnut; lastly, they may be dry and scarious, as in the *Illecebraceæ*.

4. Bracts and bracteoles may remain almost or quite rudimentary. In this condition their functions have apparently in most cases ceased. At first they probably protected the young flower-bud in its most primitive condition; subsequently, they may become coloured, and so pass under the second category, as the bracts of the bluebell; they may, however, remain almost microscopic in size, and are then most likely functionless, as in many involucres of the *Umbelliferæ*, and as they occur at the bases of the pedicels of many racemes, etc.

5. Bracts are often *spinescent*, as the involucres of thistles, of *Centaurea calcitrapa*, of *Dipsacus*, etc. In this condition they supply a means of defence, not only against browsing animals, but also against "unwelcome guests" who would rob the flower of its sweets without effecting pollenisation.*

6. Bracts may be modified into *ascidiform* structures to secrete honey. In *Marcgravia Nepenthoides*† the pendulous flowers are in umbellate whorls with ascidiform nectariferous bracts suspended below them. These attract insects, which in their turn attract insectivorous birds, which latter by brushing against the flowers thus pollenate them.

7. *Spathaceous*, as of *Aroideæ*, *Palmaceæ*, *Amaryllidaceæ*, etc. These may take on different functions—protective, nourishing, attractive, etc., according to their nature. Thus, they will *protect* the spadix in the undeveloped state; they may then become foliaceous, as in *Arum maculatum*, when they sustain a *nourishing* office; or petaloid, as in *Anthurium*, when they are *attractive*; or, perhaps, in some cases, poisonous, as a *preventive* agency, warding off herbivorous animals.

The next progressive state to a petaloid condition is for bracts to assume a more or less staminoid character. This is, however, rare. The bracts of *Abies excelsa* have been observed to assume the form and characteristics of stamens.‡ A similar substitution of anthers for bracts has been seen in *Melianthus major*, concerning which Signor Licopoli, the observer, remarks that the flowers of (chiefly) the terminal racemes were imperfect, the summit of the floriferous

* 'Flowers and their Unbidden Guests,' Kerner, p. 75.

† See Belt's 'Naturalist in Nicaragua,' p. 129.

‡ For further description see 'Teratology' by Dr. Masters, p. 192.

axis being terminated by a tuft of perfect and imperfect anthers; the petals, and the two carpels of the flower, having been atrophied or arrested.

He notices how the calyx, corolla, pedicels, and receptacles vanish by degrees: the stamens which remain being then enveloped by the concave bract, which takes the place of the calyx. The bracts of different flowers thus approximating each other, assume the form and structure of anthers, always however retaining a part which recalled the foliaceous nature of the bract.*

That bracts should ever assume a pistilloid character is, *a priori*, still more unlikely, as being further removed from the central organ of a flower. Dr. Masters has, however, described† a malformed *Lolium perenne*, in which the flowering glumes had styles and stigmas; the essential organs being absent, but replaced by a tuft of minute scale-like bodies, some of which were prolonged into styliform processes, the sexual organs being otherwise suppressed.

In a proliferous case of *Delphinium elatum*, described and figured by Cramer,‡ the parts of the flowers were metamorphosed into rudimentary carpels. The axis was elongated and terminated above in one case by a similar abortive flower; in another by an umbell of such flowers, every part of which was more or less carpellary; while all the *bracts* on the prolonged axis, even those out of the axis of which the branches of the umbell sprang, were similarly made of open and rudimentary carpels.

III. Axial and Appendicular Structures.

The organs of plants have hitherto been considered as either caulomes or phyllomes; but Homology proceeds a step further and recognises a common origin for both.

That leaves and stems are homologous is a probability that finds support in the following facts.

1. The elements of a leaf are a continuation of those of the stem, only *spread out* so as to acquire a new form in order to sustain a new function. The petiole is very frequently concave above, when the fibro-vascular bundles are mostly *open* or horse-shoe-shaped; but in terete or cylindrical petioles, the circles are *closed* and then there is no appreciable difference between them and a stem. With regard to the blade, though the fibro-vascular bundles are not usually closed cylinders as in stems, yet when leaves acquire a terete form as in *Sedum* and other *Crassulaceæ*, they resemble stems.

2. Leaves can produce buds like stems; (1) normally, as *Bryophyllum calycinum* and many ferns; and (2) abnormally, as in artificial propagation of *Begonia*, etc.

3. Leaves can develope roots as in the above methods of propagation.

* 'Bull. Soc. Bot. Fr.,' tome xiv, p. 253.

† 'Journal of the Linnean Society,' Botany, vol. vii, p. 121.

‡ 'Bildungsabweichungen,' etc., Heft i, taf. 10.

On the other hand, stems often resemble leaves not only in form, but also in constitution and function, as in the following examples:—

(1) Thick, stem-like, but green, and bearing no leaves, *Cactus*, *Euphorbia*.

(2) Foliaceous, but fleshy, *Epiphyllum*, which closely resembles the leaf of *Bryophyllum*.

(3) Acicular, as the "cladodia" of *Asparagus*, which nearly resembles the segments of the leaves of *Ranunculus aquatilis* and fennel, etc.

(4) Flat, and more or less *herbaceous* in texture, the "phyllocladia" of *Ruscus*, *Xylophylla*, and the stems of some leguminous plants.

These plants possessing no true leaves, the assimilative properties are therefore entirely sustained by the stem-structures themselves.

IV. Axial Structures—Reproductive.

Before discussing the homologies and metamorphoses of the floral whorls, the changes undergone by the floral axes need to be alluded to. Commencing with the normal condition, the various departures from it may be classified as follows:—

1. *Normal*, that is exhibiting no special difference in development, appearance, or function from ordinary stem-structures.

2. *Cirrhose*, as in the vine and Virginia creeper, of which Mr. Darwin has described the tendrils as homologous with flowering branches.*

3. *Colorised*, as in *Hyacinthus comosa*, var. *monstrosa*. In this species there is a gradual degeneration of the flowers, the stamens and pistils becoming more and more atrophied, while the perianth dwarfs until the entire flower vanishes altogether, nothing remaining but tufts of coloured pedicels borne by a similarly coloured peduncle with bracts scattered over the surface.† The brilliantly coloured fasciate stem of the garden cockscomb is another instance. Coloured pedicels are far from uncommon.

4. *Hook climbers*. A good illustration is seen in *Uncinia*, in which the peduncle curls into a hook after flowering.

5. *Burrowing apparatus*. This is seen in the rigid sharp-pointed apex of the peduncle of *Trifolium subterraneum*, which buries its fruiting head beneath the soil.

6. *Reservoirs of nutriment* for the fruit and seeds. The receptacles of *Compositæ*, as of the artichoke, the appendix to the spadix of Aroids,‡ the pseudocarp of the strawberry, cashew, and rose, as well as the inferior pome of the tribe *Pomeæ*, of the order *Rosaceæ*.

7. *Attractive*. The coloured inferior berries and pomes of many plants.

8. Abnormal modifications of axial structure occur as fasciated stems; *e.g.* cockscomb; pear-shaped axes of vegetative buds of *Pyrus*; pedicellate flowers of barren orchids, resembling the pedicel (normal) of the ray flowers of *Centaurea*, and the hypertrophy and colorisation of the axes of *Hyacinthus comosa*, var. *monstrosa*, described above.

* 'Climbing Plants,' p. 137.

† 'Bulletins de l'Acad. Royale de Belgique,' tom. xvii, part 2, p. 29.

‡ I have found that of *Arum maculatum* to have its cells laden with starch.

V. Appendicular Structures—Reproductive.

The floral-leaf Region.—That all the parts of a flower may be regarded as "metamorphosed leaves," or at least as homologous with leaves, has long been recognised and adopted by botanists as a fundamental principle of floral structure. The changes often assumed by the various floral organs may be regarded as *retrogressive* or *progressive* respectively. Under the former heading are such metamorphoses whereby the organs affected approximate to a leaf-type, either directly, or are represented, as it were, by a succession of stages.

Thus the pistil may assume a staminal character in some flowers, by bearing anthers or by producing pollen within the ovules. It may be more or less petaloid, or the carpels may be actually replaced by perfect petals, as in "double" flowers; or lastly it may be more or less foliaceous.

Stamens may be similarly petaloid as in double flowers. They may be sepaloid and virescent or foliaceous as well.*

Petals and sepals may both change their normal characters, and become virescent or even converted into true and perfect leaves.

The pistil is normally virescent in most flowers, but becomes foliaceous in the Alpine strawberry, the green rose, the double cherry, and monstrous states of *Trifolium repens*.

The ovules may be more or less leaf-like, as in the above examples and in mignionette, *Cruciferæ*, etc.

The stamens may be virescent as in the green rose, in which they also pass by transitional stages into a more or less truly foliaceous character. In several other plants the change has been observed. In a *Petunia* the stamens were virescent, while the connective only was foliaceous.†

The corolla has often been observed to be virescent or foliaceous. Thus in the green rose, Alpine strawberry, *Petunia* above mentioned, *Primula*, and some *Labiatæ*.

The sepals not unfrequently are foliaceous in the primrose, in *Anemone*, *Ranunculus*, and roses.

Lastly, bracts become foliaceous in plantains, *Primula*, and in the involucres of *Compositæ* and *Umbelliferæ*.

Homologies and Changes of the external Floral Organs. *Calyx.*—Sepals may be *homologous*,—1. with the *petiole* of a leaf, as is obviously the case in the rose, where the leaflets of the blade are represented in a rudimentary condition. In *Pedicularis* the blades appear as a minute fringed apex to the sepals. In *Ranunculus*, *Potentilla*, and probably in the majority of instances, the broad base of the petiole is the only part present.

2. The sepals may be the *blades*, as in *Caltha* and *Eranthis*, where

* *Virescent*, when they are green only, but retain their normal form; *foliaceous*, when the form is changed into that of a leaf as well. See 'Bull. de l'Académie Royale de Belgique,' tome xvii, part 2, pl. p. 131.

† 'Teratology,' p. 254, fig. 134. See also figs. 135 and 136.

the true leaf-blades are also sessile immediately below the flower, and the venation in the yellow sepals is palmate and dichotomous, as in the leaf-blades. In *Helleborus* the venation of the sepals is highly anastomosed but palmate, whereas it is pinnate in the true leaf-blades.*

3. The sepals may be normally foliaceous, and represent perfect leaves, as in *Githago;* similarly are the two inner sepals of *Polygala*, those of *Dipterocarpus*, of *Helleborus niger*, and of *Rumex*, in the fruiting states.

In abnormal *retrogressive* metamorphoses the calyx may become foliaceous. Thus, in *Primula* the *points* of the sepals develope into broad foliar expansions; in the rose they become compound leaves, while in monstrous states of *Trifolium repens* the *points* develope into basal leaf-sheaths, which are prolonged into true petioles bearing ternate leaflets above; while *stipules* may actually appear on the borders of the so-called calyx-tube. They thus reveal the true nature of the tube as being receptacular (caulome) and not calycine (phyllome).

If the calyx be provided with an epicalyx or calicule, as in the *Malvaceæ* and *Potentilleæ*, this appears to consist of stipules; the two *between* any two leaves or sepals being fused into one organ, though often having the apices of the two sepals free, thereby revealing their double origin, as figured by Payer.†

The *normal functions* of sepals may be classified as follows:—

1. *Protective*, as in all buds where a calyx exists. They develope the first of the floral whorls, and are for some time relatively much larger than the remaining parts, which they consequently completely envelope.

2. *Nourishing*, as whenever they are green they have ordinary leaf-functions,—(1) when protecting the immature or floral organs. In this state they probably absorb much of the carbon dioxide given off during the respiration of the stamens in their development. (2) In fruiting states, when the calyx is persistent and green, it in many cases grows considerably after the anthesis is over. The basal lobes of the sepals of *Viola*, the expansions in the sinuses of *Campanula*, and the long lamina to the sepals of *Githago*, etc., would increase the green surface for assimilation. (3) They may store up nutritive matter in a fleshy condition, as in *Elæagnus*, pine-apple, and mulberry.

3. *Attractive*. The sepals are often petaloid and coloured, and

* This difference occurs also in *Dipterocarpus* and *Mussænda*, and simply means that these sepals represent a more primitive type of leaf-blade; for the pinnate venation with a well-developed midrib is a more advanced stage than the palmate. This is well seen in foliage of the pinnately-leaved palms as compared with those with fan-shaped or palmate leaves. In transitional states from a single to a double flower of *Saxifraga decipiens*, described and figured by M. C. Morren in 'Les Bulletins de l'Académie Royale de Belgique,' tome xvii, part 1, p. 415, the newly-formed petals (in the place of stamens), as also the normal petals of the flower, exactly corresponded both in shape and venation with the cotyledons.

† 'Eléments de Botanique,' p. 90, fig. 144.

then assume the attractive functions characteristic of a corolla. Several, such as *Ranunculaceæ*, as well as *Labiatæ*, have coloured calyces; as also *Hydrangea*, *Rhodochiton*, *Calluna*, *Fuchsia*, etc.

4. The sepals may be at first attractive, and subsequently green and assimilative, as in *Helleborus niger*, and *Polygala vulgaris*. Or, conversely, they may be at first nourishing and protecting, as in the *green* buds of *Anemone* and *Caltha*, subsequently attractive when the flower expands; or once more assimilative in fruit, as in the *Polygala* and *Helleborus* just mentioned.

5. *Dispersive*. If they be "winged," as in *Dipterocarpus*, or represented by a "pappus," as in *Compositæ* and *Valerianaceæ*, the fruit is wind-supported; but if provided with barbs, as the fruit of *Bidens*, it may be conveyed by animals.

6. *Honey-collecting*, as the saccate sepals of *Cheiranthus* and *Melianthus*.

7. *Honey-secreting*, as the glandular sepals of *Malpighia*.

8. *Fruit-protecting*, dry and marcescent. This state occurs in *Lychnis* and *Silene*, *Physalis*, etc. It has been noticed that the withered calyx protects the young ovary of the cherry, and those ovaries so protected often escape being frost-bitten.

9. Protecting by spines in warding off unwelcome guests. This may be the use of the spreading spiny sepals of the *Labiatæ*, several calyces together thus forming a sort of barricade, effectively debarring crawling insects from reaching the nectaries.

10. *Attractive* as food, in the fleshy perianth of *Morus*, *Elæagnus*, etc.

11. Rudimentary or obsolete, as in *Asperula*, *Galium*, *Sison*, and other members of the *Umbelliferæ* and *Compositæ*.

Progressive changes in the Calyx.—*Petaloid sepals* are not at all unfrequent. In *Ranunculaceæ* the following genera may be mentioned in addition to those given as normally possessing a coloured calyx:—*Clematis*, *Aconitum*, *Aquilegia*, and *Trollius*.

In *Mussænda*, *Calycophyllum*, *Usteria*, etc., only one or more of the calyx-lobes is normally enlarged and coloured.

Normally-coloured sepals are most frequent in polysepalous genera, though *Fuchsia* and *Rhodochiton* are gamosepalous.

Abnormal colorisation, with or without a metamorphosis of the form of the sepals, is most frequent in gamosepalous flowers, as in hose-in-hose varieties of *Primula*, *Mimulus*, and *Azalea*. The calyx may be petaloid either wholly or in part only. In the former case the nerve remains green the longest.*

In partial colorisation one or more of the calyx-lobes may thus abnormally resemble *Mussænda*, etc., as described in *Syringa persica*† and in *Mimulus quinque-vulnera*.‡ In *Primula officinalis*, var. *Smaragdina*, obtained by excising the corolla and essential organs early, the colouring matter is developed in a remarkable manner upon a more vigorously produced calyx.

* In the colorisation of foliage the nerves are often coloured, while the parenchyma remains green, as in Chilian beet-root.

† 'Linnæa,' t. x, p 738.

‡ C. Morren, 'Bulletins de l'Acad. Royale de Belgique,' t. xix, part 3, p. 85.

Campanula persicæfolia has produced a *white* calyx. A curious instance is recorded by Morren (*l.c.*) of a *Calceolaria* bearing two coherent blossoms; the calyx of one was normal, but two of the four sepals of the other were converted into slipper-like petals of the corolla.

In orchids the partial development of a *labellum* on one or more of the members of the outer (sepaline) whorl is not unfrequent. Mr. J. T. Moggridge has described such a case in *Serapias*.*

Eranthis has been found developing the sepals into tubular processes resembling the nectariferous petals within.

Staminoid sepals are of very rare occurrence. It is recorded that they have occurred in *Philadelphus speciosus* alone.†

Pistilloid sepals. These have been observed in the double flowers of a garden pea, in which there was a five to six-leaved calyx, some of the segments of which were of a carpellary nature, and bore imperfect ovules on their margins, the extremities being drawn out into styles.‡

Progressive changes in the Perianth.—Staminoid perianths, as in the corona of *Narcissus poeticus* and other species, are not of uncommon occurrence.

Pistilloid perianth.— This is not unfrequent in tulips, the change being generally associated with partial virescence.§

Duchartre, in a note upon two monstrosities of the *Crocus*,‖ describes transformations of segments of the perianth into male and female structures.

Progressive Changes in the Corolla.—Staminoid petals. It is a normal occurrence for petals to develope anthers with pollen, in *Atragene* and in the *Nymphæaceæ*, where a perfect gradation may be traced from a normal petal to a true stamen, the gradual development of the anther being correlated with the gradual reduction of the petaloid filaments.

Several instances of petals assuming more or less of staminoid functions have been recorded. In a haricot the wings and keel-petals were converted into stamens.¶ Corollas of *Digitalis* and *Campanula* have borne anthers. In *Saxifraga granulata*, in the potato, and in the shepherd's purse, the petals have been replaced by stamens. Cramer describes how a stamen replaced a petal in the carrot.** Lastly, the *spurs* of the corolla of an *Aquilegia* have borne pollen.

Pistilloid petals are of rare occurrence; still such have occurred in a *Begonia* belonging to Mr. Veitch, where the apex of the petal was green and stigmatiform, the basal part broad, coloured, and ovuliferous.

* 'Journ. Lin. Soc.' Botany, vol. xi, p. 490, pl. 3.
† 'Bull. Soc. Bot. Fr.' 1858, p. 330.
‡ 'Gardeners' Chronicle,' 1866, p. 897; and 'Teratology,' p. 302.
§ 'Teratology,' p. 302.
‖ 'Bull. Soc. Bot. Fr.' 1878, p. 233.
¶ De Candolle, 'Mém. Leg.,' p. 44.
** 'Bildungsabweichungen Pflanz. Fam.,' tab. 8, f. 12.

HOMOLOGY OF THE STAMENS.—That a stamen is homologous with a leaf is obvious from the many cases in which it is transformed into a leaf-like organ, as a petal or true leaf. But whether the filament corresponds to the petiole, and the anther to the blade, is not always determinable. The water-lily shows that a petal, possibly representing the petiole or the lamina, passes into a stamen by a narrowing of the basal part; but in abnormal fuchsias the anther alone may be converted into a blade, from which it might be inferred that in this case the filament was a petiole. In the green rose the anther is often borne on a leaf-blade, which tapers into a petiole below.

Progressive changes in the Andrœcium.—Pistilloid stamens. Under this heading it is proposed to include modifications of stamens which take on more or less perfectly the form if not the functions of the pistil. These metamorphoses are much more frequent than of the perianth into pistilline structures; for that a very close homology exists between the stamens and pistil has been long recognised, as shown by Robert Brown,* De Candolle, and others.

Of the changes undergone by the stamens, Dr. Masters observes that "in some cases the whole of the stamen appears to be changed, while in others it is the filament alone that is altered, the anther being deficient, or rudimentary; while in a third class of cases, the filament is unaffected, and the anther undergoes the change in question." The following examples may be taken to illustrate these changes experienced, respectively :—

The *filament* has been observed to be more or less "ovarian," bearing rudimentary ovules in *Begonia*,† *Primula*,‡ *Papaver*,§ and *Fuchsia*.‖

The *anther* may become ovarian, as is often the case in *Sempervivum*,¶ *Begonia*,† and *Salix*;** while the ovules thus borne by anthers may themselves produce pollen, as in *Rosa arvensis*.†† Such an ovule may be converted into a stigma, as described by Müller in the case of *Begonia*.†

The *anther* may assume a stigmatic form, as in *Papaver*,§ or be *styliform*, as in the bamboo.‡‡

The *connective* assumes a stigmatiform structure in *Begonia* † and *Thalictrum minus*.§§

The complete substitution of carpels for stamens occurs in many plants, as in *Malus apetala*,‖‖ the minor stamens of *Magnolia*, of

* 'Trans. Lin. Soc.,' vol. xii, p. 90.

† 'Bot. Zeit.' 1870, p. 150, taf. ii.; 'Journ. Lin. Soc.' Botany, vol. xi, p. 472, 1871; 'Gardeners' Chron.' 1876, vol. vi, p. 239.

‡ Masters in 'Trans. Lin. Soc.' 2nd. Ser., Botany, vol. i, p. 285; and Henslow in 'Journ. Lin. Soc.,' Bot., vol. xvi, p. 210.

§ 'Teratology,' p. 304. ‖ *l. c.* p. 198. ¶ *l. c.* p. 309.

** 'Ann. Nat. Hist.' 2nd Ser., vol. xviii, p. 254.

†† 'Journal of Botany,' Nov. 1867, p. 318, tab. 72.

‡‡ Gen. Munro, 'Trans. Lin. Soc.,' vol. xxvi, p. 7. §§ 'Terat.,' p. 307.

‖‖ Poiteau et Turpin, 'Arbr. fruit.,' t. xxxvii, referred to by Moquin-Tandon in his 'Tératologie,' p. 220, where other cases are given.

Tulipa Gessneriana,* *Rumex*, etc.; while it is by no means an uncommon occurrence to find male plants of normally diœcious or monœcious character bearing female organs.†

Homology of the Pistil.—That the carpel is a metamorphosed leaf-blade‡ appears obvious from many cases, while its analogy with the proliferous leaf of *Bryophyllum calycinum* shows that the ovules are homologous with buds inserted at the sinuses, in addition to the fact that leaf-buds not unfrequently replace ovules. The stigmas, as Robert Brown long ago pointed out,§ are metamorphosed margins of the leaf, and which usually become confluent at the apex into one stigmatic surface. Hence the presence of two stigmas in a flower mostly indicates two carpels.

Metamorphoses of the Pistil.—Before alluding to *the Retrogressive changes of the Gynœcium*, the substitution of pistilloid and other structures in the place of ovules must be mentioned. Thus a pod may be formed within an ovary, as in wallflowers,‖ or a grape within a grape.¶ Even entire flower-buds may occur, as in *Sinapis*,** and *Primula*, or else a bunch of petals, as is not unfrequently the case in *Cardamine pratensis*. Lastly, more or less perfect foliage-buds not unfrequently represent ovules.

Staminoid pistils.—The development of stamens within the ovary has occurred in *Bæckia diosmæfolia*†† and *Primula Acaulis*;‡‡ while ovules have been replaced by sessile anthers in *Salix*, *Matthiola*,§§ *Prunus*, *Ranunculus auricomus*, and *Pæonia*. In *Chamærops humilis*‖‖ even the placental edge has been *antheroid* with pollen.

Polleniferous ovules have been already alluded to in the case of the dog-rose, in which the anthers bore ovules which contained pollen. But, in *Passiflora cærulea* and *P. palmata*, the ovules were in malformed ovaries, on the edges of which the ovules were carried and "presented various intermediate conditions between anthers and ovules."¶¶

Anthers occupying the place of stigmas appears to have occurred in *Campanula*,*** *Galanthus nivalis*, and double tulips.

In *Ophrys insectifera* the rostellum has been replaced by an anther.†††

In *Colchicum autumnale* two styles were changed into antheriferous filaments.‡‡‡

Double Flowers.—There remains but one change to be considered; namely, the conversion of carpels and stamens into petals.

* De Candolle, 'Organographie Végétale,' vol. i. p. 556 (note).

† See Masters' 'Teratology,' chap. iv. "Heterogamy," also p. 190.

‡ Warming appears to bring all the supposed axial instances of ovules under the carpellary.—'Ann. Sc. Nat.' 6me Ser. t. v, pp. 181-195.

§ 'Miscell. Bot. Works of R. Brown,' vol. i, p. 558.

‖ 'Teratology,' p. 182.

¶ *l. c.* p. 183.

** 'Adansonia' vol. iii, p. 351, pl. xii.

†† 'Teratology, p. 183.

‡‡ 'Bot. Zeit.' 1829, p. 422.

§§ 'Teratology,' p. 299.

‖‖ 'Teratology,' p. 300.

¶¶ *l. c.* 185.

*** *l. c.* p. 300.

††† Seemann's 'Journ. of Bot.,' vol. iv, p. 167, Tab. 47, f. 1.

‡‡‡ Moquin-Tandon, 'Tératologie,' p. 219.

This occurs in "double flowers." Since, however, what are popularly called double flowers may have very different origins, it will be as well to consider them as a separate subject.

It often happens that a flower, though apparently quite as "double" as some other, which may be *entirely* so, is not really like the latter; hence the following varieties may be distinguished and which will explain such differences as occur.

1. Carpels only petaloid. *Anemone nemorosa*, *Viola*, and *Gentiana Amarella*.*

2. Stamens multiplied and more or less petaloid, with the pistil normal or more or less unchanged. *Tacsonia*,† white hyacinth, Chinese primrose.

3. Do. with the pistil foliaceous of two leafy carpels. The double cherry.

4. Do. with the pistil replaced by a tuft of green leaves. The purple hyacinth.

5. Petals multiplied with no change in stamens and pistil. Double stocks.

6. Do. with entire loss of stamens and pistils. Wallflowers, *Ranunculus*, rose, and many of the garden "double flowers."

7. Hose-in-hose forms:—(1.) Calyx and corolla repeated one within the other. *Helianthemum vulgare*. (2.) Calyx petaloid. *Primula*, *Mimulus*, *Azalea*, *Campanula persicifolia*. (3.) A cata-corolla. *Campanula*. (4.) Inner perianth-whorl resembling the outer. *Iris*, *Orchis*.

It must not be supposed that the above cases never vary. It is more than probable that they do. But as far as observations go, they seem to be tolerably true for the different methods given.

The conversion of stamens or carpels to petals may be incompletely effected, so that, just as a distinction between *virescence* and *foliation* may be made, when they become green; so *petaloid* or truly *petaline* may be recognised as corresponding degrees of metamorphosis, as in the following cases.

1. *Connective* only petaloid, e.g. *Primula*, *Fuchsia*, etc.
2. *Filament* ,, (normal) e.g. *Nymphæa*, *Atragene*.
   ,, ,, (abnormal) e.g. *Hibiscus Rosa-sinensis*.

Double composite flowers are due,—(1) to the conversion of the disk pentamerous tubular florets into ligulate trimerous florets, by the suppression of two petals, and all the stamens: while the arms of the style undergo a reduction in size. Or they may be caused (2) by elongation of the tube with the five-toothed border more or less suppressed. This furnishes the 'quilled' form. Or (3) the border may be also abnormally enlarged, hence arise the 'dragon' forms of *Chrysanthemum*.

In the double *Poinsettia*, which is remarkable for its brilliant foliage, the "doubling" merely consists in the increase of the number of coloured leaves obtained in some cultivated varieties.‡

* 'Gardeners' Chronicle,' 1843, p. 628.
† 'Gardeners' Chronicle,' 1875, p. 167.
‡ For further details on double flowers see 'Teratology,' Appendix, p. 491.

ANALOGY.

Having now considered the *Homology* of the different plant-organs, and the various functions each may sustain, we may collect under different heads the functions which various organs possess in common. In other words, such lists will exemplify the data upon which the possibility of *Analogy* of plant-organs exists, irrespective of their origin. Though, we must remember that all those of each group which are (on the one hand) axial or caulomes, as well as (on the other) all organs that are phyllomes, will be, respectively, homologous.

I. Reservoirs of Nutriment.

Caulomes:—

1. Roots, tuberous—*Dahlia*, *Pæonia*.
2. Stems, subterranean—*Tubers*, *Corms*, etc.
   ,, aerial—*Sagus*, *Saccharum*, etc.
   ,, medullary rays—*Exogenous wood*.
   Radicle and root—*Biennial tap-roots*.
3. Branch—*Vitis gongyloides*.
4. General receptacles—*Compositæ*, e.g. *Artichoke*.
5. Floral receptacles—*Fig* and *Rose*.
6. Receptacular tube—*Apple*.
7. Appendix of spadix—*Arum maculatum*.

Phyllomes:—

1. Leaf-scales—*Bulbs*.
2. Leaf-petiole—*Oxalis*, *Aucuba*, etc.
3. Leaf-blade—*Bryophyllum calycinum*.
4. Bracts—*Artichoke*.
5. Calyx—*Mulberry*.
6. Perianth—*Pine-apple*.
7. Corolla—*Bassia*.
8. Pericarp—*Plum*.
9. Testa—*Currant*.
10. Albumen—*Cotyledons* and *radicles*.

II. Assimilative Organs.

All green parts generally possess the power of assimilation, and may be enumerated as follows:—1, (*a*) young stems containing chlorophyll, (*b*) foliaceous stems of *Cactus*, *Euphorbia*, *Ruscus*, etc.; 2, stipules (*Pisum*); 3, petioles, as phyllodes (*Acacia*); 4, blades; 5, green bracts; 6, sepals; 7, carpels and ovules.

III. Reproductive Organs.

Vegetative multiplication may take place on (1) caulomes and (2) phyllomes:—

(1) 1. Roots—*Prunus*, *Aucuba Japonica*, etc.
2 Subterranean stems—*Bulbils*, *tubers*, *corms*, etc.
3. Aerial stems—*Offsets*, *runners*, *aerial bulbs*.
4. ,, branches—*Vitis gongyloides*.

5. Terminal buds—*Utricularia.*
6. Artificial propagation by *cuttings*, etc.

(2) 1. Bulb-scales—*Hyacinthus.*
2. Apex of petiole—*Nymphæa* (sp.).
3. Surface of lamina—*Ferns.*
4. Margin of lamina—*Bryophyllum, Malaxis.*

Reproduction (proper) is by seeds; hence, as the function of bulbs and seeds is the same, they are analogous; and if an ovule be regarded as a metamorphosed bud, they may be regarded as homologous as well.

IV. Methods of Climbing.

Caulomes :—

1. Roots—*Orchids, Ivy, Marcgravia.*
2. Stem-twiners—*Hop, Convolvulus,* etc.
3. Branch-twiners—*Hippocrateria.*
4. Peduncle (tendril)—*Vine and Virginia Creeper.*
5. Peduncle (hook)—*Uncaria.*

Phyllomes :—

1. Petiole—*Clematis, Corydalis claviculata.*
2. Blade (tendril)—*Gloriosa.*
3. Leaflets (tendrils)—*Pea.*
4. Stipules (tendrils)—*Smilax.*
5. Thorns—*Brambles.*
6. Glands—*Nepenthes, Passiflora* (?).

V. Armature or Defensive Organs.

Caulomes :—

1. Axillary branches—*Prunus, Gleditschia.*
2. Peduncles—*Alyssum spinosum, Mesembryanthemum spinosum.*
3. Cladodia—*Ruscus aculeatus.*
4. Pulvinus—*Ribes grossularia.*

Phyllomes :—

1. Leaf-ribs—*Berberis.*
2. Midrib—*Astragalus gummifer*, awns of *grasses*, species of *Euphorbia, Cactus*, etc.
3. Marginal serratures—*Pandanus, Agave, Grasses.*
4. Bracts—*Carduus, Carlina, Centaurea calcitrapa, Dipsacus.*

Cortical and Epidermal :—

Thorns, spinescent processes of palms, *stings*, and floral armature for the purposes of preventing ingress of "unwelcome guests."*

VI. Attractive Organs.

Organs adapted to attract insects or other animals may be classified as follows :—

1. Leaves,—(1) by colour—*Poinsettia ;* (2) by scent—*Labiatæ ;* and (3) by honey—*Sarracenia.*

* See Dr. Kerner's 'Flowers and their Unbidden Guests.'

2. Bracts, when coloured—*Darwinia*, *Salvia*, etc.
3. Peduncles—*Hyacinthus comosa.*
4. Calyx,—(1) by colour—*Caltha*; (2) as food—*Morus.*
5. Corolla, usually attractive by colour.
6. Stamens—*Thalictrum*, *Salix.*
7. Styles—*Iridaceæ.*
8. Disk—*Reseda.*
9. Fruits—*Berries*, etc.
10. Seeds—*Iris*, *Abrus*, *Euonymus*, etc.

VII. Honey-secreting Organs.

1. Stipules—*Bean.*
2. Petiole—*Acacia sphærocephala*, *Prunus*, *Pteris.*
3. Blade,—(1) apex—*Nepenthes*; (2) surface—*Sarracenia.*
4. Bracts—*Marcgravia.*
5. Calyx—*Malpighia.*
6. Corolla—*Aconitum*, *Helleborus*, *Ranunculus.*
7. Perianth—*Lilium.*
8. Stamens—*Viola*, *Penstemon*, *Stellaria.*
9. Pistil—*Arum.*
10. Receptacle,—1 gland—*Prunella*; 2 glands—*Vinca*, *Cheiranthus*; 5 glands—*Geranium*; annular disk (hypogynous) —*Citrus Acer*; (perigynous)—*Rosaceæ*; (epigynous)—*Caprifoliaceæ* and *Umbelliferæ.*

In the foregoing paper I have endeavoured to give as concisely, but as clearly as I could, the facts upon which homology and analogy are based; for I thought such data presented in a tabulated form with references might be more useful to any one studying the subject than if it were treated in a more popular and readable style, but with less of detail. The inference, however, that may be drawn from the natural-history point of view, is, the wonderful adaptability of living matter to change its character in accordance with requirements. The origin of species of both the Animal and Vegetable Kingdoms depends upon this inherent property of protoplasm, though the actual causes which induce this "physical basis of life" to effect Morphological Metamorphoses are still unknown to us.

VI.

NOTES ON BIRDS OBSERVED IN 1879.

By John E. Littleboy.

Read at Watford, 20th January, 1880.

Following the course adopted on a previous occasion,* I propose to notice, in the first place, a few birds that have not been previously reported, and which are consequently additions to our register of Hertfordshire species. They are eight in number.

1.—The Wood-Wren (*Phylloscopus sibilatrix*).—The wood-wren or wood-warbler, as it is frequently called, is probably more abundant than is generally supposed; it is very similar in appearance to others of its genus, and is distinguished with difficulty from the chiff-chaff and willow-warbler. It frequents plantations and woodland districts, appearing to prefer the higher and larger class of trees. It arrives in England about the beginning of May, and was observed by Mr. T. Toovey, near King's Langley, on the 11th of that month.

2.—The Bunting (*Emberiza Miliaria*).—On the 6th of April, when driving along the turnpike road, a little to the north of King's Langley, I noticed a bird which at once attracted my attention. At first sight I thought that it was a yellow-hammer, but I had never before seen one so devoid of colour; its speckled breast quickly convinced me that I was mistaken. I was fortunately able to observe it closely, and had no hesitation in identifying it as a common bunting.

3.—The Red-winged Starling (*Agelæus Phœniceus*).—A specimen of this rare bird was shot last spring near Bovingdon; it is now in the possession of Mr. Norman Evans, Nash Mills. The red-winged starling is of American origin, and when met with in large flocks, as is frequently the case in the United States, it is said to commit serious ravages on the corn crops. It is distinguished from the common starling by a brown or light bronze stripe across its wings and shoulders.

4.—The Green Sandpiper (*Helodromas Ochropus*).—Two of these elegant little waders were shot by Mr. Abel H. Smith during last January, near the River Beane, at Sacombe. They are at present in his collection. Mr. Smith states that they frequented a ditch which runs parallel to the river; that they got exceedingly shy after being once flushed, and flew up to a considerable height, generally flying in a circle, and coming down within 300 or 400 yards of the same place. Green sandpipers are not uncommon in Yorkshire and parts of Norfolk, but all the authorities I have been able to consult concur in considering them to be rare in the Midland Counties. The Rev. C. A. Johns† writes of them as follows: "In habits the green sandpiper differs considerably from most of its

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 143.

† 'British Birds in their Haunts,' p. 427.

congeners, in that it is not given to congregate with others of its kind, and that it resorts to inland waters rather than to the sea. It is seen for the most part in spring and autumn, at which seasons it visits us when on its way to and from the northern countries in which it breeds."

5.—THE WATER-RAIL (*Rallus aquaticus*).—A water-rail frequented the stream at Hunton Bridge for several days during the month of August, and was generally observable on the grass-plot early in the morning. It is a graceful bird, somewhat larger than the dabchick and standing decidedly higher. Its prevailing colour is a light brown, many of its feathers being marked with black, and its breast shading off into a light slate colour.

6.—THE GOLDEN PLOVER (*Charadrius pluvialis*).—Mr. Harold Procter informs me that he observed a flight of golden plovers on the 25th of February, near the Hoo, Great Gaddesden. Mr. R. T. Andrews, of Hertford, reports that a considerable number were seen on November 21st, near the Rye Common. Mr. H. G. Fordham states that several were observed flying over Odsey Grange towards the south-west on February 9th, that on November 15th a large flock was seen at Ashwell North Fields, and that a nearly equal number visited the same place on December 22nd. The golden plover is common in Yorkshire and in parts of Cambridgeshire, but is said to be only an occasional visitant in Herts. It is remarkable that so large a number should have been reported from various parts of the county during the past year. If, as its name (*pluvialis*) would seem to indicate, it evinces a partiality for rainy weather, the occurrence may perhaps be easily accounted for.

7.—THE POCHARD (*Fuligula ferina*).—Three pochards are reported by Mr. Henry Manser as having wintered on the lake at Hoddesdon. I am also informed by Mr. Abel H. Smith that they are fairly plentiful in the neighbourhood of Sacombe. The pochard is abundant in Norfolk; it is a winter visitor, and but rarely builds in this country. It is readily identified by its prevailing grey, varied by exquisite pencillings of a darker shade. It is stated by Meyer that "the female bird usurps the prerogative of choice, and is said to select her own mate."

8.—THE TEAL (*Nettium Crecca*).—Mr. Abel H. Smith reports that teal were plentiful near Sacombe about the beginning of the year. Although not previously reported since our register was commenced, it is probable that these small but beautiful ducks are by no means specially rare in Herts, and I have already reported them as having been shot many years ago at Great Munden.

The mention of the teal completes the enumeration of species new to our register, and raises the number of birds at present recorded to one hundred and eighteen. There is therefore plenty of room for further additions.

I have again recorded a few particulars respecting the periods of arrival in this county of migratory birds, together with sundry ornithological notes kindly forwarded to me from various quarters during the past year. The Society is much indebted for information of this description to Mr. H. G. Fordham, Odsey Grange, Royston; to Mr. Abel H. Smith, Woodhall Park, Sacombe; to Lord Ebury, Moor Park; to the Rev. C. M. Perkins, St. Albans; to Mr. Toovey, King's Langley; and to several others. In order to prevent the too frequent repetition of the same names, I will here state that the reports from Odsey and Ashwell have been furnished by Mr. Fordham; those from Sacombe and Woodhall Park by Mr. Smith; those from Redbourn and St. Albans, when not otherwise specified, by Mr. Perkins; and those from King's Langley by Mr. Toovey.

I have selected the following memoranda as likely to interest our members.

THE NIGHTINGALE (*Daulias Luscinia*).—First heard by Mrs. Fawcett, near Mardale House, Watford, and by Mr. R. B. Croft, at Ware, on the 19th of April; reported at Hertford by Mr. H. C. Heard, on the 22nd, at Odsey Grange on the 24th, at King's Langley on the 26th, and became general throughout the district before the end of April. It was last heard at Odsey Grange on the 23rd of June.

The song of the nightingale was less frequent during the past spring than is ordinarily the case. It was tolerably frequent about the end of April, but for a fortnight after that date, owing probably to ungenial weather, it was but seldom heard, and after again commencing, continued, but with decidedly diminished power, somewhat later than usual.

THE STONECHAT (*Pratincola rubicola*).—A pair of stonechats was seen on the 23rd of March, at Broadway, near Berkhampstead; and on the 11th of December a pair was also observed between Hunton Bridge and King's Langley.

THE MISSEL-THRUSH (*Turdus viscivorus*), THE SONG-THRUSH (*T. musicus*), THE REDWING (*T. iliacus*), THE FIELDFARE (*T. pilaris*).—Thrushes appear to have suffered to an unusual extent through the severity of last winter. There is a marked diminution in their number, and gardens in which it is generally impossible to mature fruit without netting, have this summer enjoyed a comparative immunity from their attacks. During the early part of December, fieldfares and redwings were abundant. Fieldfares are hardy birds, and remain with us, very generally, during the winter months, but I did not see one after the middle of January, 1879. Mr. H. G. Fordham writes as follows: "Odsey Grange, December 13th, 1878.—Early in November fieldfares were extremely abundant in the open fields, now they have almost all gone." And again, under date Jan. 17, 1879: "Fieldfares have entirely left this neighbourhood since Christmas." The mortality among redwings and thrushes has been almost, if not quite, unprecedented; they were observable during January, either dead or dying, by the side of nearly every hedgerow. The redwing did not appear to possess sufficient strength to migrate, like the fieldfare, to more genial climes, and it was a pitiable sight to see such numbers of them indifferent to the approach of observers, and, with drooping wing, absolutely dying of starvation and cold. A few fieldfares are reported to have been seen in sheltered districts during the month of December, 1879, but they are again scarce, and the same remark will equally apply to redwings. Lord Ebury writes as follows: "Moor Park, 15th Dec., 1879.—Redwings and fieldfares are this year conspicuous by their absence."

THE BLACKBIRD (*Turdus Merula*). — Blackbirds suffered very severely from the cold of last winter, but not, I think, to the same extent as the birds last mentioned. I am indebted to a gentleman at St. Albans for the following interesting anecdote:—A pair of blackbirds frequented, during the spring and summer, a garden near the River Ver. One morning the owner of the garden found, to his extreme annoyance, that the cock-bird had been shot, and was lying on one of the paths; he also noticed that the hen was perched upon a neighbouring tree, apparently bemoaning the fate of her mate and watching over him. He took up the bird, and examined it, and finding it lifeless, threw it into the stream. No sooner had he done so than the hen blackbird flew to its rescue, and actually plunged twice into the water in fruitless attempts to recover the body of her companion.

THE CHIFFCHAFF (*Phylloscopus collybita*).—First heard at King's Langley on the 18th of March, at Kimpton on the 14th of April, by the Rev. T. D. Croft, and at Hunton Bridge on the 24th.

THE WILLOW-WREN (*P. Trochilus*).—Several seen at Odsey Grange on the 13th of May.

THE WHITETHROAT (*Sylvia rufa*).—First seen at King's Langley on the 19th of April, and near Hunton Bridge on the 27th.

THE LESSER WHITETHROAT (*S. curruca*).—First seen at King's Langley on the 26th of April, and in the garden, Hunton Bridge, on the 5th of May.

THE BLACKCAP (*S. atricapilla*).—First noticed by Miss Wilson, near Nutfield House, Watford, on the 29th of March, and at King's Langley on the 19th of April.

THE SEDGE-WARBLER (*Calamodus schœnobænus*).—First seen at Hunton Bridge on the 5th of May.

THE COLE-TIT (*Parus ater*), THE GREAT-TIT (*P. major*).—Respecting tits, Mr. Edward Brown, of Luton, writes to me as follows: "Tits will frequently enlarge holes in trees in which they wish to build. For several days last spring I watched a cole-tit continually carrying small pieces of wood out of a hole in a root, all of which it carefully deposited out of sight, no doubt in order to prevent the discovery of its nest." And again: "Tits always exhibit the greatest affection for their eggs. Last summer, on thrusting my hand into a hole in a root, I was greeted by a loud hiss, which I soon found proceeded from a great tit. I wished to see the eggs, and determined to frighten her off, but it was no easy task. After a few minutes she worked herself into a perfect fury, and hissed and snapped her beak at me whenever I tried to disturb her. At last I lifted her off with a stick, and she flew right into my face. When able to examine the eggs, I found that they were six in number, and that they had been laid quite recently. I may add that another egg was deposited on the following day."

THE GREAT GREY SHRIKE (*Lanius excubitor*).—We are indebted to a lady, Miss E. Vicars, of St. Albans, for the mention of one of our rarest birds. When walking, during the month of July last, near Tittenhanger Green, she was fortunate enough to observe a great grey shrike, and was able unhesitatingly to identify it. These birds are extremely scarce in Herts, and only once before has their occurrence been noted in our register.

THE RED-BACKED SHRIKE (*Lanius collurio*).— This bird was tolerably abundant during the summer. It was observed near King's Langley, singing on the top of an ash-tree, on the 2nd of May. On the 14th of May a male bird, in splendid plumage, was seen near Elstree. On the same day another was noticed near Odsey Grange. They are reported, by Miss E. Vicars, as frequent at St. Albans, where they have been observed perched on the telegraph wires by the side of the road.

THE SPOTTED FLYCATCHER (*Muscicapa grisola*).—First seen at Watford, by Mr. Bernard Smith, on the 18th of April; at King's Langley on the 22nd of May; and at Odsey Grange on the 23rd.

THE GREY WAGTAIL (*Motacilla sulphurea*).—The grey wagtail has been tolerably abundant during the past year. It constantly frequented the gardens at Hunton Bridge during the months of September, October, and November, and is reported to have been frequently seen near Redbourn. Lord Ebury informs me that a pair of these birds built in the gardens of the Hon. H. Coke, at Batchworth House, near Moor Park.

THE YELLOW WAGTAIL (*Motacilla Raii*).—This beautiful and most graceful bird has been reported from three different localities. On the 17th of February three birds were observed near Bury Mill End, Hemel Hempstead, by Mr. Wyman; on the 2nd of February it was noticed near Redbourn; and again, on the 24th of May, in the low meadows near King's Langley.

THE HAWFINCH (*Coccothraustes vulgaris*).—During the months of January and February the hawfinch was unusually abundant throughout our county. I first saw it on the 2nd of January, and a pair frequented the garden at Hunton Bridge till about the end of that month. It was also observed on the 2nd of January at Russell Farm by Mr. W. F. M. Copeland; on the 15th of January at Hitchin by Mr. James H. Tuke; and on the 19th at King's Langley. Mr. Abel H. Smith reports that he saw hawfinches on several occasions during the month of January at Woodhall Park; and Mr. Bernard Smith noticed one at Southfield House, Watford, on the 9th of February. Lord Ebury states that he observed hawfinches at Moor Park on the 23rd of January; and that for several days a pair regularly fed, in company with sparrows, chaffinches, and tomtits, on crumbs supplied from the mansion. It would be interesting to ascertain whether the hawfinch will ordinarily accept crumbs as his daily food, or whether the exigencies of a hard winter reduced him to that extremity. The hawfinch is supposed to feed principally on berries—those of the laurel, holly, and hawthorn being mostly preferred—and its generic name, *Coccothraustes*, from *coccos* (a berry), and *thrauo* (to break), would seem to indicate its preference for this description of food. Hawfinches are said to be adepts at stripping and shelling peas, and in gardens which they visit they are found to be even more destructive than the bullfinch. Considering their prevalence during the early portion of the year, it is remarkable that they have not been reported from any part of the county during the present winter. Mr. Solly informs me that he saw three together at Serge Hill on several occasions during August, and again on the 26th of September. A few days later a pair was also observed at the same place, but from that date, as far as I am able to ascertain, they have deserted Hertfordshire. Mr. James H. Tuke, of Hitchin, writes that in a garden near that town, where hawfinches generally abound, not one had been seen during the autumn and winter of 1879.

The Crossbill (*Loxia curvirostra*).—A large flock of these very peculiar birds frequented the Gorhambury woods near St. Albans, in the early part of 1879. They were extremely tame, and were caught with ease by the use of bird-lime. I am informed that two of them were successfully kept in captivity for several months. The tameness of the crossbill appears to be one of its leading characteristics. Mr. Solly informs me that some years ago they were abundant at Serge Hill, and that on that occasion he succeeded in catching them, without the least difficulty, by the use of a noose fastened to the end of a fishing-rod. The crossbill lives principally on seeds contained in fir-cones. The extraordinary formation of its beak is thus referred to by the Rev. C. A. Johns:* "The beak of the crossbill is a perfect implement always at its owner's command, faultless alike in design and execution, and exquisitely adapted to its work, not an easy one, in performing by a single process the office of splitting, opening, and securing the contents of a fir-cone; and he must be a bold man who could venture to suggest an improvement in its mechanism."

The Rook (*Corvus frugilegus*).—Mr. Sydney Humbert reports that rooks commenced building in the Grove Park about the 28th of February. They are reported, by Mr. R. T. Andrews, to have commenced near Hertford on the 1st of March, and at Ware, by Mr. R. B. Croft, on the 8th. At Odsey Grange they commenced work about the 26th of February, and young birds, fully fledged, were observed on the 3rd of May. Respecting the habits of rooks in foggy weather, Mr. H. G. Fordham writes as follows: "December 12th, 1878.—A very foggy day. Rooks belonging to the Odsey Grange rookery roosted here all night. During the winter months they rarely or never roost in their nest-trees; they usually assemble about sunset and fly off to larger woods. It appears, however,

* 'British Birds in their Haunts,' p. 231.

that in foggy weather they cannot find their way, and therefore remain here."

The Carrion-Crow (*Corvus corone*).—Mr. Abel H. Smith reports that a pair of carrion-crows built at the top of a high fir-tree in Woodhall Park. The hen bird was killed and four eggs were found in the nest.

The Hooded Crow (*Corvus Cornix*).—Royston has vindicated its right to claim the hooded or Royston crow as its own. This bird is a winter visitant, and was observed near Odsey Grange for the last time during the season 1878–79 on the 16th of March. A single bird was again seen, probably a very rare occurrence, as late as the 8th of June, and a flock of eight or nine was first observed during the present season on the 26th of October in the same locality. Mr. J. E. Harting, F.L.S., writes* of the hooded crow as follows: "In Scotland it is said to pair habitually with the carrion-crow, and on this account has been regarded by some naturalists as specifically identical with that bird."

The Swallow (*Hirundo rustica*).—First seen at St. Albans on the 6th of April; at King's Langley on the 10th; at Watford, by Mr. Bernard Smith, on the 11th; at Ware, by Mr. R. B. Croft, on the 13th; at Hunton Bridge on the 14th; at Boxmoor on the 17th; at Sacombe in large numbers on the same day; at Hertford, by Mr. R. T. Andrews, on the 19th; at Ashwell on the 24th; at Kimpton, by the Rev. T. D. Croft, on the 25th; and at Nutfield House, by Miss Wilson, on the 3rd of May.

The Martin (*Chelidon urbica*).—First seen at Southfield House, Watford, by Mr. Bernard Smith, on the 6th of April; at King's Langley on the 10th of April; and near Odsey Grange on the 25th of May. It was last seen in that district on the 10th of October; and a pair was observed near St. Andrew's Church, Watford, on the 11th of November. It is probable that these were young birds left behind at the period of general migration through inability to accompany their fellows. It has been remarked more than once in 'The Field' that the number of house-martins has decreased of late years, in consequence of the persistent manner in which their nests are appropriated by sparrows. Mr. T. Toovey has kindly furnished me with some interesting particulars on this subject. He informs me that a martin's nest, built under the eaves of the mill at King's Langley, was, last summer, forcibly taken possession of by a pair of sparrows. He at once shot the cock-bird, hoping to restore the nest to its legitimate owners, but the attempt was completely unsuccessful; the hen immediately paired a second time, and retained possession. This process was again and again repeated, and it was not until six male birds had been shot, that the hen became inconsolable, accepted her condition of widowhood, and abandoned the long-cherished nest.

The Sand-Martin (*Cotyle riparia*).—First seen at King's Langley on 10th of April. The following particulars respecting

* 'Hand-book of British Birds,' p. 31.

the attack of a stoat on a colony of sand-martins have been kindly sent to me by Mr. Alfred Ransom, of Hitchin. "The sides of the chalk-quarries near the Hitchin Station rise to a height of from 60 to 70 feet above the level of the rails, and in some places they are nearly perpendicular. On the top of the chalk is a deposit of clay, gravel, or sand, varying greatly in thickness, and almost every vein of sand is bored and inhabited during the summer by sand-martins. In one part where the cliff is almost upright, and the vein of sand about 14 feet in thickness, there is the largest settlement of these interesting and useful little birds. On several occasions this season, after the young were hatched, the workmen below noticed a great commotion among the old birds, accompanied by cries of alarm and distress. At last they discovered that a stoat, which had made its way down the cliff where it was not quite so steep, having worked a gallery through an angle of the sand, was climbing from hole to hole on the nearly perpendicular face, abstracting and running off with the young birds."

THE GREAT SPOTTED WOODPECKER (*Picus major*).—I am informed by Mr. Solly that a pair of these beautiful birds has been located in the grounds at Serge Hill for several months, and that both birds are seen and heard quite frequently.

THE LESSER SPOTTED WOODPECKER (*Picus minor*).—A specimen of this species was observed by Mr. Harold Proctor, at the Hoo, Great Gaddesden, on the 24th of January.

THE GREEN WOODPECKER (*Gecinus viridis*).—Observed near Elstree, on the 5th of February; at Russell Farm, on the 19th of April; and at Moor Park, by Lord Ebury, on the 16th of April.

THE CUCKOO (*Cuculus canorus*).—First heard at Russell Farm, by Mr. W. F. M. Copeland, on the 16th of April; at St. Albans, on the 18th; at Hunton Bridge, on the 21st; at Ware, on the 22nd, by Mr. R. B. Croft; at Nutfield House, by Miss Wilson, on the 23rd; and near Odsey Grange on the 26th.

Mr. R. D. East informs me that he found a young cuckoo in a hedge-sparrow's nest near Chipperfield; and Mr. Abel H. Smith has forwarded the following very interesting particulars of the manner in which young cuckoos are fed and nourished by their foster-parents. "I saw the other day a curious sight—a young cuckoo being fed by wagtails. I watched them through a glass, and distinctly saw them bring something and put it right into the cuckoo's mouth, both birds sharing the labour; the cuckoo now and then took a short flight, and was followed by the wagtails." I think there can be no doubt that the cuckoo here referred to had been hatched in the nest of the wagtails. It will be remembered that in May, 1876, Dr. Brett reported to this Society* two instances that occurred at Wiggenhall, in which cuckoos selected the nest of the wagtail for purposes of incubation. A similar case was recently reported in the 'Daily News,' and the Rev. F. O. Morris has written to the 'Times' on the same subject. Mr. Morris relates

* 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 136.

an occurrence so extremely similar to that reported by Mr. Smith that I shall venture to give a short extract. "I was looking out of my window one morning when I noticed a bird lying on the grass of the lawn; before long it was up and away out of sight. It soon, however, appeared again, and this time not alone, but accompanied by a water wagtail. It was marvellous to watch the ceaseless attention of the little bird, no *injusta noverca*, to the wants of its great foster-child, so many times larger than itself. It would run and flit about incessantly, each time catching an insect, with its bill full of which it would then fly to the open mouth it had to fill; but it never was filled, and the constant 'psib-psib' of her adopted child was the way in which it said it wanted more."

It appears from the remarkable concurrence of testimony that I have just recorded, that, whenever it is available, the cuckoo selects the nest of the wagtail for the deposition of her eggs at least as frequently as that of any other bird.

THE NIGHT-JAR (*Caprimulgus europæus*).—Respecting these birds, I have received one or two interesting notices. I am informed by Mr. William Hill, jun., of Hitchin, that he found two night-jar's eggs deposited on the bare ground near a wood at High Down, and that the hen bird attempted to divert his attention from her eggs by all kinds of feints. On returning to the spot after a week's absence, he found that one of the eggs was hatched, and that the little chick was covered with a dark grey down. He watched it for several days, but at last failed to find it. About the same time Mr. Hill succeeded in finding, in an adjoining wood, a pair of night-jars with two young birds just hatched, and he states that the parent birds, like the one previously mentioned, attempted to divert his attention from their young by every means within their power. On returning to the spot after a few days, he found that the chicks had been moved eleven yards, and although they did not leave a circuit of about thirty yards, they were never to be found in the same place on two succeeding days. Mr. Hill states that the parent bird brooded over her young during the day, and that her appearance so resembled a piece of lichen-covered wood that two gentlemen to whom he pointed her out could hardly believe, when not more than two or three yards distant from her, that a live bird was before them. He further informs me that the night-jar always lies lengthways along the branch on which it perches, not crossways, as is ordinarily the case, and that he has been able to find it even in the dusk of evening by following its long, soft whistle.

A night-jar is reported to have been observed near Odsey Grange on the 31st of August, and again on the 4th of September.

Miss Selby, of Aldenham, reports the finding of two eggs on the ground, among the scrubbs, at Bricket Wood, on the 20th of last June, and states that no kind of nest appeared to exist. She also informs me that a night-jar was observed sitting on the side of a road near Shenley, and that on being approached the bird flew away, leaving a new-laid egg, deposited on the bare road.

There can, I think, be no doubt as to the correctness of the received belief that the night-jar fails to provide any kind of nest for the accommodation of its young.

THE SWIFT (*Cypselus Apus*).—First seen by Mr. R. D. East, near Hunton Bridge, on the 5th of May, and on the same day at King's Langley; on the 14th near St. Albans; on the 16th near Ashwell; on the 18th near Hemel Hempstead; and on the 19th at Ware, by Mr. R. B. Croft.

THE KINGFISHER (*Alcedo Ispida*).—These beautiful birds have been less plentiful than usual at Hunton Bridge during the year, and it seems probable that the hard winter of 1878–79 must have killed a good many of them. Mr. Abel H. Smith reports having taken a nest with six eggs in the bank of a small water-course running into the Beane. The nest was more than a yard from the entrance of the hole.

THE QUAIL (*Coturnix communis*).—I find, from a newspaper paragraph, that "a bevy of quails are said to have located themselves in the County of Herts." Two quails were observed at Ashwell High Fields on the 24th of June, and a single bird in the same locality on the 31st of July.

THE HERON (*Ardea cinerea*).—Dr. Brett reports that a heron was recently shot in Cassiobury Park, and Lord Ebury writes as follows: "Moor Park, November 26th, 1879.—Three years ago two or three herons made their appearance on my property. They were wonderfully tame, and frequented not only the water in the park, but also the pond within the old pleasure grounds, which, being very shallow, suited their peculiar mode of fishing. This tempted some of the people about to try and catch or destroy them, and I found one half dead in a field. I then sent a notice to my neighbours expressing a hope that they would not injure them, as they did no harm, and one liked to look at them. The next year they did not return, but this year they have again been frequent visitors, and some so late as a fortnight ago. I expect they owe their existence in these parts to the large Ruislip mere, and to the thick reeds and plants on its margin, together with the large woods that encompass it on three sides." A heron is reported to have flown over Odsey Grange on the 5th of September.

THE WOODCOCK (*Scolopax Rusticola*).—It is probable that woodcocks have been more abundant in the county of Herts during the past winter than for many previous years. Several are reported by the Rev. H. R. Peel as having been seen near Abbot's Hill on the 29th of October. Dr. Brett informs me that fourteen were seen in Oxhey Woods about the middle of November. Mr. R. T. Andrews, of Hertford, writes that "seven were shot in one day on the Broxbournebury Estate;" and Mr. H. G. Fordham, that "five were shot on the 13th of November in the north of Bedfordshire." They are said to be unusually numerous in Bricket Wood, and are reported as abundant in several other localities.

THE SNIPE (*Gallinago gallinaria*).—Thirty or forty snipes are reported by Mr. J. King as having been seen about the middle of

November in the meadows near Hamper Mills, and Mr. Barraud noticed a similar number on the 15th of November in the Bushey Meadows.

THE LAPWING OR PEEWIT (*Vanellus cristatus*).—Lapwings are, this year, extremely abundant in all parts of the county.

THE CRESTED GREBE (*Podiceps cristatus*).—A crested grebe is reported by Mr. Manser to have frequented the lake at Hoddesdon during the month of January.

THE WILD DUCK (*Anas Boschas*).—Mr. Abel H. Smith reports that a brood of young ducks was hatched on the river Beane, near Sacombe. When first found the old duck attempted to divert attention from her young by shamming injury, but finding that they were unmolested she returned to them. On the 7th of December a mallard was seen by Mr. W. F. M. Copeland, on the Gade near Russell Farm, and a flock of five was noticed about the same time on the canal near King's Langley. Wild ducks are also reported as numerous on the Gade at Great Gaddesden.

THE TUFTED DUCK (*Fuligula cristata*).—The tufted duck is reported from three different localities. A fine drake frequented the lake at Hoddesdon for several days about the end of January. It is thus described by Mr. Henry Manser: "He is jet black, with distinct panels of pure white, one on each side, a curling crest on the back of the head, rather like that of the peewit, and splendid yellow eyes, almost golden." A female was shot near Sacombe; and Mr. John Evans reports that a pair was seen in the meadows between Nash Mills and King's Langley, the drake being secured by his keeper.

In drawing my notes to a conclusion, I will attempt briefly to summarise what appear to be the distinct ornithological peculiarities of the present year. The extraordinary diminution in the number of small birds may probably be regarded as one of its leading characteristics; I have before alluded to the excessive mortality among the Thrush family, and the same remark is equally applicable to other species. The entire absence, during the winter, of the hawfinch and the ring-ouzel, notwithstanding the abundance of the former at the commencement of the year, is very noticeable. The scarcity of the partridge, the unusual abundance of the woodcock and snipe, and the occurrence of the golden plover in such large numbers and in so many different localities throughout our county, are also prominent features in the year 1879 that it seems desirable to record.

It only remains for me to thank our various correspondents, both ladies and gentlemen, for the information so kindly forwarded, and again to remind our members that the interest of future notes must mainly depend on a continuance of their contributions.

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VERTIGO MOULINSIANA. *Dupuy.*

Magnified

VII.

ON THE OCCURRENCE OF *VERTIGO MOULINSIANA*, DUPUY, IN HERTFORDSHIRE.

By Henry Groves.

Communicated by J. Gwyn Jeffreys, LL.D., F.R.S., President.

Read at Watford, 20th January, 1880.

Plate I.*

Dr. Gwyn Jeffreys has suggested to me that a few remarks upon the occurrence of *Vertigo Moulinsiana* in Hertfordshire would be interesting to the Society.

This rare mollusk is one of the largest of our British species of *Vertigo* (although it is less than an eighth of an inch in length); and it is by far the largest of those which have teeth or plications in the mouth of the shell; it is equalled in size by the toothless species *V. edentula*. *V. Moulinsiana* may be readily distinguished from the allied species *V. pygmæa* by its larger size and much more swollen whorls. It usually occurs in company with *V. antivertigo*, which differs from it in its darker colour, and by having from eight to nine instead of four or five teeth. The name *V. Moulinsiana*, given by the Abbé Dupuy, has been adopted by Dr. Gwyn Jeffreys in his work 'British Conchology.'

Vertigo Moulinsiana is distributed over central, western, and north-western Europe. Dr. Gwyn Jeffreys has recorded its occurrence in Carinthia, Sweden, Denmark, western Germany, the north, west, and south of France, and Switzerland. It was added to our list of English species in 1877, in which year it was collected by my brother and myself in Hampshire. The locality in which we first found it was in a small boggy marsh in the Itchen Valley, near Otterbourne, and within a short distance of Bishopstoke. I next found it in the neighbourhood of Hitchin, in the broad marshy margin of the river which flows through the moorland known as Oughton Head. I afterwards found it near the Essex border of Hertfordshire whilst shell-hunting last autumn in company with Dr. Gwyn Jeffreys and Mr. Rimmer, in a large marsh by the side of the Cambridge line of the Great Eastern Railway, just where it crosses the River Lea, a short distance below Rye House; since then I have found a new locality for it in Hampshire, about a mile from that previously mentioned, and a short distance below Bishopstoke, where it exists in great numbers and comparatively of a large size.

The point which I wish particularly to make clear is the habitat in which this mollusk should be looked for. The localities in which I have found it are very wet marshes, and the swampy margins of rivers and ditches, along with such plants as *Carex paniculata*, *C. paludosa*, *C. riparia*, *Juncus*, *Iris*, *Typha*, *Phragmites*, and other

* From drawings by the author of a specimen of *Vertigo Moulinsiana* found by him near Hitchin. The mark + indicates the natural size.—Ed.

plants which live in very watery places. *Vertigo Moulinsiana* usually occurs in the greatest numbers at some distance up the growing leaves and stems of the plants, while *V. antivertigo*, its companion, seems to prefer the decaying leaves which have fallen into the water, and is found only just above the surface of it. It is rather remarkable that this shell should not have been previously found or noticed in England; and I can only account for it by supposing that most conchologists have been afraid of venturing into these very marshy places, which require tall fishing boots to go into them with impunity; otherwise a good wetting is inevitable. I hope, however, that these remarks will not deter those members of this Society who may be induced to take an interest in conchology from searching similar places in other parts of the county; because I feel certain that this, at present, very rare shell will be found to be much more widely distributed than is generally supposed. It will be seen that the localities which I have mentioned show its existence in the three great divisions of southern and eastern England, viz. the tract of Hampshire which drains into the Channel, the Thames watershed, and the Ouse district; and this is a mollusk whose distribution would necessarily be much influenced by river-systems.

There is one other point suggested by *V. Moulinsiana*, and that is as to the effect of what Darwin has called in-breeding, in reference to which he explains the small size of animals which occur on small islands at a distance from the mainland. I noticed that the specimens of *V. Moulinsiana* which I last found were much larger than those from the locality in which I first discovered it; and I think it possible that this may in some degree be referable to the isolation of the first-mentioned locality, which was a small boggy marsh, with apparently no stream flowing in or out of it, and where a few specimens only could be detected; on the other hand, these specimens were somewhat weather-worn at the apex, which would seem to point to the somewhat exposed position as having some influence on the size of the shells. I think that it is well to call the attention of naturalists to this question; and I think it would be desirable to examine specimens of water-loving animals, which cannot traverse dry tracts, when occurring in small isolated localities. In investigating such questions it is necessary to consider very carefully the physical conditions of the habitat, as, for instance, with regard to a water-loving mollusk, a drier locality, or a great altitude, usually results in smaller specimens. In the case before us the Hampshire marsh is very little above the river-level, and when my brother visited it in the middle of the summer he found no appreciable difference in the amount of water as compared with that at Easter when we first collected the shells.

VIII.

NOTE ON THE PUPATION OF THE STAG-BEETLE.

By Arthur Cottam, F.R.A.S.

Read at Watford, 20th January, 1880.

The stag-beetle (*Lucanus Cervus*) is occasionally found in Hertfordshire (as mentioned in my paper on our British beetles read before the Society recently), but it can hardly be looked upon as an insect that a collector in Hertfordshire only would be sure to come across. In its usual habitats it is, however, an exceedingly common insect, and in Kent, Surrey, Essex, and Suffolk one would be almost certain to find it, probably in some numbers.

The larva feeds on wood, generally in old oak trees, and like most wood-feeders, it usually changes into a pupa in one of its burrows, and there changes into the beetle. From a note in the English edition of the 'Insect World,' by Louis Figuier, it appears that it is known to bury itself in the ground, and there change into a pupa. Many of the larvæ of the Noctuæ amongst the Lepidoptera bury themselves and change into pupas underground, but I am not aware that any wood-feeding larva of a moth changes to a pupa in the earth. It is remarkable that a wood-feeding larva of any kind should have the power of forming a "cocoon" of earth, for it must be necessary that it should have the power of exuding some fluid of which to make a paste of the earth. In its natural condition, changing into a pupa in the wood, no such power would be necessary. Accompanying this paper is a portion of a pupa-case formed of earth by the larva of the stag-beetle. It is very hard, and beautifully smoothed internally.

About a fortnight ago two professional collectors of Lepidoptera were at work in Epping Forest digging for pupas, and in a bank they came upon an enormous pupa-case, in which, when they had broken it, they found a perfect stag-beetle. Further digging produced three others: two of the four contained male, and two female stag-beetles, all in the perfect state, though torpid. I possess one of these pupa-cases, in which a hole has been made sufficiently large to show that within is a perfect male stag-beetle. It would therefore appear that the pupa changes into the perfect insect early in the winter, and that the beetle remains dormant in the pupa-case until its usual time of appearance.

A large number of beetles hybernate in, or near the surface of, the ground, and may sometimes be found during the winter in considerable numbers together in a torpid state, but it is a new fact, so far as I know, that an insect should come to maturity and then remain in the pupa-case for some months before emerging.

These beetles, which have now (at the beginning of January) been found in a perfect state in their pupa-cases, would probably not have been found on the wing till about the end of May or beginning of June, so that for about five months they would have been buried, though perfect and apparently ready to emerge. This may account for the capricious appearance of some insects which in early seasons appear earlier than usual, tempted out by the unusual warmth.

I intend to keep the specimen I have, in (as nearly as I can) its natural condition, and see how long the beetle will be before it works its way out of its case.

Postscript, *October*, 1880. I kept the cocoon in the box in a room in which a fire is never lighted, and one morning at the beginning of May (I did not note the exact date) I heard a scraping in the box that induced me to look into it, and there I found my beetle out of its case. It was very sluggish, and, until I took it into a warm room, hardly moved. The opening in the cocoon, by which it had emerged, was only just large enough to allow the insect to pass through.

IX.

ANNIVERSARY ADDRESS.

By the President, J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., Treas. G.S., Etc.

Delivered at the Annual Meeting, 17th February, 1880, at Watford.

Ladies and Gentlemen,—

The report of the Council for the past year, which has now been read, shows that the Society is in a most flourishing condition, not only as regards the increase of members and the consequent addition to its income, but also in its enlarged publications and the enrolment of new workers in the field of science, especially in local natural history and meteorology. The extension of the area of observation (which was owing to the suggestion of Mr. Croft and the indefatigable exertions of our Secretary, Mr. Hopkinson), so as to comprise the whole instead of part of the county, mainly caused the great improvement in the number and more active co-operation of members, both of which matters are essential to the prosperity of the Society. But we must take care not to be too ambitious, and (to use a common expression) "come to grief" by going beyond our prescribed limits, or by spending more on our publications than we can prudently afford. On the latter rock some of the leading scientific societies in the kingdom have lately struck and narrowly escaped shipwreck or serious damage.

I am afraid I may be charged with preaching and not practising, when I take for the subject of this Anniversary Address an over-bold and rather lengthy theme, viz. the hypothesis which is called the doctrine of "Evolution," considered from a geological point of view.

In approaching this confessedly obscure and very difficult subject, I must premise that I am only a "*homo unius libri*," and that I am far from being master of that one book—Conchology. Nevertheless, the study of recent and fossil shells, to which I have devoted my leisure during more than half a century, has led me to a conclusion different from that which Mr. Darwin and his followers have advocated and adopted with respect to "The origin of species by means of natural selection."

Let us see how our best lexicographer, Dr. Johnson, defined the word "evolution." He derived it from the Latin adjective *evolutus*, and gave five meanings, of which the first is the only one applicable to the present case. It is "the act of unrolling or unfolding," and is exemplified by the following quotation from Boyle, viz. "The spontaneous coagulation of the little saline bodies was preceded by almost innumerable *evolutions*, which were so various, that the little bodies came to obvert to each other those parts by which they might be best fastened together." This quotation is a specimen of the imaginative science of a great philosopher, who lived and flourished in the seventeenth century.

I can well understand another meaning of the word, which signifies the natural process of growth or development; but when it is strained to convey the idea of transmutation, I do not think it is warranted by our present means of information.

The hypothesis does not seem to have been broached by any of the ancient philosophers; not even by Plato. His εἶδος in the Parmenides does not mean the same as our "species," but logically the form of a thing or an idea. I have gone through the wonderfully laborious and erudite work of Lucretius, '*De Natura Rerum*.' His views do not agree with those of modern evolutionists. On the contrary, he said in his second book that the first created things were very numerous, and originally moved in the same way as they then did and would continue to do, and that there had been always the same law of generation and increase; and he thence inferred that the beginnings of all things (*cunctarum exordia rerum*) widely differed and were varied by manifold diversities of shape. One of his notions is extremely suggestive, and occurs also in the second book. It refers to the succession of life, and may be applied to the frequent and therefore short periods of sequence in fossiliferous formations. It is contained in these lines:—

> "*Augescunt aliæ gentes, aliæ minuuntur,*
> *Inque brevi spatio mutantur secla animantum,*
> *Et, quasi cursores, vitai lampada tradunt.*"

I subjoin a literal translation:—

> Some kinds increase, others diminish,
> And in a short time the races of animals are changed,
> And, like runners, hand over the lamps of life.

This last line alludes to the pedestrian contest of the lamp-bearers at the Athenian festivals in honour of Vulcan.

It may be true that Lucretius was not a geologist; but his speculations are as good as any others that are not based on geology.

In 1794 Dr. Erasmus Darwin, the grandfather of our justly celebrated naturalist, Charles Darwin, published his remarkable work, 'Zoonomia; or, the Laws of Organic Life,' and he started the theory which his grandson has so ably developed and expounded. I will give some extracts from his chapter on Generation.

"Every individual tree produces innumerable seeds, and every individual fish innumerable spawn, in such inconceivable abundance as would in a short space of time crowd the earth and ocean with inhabitants." Hence the struggle for existence.

"The idea of the reproduction of animals from a single living filament of their fathers, appears to have been shadowed or allegorized in the curious account in sacred writ of the formation of Eve from a rib of Adam."

"From this account of reproduction, it appears that all animals have a similar origin, viz. from a single living filament; and that the difference of their forms and qualities has arisen only from the different irritabilities and sensibilities, or voluntarities, or associabilities, of this original living filament; and perhaps in some degree from the different forms of the particles of the fluids by which it has been at first stimulated into activity; and that from hence, as Linnæus has conjectured in respect to the vegetable world, it is not impossible but the great variety of species of animals, which now tenant the earth, may have had their origin from the mixture of a few natural orders."

"Considering the great changes naturally produced in animals after their birth, as the butterfly from the caterpillar, the frog from the tadpole, and even in mankind from youth to maturity; the great changes introduced into various animals by artificial or accidental cultivation, as in horses, dogs, cattle, camels, sheep, rabbits, or pigeons; as well as in monstrosities, which are propagated and continued; and the great similarity of structure which obtains in all warm-blooded animals, including man, one is led to conclude that they have been alike produced from a similar living filament."

"From thus meditating on the great similarity of the structure of the warm-blooded animals, and at the same time of the great changes they undergo both before and after their nativity; and by considering in how minute a portion of time many of the changes of animals above described have been produced, would it be too bold to imagine, that in the great length of time since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine that all warm-blooded animals have arisen from one living filament which the Great First Cause endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end."

After treating of cold-blooded animals and plants in the same way, he adds :—

"Shall we then say that the vegetable living filament was originally different from that of each tribe of animals above described? And that the productive living filament of each of those tribes was different originally from the other? Or, as the earth and ocean were probably peopled with vegetable productions long before the existence of animals, and many families of these animals long before other families of them, shall we conjecture that one and the same kind of living filaments is and has been the cause of all organic life?"

Herr Krause has lately published a critical essay on the writings of Erasmus Darwin, and thinks that he ought to be accredited as the real author of the doctrine of evolution in its modern form.

Lamarck's views are better known to naturalists. They culminated in his famous work, 'Philosophie Zoologique,' which was published in 1809. He believed in the successive creation of species, but not in their extinction; and he conjectured (t. ii, pp. 456–462) that by means of direct or spontaneous generation the most simply organised animalcules were originally produced, "et que de ceux-ci sont provenus successivement tous les autres animaux,"—that worms became insects; insects became crustaceans, annelids, and molluscs; molluscs became fishes; fishes became reptiles; reptiles became birds; and ultimately birds were transmuted into aquatic and terrestrial mammals. These strange conceits were always and strenuously opposed by Cuvier, and may now be considered obsolete.

Half a century later (1859) appeared 'The Origin of Species by Means of Natural Selection.' It was the result of long and careful observation, and is written in much more readable English than the work of the author's ancestor. I will now give some extracts, which relate to the subject before us, taken from the last edition of 1878.

Page 409.—After mentioning the absence of strata beneath the Cambrian formation, the author says: "That the geological record is imperfect all will admit; but that it is imperfect to the degree required by our theory, few will be inclined to admit. If we look to long-enough intervals of time, geology plainly declares that species have all changed; and they have changed in the manner required by the theory, for they have changed slowly and in a graduated manner."

Page 417.—The paragraph as to the imperfection of the geological record is too long to quote in its entirety, but it states that "The extinction of species, and of whole groups of species, which has played so conspicuous a part in the history of the organic world, almost inevitably follows from the principle of natural selection; for old forms are supplanted by new and improved forms. Neither single species nor groups of species reappear when the chain of ordinary generation is once broken." The remainder of this paragraph is considerably qualified by the use of such words as "in some degree," and "generally"; and it is therefore not open to any critical comment.

Page 424.—"I believe that animals are descended from at most only four or five progenitors, and plants from an equal or lesser number. Analogy would lead me one step further, namely, to the belief that all animals and plants are descended from some one prototype."

'The Origin of Species' is couched in a most attractive style of scientific and philosophical candour; but I venture to think that the hypothesis advanced or advocated by the author is inconclusive and unsatisfactory.

I may here parenthetically observe that both the Darwins had been to a certain extent anticipated in some of their conclusions. In 1733 Sellius ('Historia naturalis Teredinis seu Xylophagi marini'), a learned lawyer and philosopher of Utrecht, and a Fellow of our Royal Society, disputed the common opinion which was entertained in his time by some neoteric writers that all living beings had descended from original forms or types.

That part of Charles Darwin's work which proposes a *vera causa* for the origin of species by means of what he calls "natural selection" does not seem to have met with general acceptance, even from Professor Huxley, who otherwise approves the doctrine of evolution. It is a very convenient *Deus ex machina* for solving all difficulties. Nor, when he added a subsidiary cause in "sexual selection," is that opinion shared by Mr. Wallace, who was the co-originator of the first-named and principal theory.

What are the facts, so far as geology can teach us, with regard to the origin of species?

Our knowledge of the earliest life-history of the world is entirely derived from the study of the fossilized remains of marine animals. It is unquestionable that the geological, or rather the palæontological, record is imperfect, especially when we consider that more than three-fourths of the earth's surface is covered by the sea, and is therefore inaccessible to us, and also that what we now call the primeval formations, such as the "fundamental gneiss" of Murchison and of the Laurentian rocks, have been subjected, perhaps over and over again, to volcanic or metamorphic action, and have consequently been deprived of all traces of their organic contents. But we can only take the data which our researches have enabled us to procure; and, until we have more complete information, we have no right to endeavour to explain the "*ignotum per ignotius.*" Let us examine the organic contents of those formations which appear to be the oldest in point of time.

Having, as our present basis, the fact that the earliest fossiliferous formation known to us is marine, it is useless to expect to discover in that formation the original horse* or other land mammal. But we do find in it among the marine organisms neither a less variety, nor a lower degree of organisation, than at present exists in the same classes and orders of the animal kingdom.

In the Bohemian fossiliferous formation, called the Primordial Zone by that experienced palæontologist, M. Barrande, and corresponding with our Cambrian rocks, he had found up to 1846 "twenty-six species of trilobites, all of them belonging to new species, and the greater part of them to new genera" (Lyell's 'Elements of Geology'). He spoke of this formation as occupying "le même horizon que les formations fossilifères les plus anciennes de Suède, de Norvége, et des Iles Britanniques." At a later period, 1856, Barrande stated that he had in his collection between 1400 and 1500 species of fossils from the Silurian and Primordial rocks of Bohemia. These consisted of Mollusca, Crustacea, and many other kinds of Invertebrata. Among them cephalopods are the highest or most perfect forms of Mollusca, and allied to fishes. The Cephalopoda, which were provided with external shells, *e.g.* *Nautili* and allied forms, have left scarcely any surviving representatives, although they abounded in the Palæozoic epoch, and comprised a very great number of orders, families, genera, and species.

> "Tis as the gen'ral pulse
> Of life stood still, and Nature made a pause,
> An awful pause! prophetic of the end!"

This, however, was the conception of a poet, not of a palæontologist! The Brachiopods, which constitute an aberrant group of Mollusca, are entitled to even a greater claim of antiquity, being

> . . . . "of ancestry
> Mysteriously remote and high."

Professor King says: "So far as is known, the second and highest

* I am one of those who are not satisfied with the evidence adduced as to the supposed progenitor of the horse, or *Hipparion*. See Professor W. C. Williamson's Lectures on 'The Succession of Life on the Earth,' 1877.

division was the first that made its appearance." Mr. Davidson, who has made the Brachiopoda his special and life-long study, asks: "Why should a number of genera, such as *Lingula*, *Discina*, *Crania*, and *Rhynchonella*, have continued to be represented with the same characters, and often with but small modification in shape, during the entire sequence of geological strata? Why did they not offer modifications or alter during those incalculable ages?" He tells me that the genera and species were immensely more varied and numerous in the older than in subsequent formations. As to Trilobites, an aberrant group of Crustacea, which are now quite extinct, and included numerous sectional divisions, Professor Packard regards them as allied to the strange and anomalous *Limulus* or king-crab; and the late Mr. Salter, in his exhaustive Monograph, published by the Palæontographical Society, says: "They meet us in the earliest formation in which we have any abundant traces of animal life, viz. the *Lingula*-flags. In this their commencement we have some of the smallest and most rudimentary, as well as some of the largest forms."

All these different animals must have been originally accompanied by their food, which consisted partly of the kinds whose hard remains have been preserved, but mainly of other animals of a soft nature and microscopic size, of which no traces exist.

Another illustration, taken from the animal kingdom, has lately occurred to me. The 'Quarterly Journal of the Geological Society' for last year contained a valuable paper by Mr. Jennings Hinde, on Annelid Jaws from the Cambro-Silurian, Silurian, and Devonian formations in Canada, and from the Lower Carboniferous in Scotland, in which these organisms were very numerous. They were classified from their resemblance to existing forms under seven genera, and included fifty-five different species. Here we have number, variety, and correspondence with present life in a group of the marine invertebrate fauna, which has hitherto received scant attention. In fact, as far as we can go back in time, and examine the most ancient fossiliferous strata within our reach, we see the same diversity as now exists, instead of a very few and simple forms. The Annulosa, to which annelids belong, have a considerably advanced degree of organisation.

In the 'Memoirs of the Boston Society of Natural History,' for last year, a well-known entomologist, Mr. Scudder, remarked that apparently "the general type of wing-structure in insects has remained unaltered from the earliest times."

With respect to botany, I would refer my hearers to an admirable essay by Dr. Carruthers, the Keeper of Botany at the

British Museum, in the 'Contemporary Review' for February, 1877, entitled "Evolution and the Vegetable Kingdom." He sums up as follows :—

"The whole evidence supplied by fossil plants is thus opposed to the hypothesis of genetic evolution, and especially the sudden and simultaneous appearance of the most highly organised plants at particular stages of the past history of the globe, and the entire absence among fossil plants of any forms intermediate between existing classes or families."

I will now take leave to repeat my own published opinions on the subject.

In the introduction to my work on 'British Conchology,' I stated (page xxviii), under the head of *Progressive Development*: "The researches of geologists have established by positive evidence, that the organisation of many animal and vegetable types has not become more specialised or been rendered more perfect since the period to which we ascribe their creation, and that, notwithstanding the enormous lapse of time which is indicated by the accumulation of fossiliferous strata, the modification or change which these types have undergone has been remarkably slight. There is abundant evidence of variation, but none of what is usually understood as 'progression.' (See Professor Huxley's Address delivered at the Anniversary Meeting of the Geological Society, 21st February, 1862.) The theory of 'progressive development' appears to have been very hastily advanced, and is by no means borne out by geological facts."

After expressing my agreement with the opinion entertained by Forbes and Hanley, that "the true source of our molluscan fauna was first manifested by the assemblage of Testacea preserved in the deposit called Coralline Crag," and disputing the views of D'Orbigny, Agassiz, and others, that there is no specific identity between any of the Tertiary and recent or existing Mollusca, I said (page lxxxix): "At all events, he must be a bold species-maker who can pretend to distinguish Crag specimens of the common European cowry, and of many other species, from those which now live in the adjacent seas; and their varieties and monstrosities also, both in a fossil and recent state, coincide in the most minute particulars, the only difference being that the latter are glossy and comparatively transparent, while the former are dull and opaque. Even the *Lingula* of the Wenlock Silurians could not be distinguished by Mr. Davidson (who has especially and so thoroughly studied the fossil Brachiopoda) from a living species (*L. anatina*), by any character which he could recognise as constituting a valid specific difference.

"These considerations, however, involve the difficult question of the origin of species; and I will not pursue them further, except by suggesting the very great probability that *all* existing species have descended by modification from primeval forms, but at the same time not admitting the hypothesis of Mr. Darwin that such forms were very few or perhaps unique. In those strata which contain our earliest records of the world's history, as great a diversity of form is exhibited in the groups which we call genera and species as in the existing fauna; and it seems evident that the plan of the Creator, so far as we can comprehend it, has not been that of progressive development."

The above views of mine were published in 1862, not long after the appearance of Mr. Darwin's work; and I have not since seen any reason for changing them.

In 1877, when I had the honour of occupying the presidential chair of the Biological Section of the British Association at Plymouth, I said with respect to a brachiopod from the Chalk and an existing brachiopod, which I considered distinct species: "This question of identity depends, however, on the capability of hereditary persistence which some species possess; and although a certain degree of modification may be caused by an alteration of conditions in the course of incalculable ages, our knowledge is not sufficient to enable us to do more than vaguely speculate, and surely not to take for granted the transmutation of species. We have no proof of anything of the kind. Devolution, or succession, appears to be the law of nature; evolution (in its modern interpretation) may be regarded as the product of human imagination. I am not a believer in the fixity of species, nor in their periodical extinction and replacement by other species. The notorious imperfection of the geological record ought to warn us against such hasty theorisation."

Dr. Wright, in his Address to the Geological Section of the British Association at Bristol, in 1875, remarked that "Palæontology affords no support to the hypothesis which seeks by a system of evolution to derive all the varied forms of organic life from pre-existing organisms of a lower type. As far as I have been able to read the records of the rocks, I confess I have failed to discover any linear series among the vast assemblage of extinct species, which might form a basis and lend reliable biological support to such a theory. Instead of a gradation upwards in certain groups and classes of fossil animals, we find, on the contrary, that their first representatives are not the lowest, but often highly organised types of the class to which they belong." He then gave illustrations, not only from all the primordial fossils of the Palæozoic period,* but also from the fishes of the Old Red Sandstone and the reptiles of the Mesozoic period.

Dr. Wright's experience is confirmed by the well-known authority of Mr. Etheridge, the Palæontologist of the Geological Survey, and now the President of the Geological Society. The late Professor Agassiz and Professor Dana (geologists of undoubted eminence), and Professor Virchow (one of the greatest zoologists of the present day), have also rejected the Darwinian hypothesis.†

One of the latest champions of the new creed is Professor Martins, of Montpellier, who inserted in the 'Revue des deux mondes' for 1877, an interesting article, entitled, "Valeur et concordance des preuves sur lesquelles repose la théorie de l'évolution en histoire naturelle." It is written with that *esprit spirituel* of which an intellectual Frenchman only can boast; but I am not convinced by this author's reasoning. In legal phraseology, I demur to the very first sentence of his essay, viz. "La science n'a pas de prétention à la vérité absolue." Surely truth is, or ought to be, the essence of science. I highly esteem Professor Martins as a kind friend, but not as an exact philosopher.

Any argument founded on hybridism cannot give a sufficient answer to the present inquiry, because the greater number of invertebrate animals, and consequently of all animals, are hermaphrodite *sine congressu*.

If the earliest forms of life, which are known to us, exhibit a degree of variation similar to that which occurs in living animals, or indeed exhibit any variation at all, it seems to dispose of Darwin's inference drawn from the difficulty experienced by naturalists in defining the limits of species and other groups. No individual animal or plant has ever been precisely like another individual of the same species.

The well-established fact of the persistence or continuity of certain species from the primeval to the present time is opposed to the idea of progressive development and of transmutation.

Some of my hearers may naturally expect me to offer some hypothesis instead of that which I have ventured to criticise. I am by no means prepared to do this in the absence of the requisite palæontological data; but I will shortly state the articles of my faith.

* See also Postscript on Progressive Development, p. 96.

† Since the delivery of this Address, several other distinguished and experienced palæontologists have expressed their agreement with the views here set forth. The adaptability to altered conditions of life, and the extent of such adaptability, as well as the improvement or disuse of certain organs, involve a very different principle.

1st.—I believe in the continuous succession of what are known to naturalists as genera and species, with a limited extent of modification, but not in their evolution or transmutation from previous and very different forms.

2nd.—I believe in the extinction of many genera and species from time to time during the world's duration, and that such extinct genera and species have never been reproduced.

3rd.—I believe that the fossiliferous deposit, so very inconsiderable in extent compared with the area of the whole globe, which we consider the most ancient, was not the only fossiliferous deposit which was formed during the same period, but that numerous other deposits containing fossils of various kinds, terrestrial as well as marine, and also vast tracts of land and sea, must have then co-existed in different parts of the world, such co-existing or synchronous deposits and tracts being now inclosed and concealed in the crust of the earth or covered by the ocean. Were those other deposits discoverable, we might probably find the missing links of creation, and possibly the remains of the original man and monkey! The Lower Silurian or Cambrian formation, which is composed of apparently the primary series of fossiliferous deposits, is of enormous thickness. It clearly implies the presence of land elsewhere, because such deposits could only have been made from the wearing away of a continent by the long-continued action of rivers. Assuming that in the primeval epoch the surface of the globe consisted of land and water in the same proportions as at present, or in any approximative proportions, it is improbable that the fossiliferous deposit first mentioned could have been the only one, inasmuch as its fauna (*e.g. Lingula*) is indicative of a shallow sea and the consequent proximity of land. What became of the deeper seas and of the land?

These considerations serve to show our ignorance of the origin of species; nor am I confident that the problem will ever be solved, notwithstanding the prediction of Horace:

> "*Quidquid sub terra est in apricum proferet ætas,*
> *Defodiet condetque nitentia.*"

In English:

> "Whatever is underground time will bring to light;
> It will bury and conceal glittering things."

The latter part of the prediction, however, is more likely to be fulfilled than the former.

Ladies and gentlemen, let me now express my best thanks for your patient attention to this unreasonably long address. I promise that the next address, if I should have to give it, will be much shorter, and I hope less wearisome.

POSTSCRIPT.

Progressive Development.—Some physiologists have lately, on embryological grounds, advocated the doctrine of evolution; but Professor Alexander Agassiz is of a different opinion, and his authority on the subject is undeniably very great. In his admirable and exhaustive Address on "Palæontological and Embryological Development," delivered in August, 1880, at the Boston Meeting of the American Association for the Advancement of Science, he tells us for instance that "the Cidaridæ retain unchanged from the earliest time to the present day" the same peculiar characters—that, "among the fossil Echinoderms of the oldest periods, we have not as yet discovered the earliest type from which we could derive either the star-fishes, ophiurians, sea-urchins, or holothurians"—and that, with respect to the "speculations regarding the origin of certain groups," "we are building in the air." And he adds: "It seems hardly credible that a school which boasts for its very creed a belief in nothing which is not warranted by common sense should descend to such trifling." This is hard hitting!

See also Mr. Lapworth's paper in the 'Annals and Magazine of Natural History,' for April, 1880, on the geological distribution of the Rhabdophora (graptolites), in which he says: "The more complex genera seem to have been the first to appear, ... intermixed with simple forms."

Sir Wyville Thomson, in his lately published 'Report on the scientific results of the Voyage of H.M.S. *Challenger*,' states as one of his general conclusions that "the character of the abyssal fauna refuses to give the least support to the theory which refers the evolution of species to extreme variation guided only by natural selection." It must be remembered that the title of Mr. Darwin's great work is 'The origin of species by means of natural selection,' this being the only cause assigned for the origin of species, or in other words for their derivation by evolution from other and pre-existing species.

X.

NOTES ON SPONGES, RECENT AND FOSSIL.

By Henry Gilbertson.

Read at Hertford, 24th February, 1880.

It may not have occurred to many of my hearers that we at Hertford should have any local interest in sponges. Nevertheless such is the case. All our roads and paths are made of flints, and many of our churches and walls are built of the same kind of stone. All Saints' Church and St. Andrew's Church, at Hertford, and St. Mary's, at Ware, are examples. Now, it will be my endeavour this evening to prove to your satisfaction that most of these flints are fossil sponges or enclose allied forms of animal life. Beyond our local interest in sponges in their fossil state, we have also an interest in them in their recent state. We will, therefore, first glance at them in their recent forms.

There are several species of sponge in use for economical purposes, chiefly obtained from the Mediterranean, and known as Turkey sponge; a common variety is also used which comes from the West India Islands, and is known as Bahama sponge. The trade in sponges is very considerable, and is carried on chiefly by Turks, Greeks, and the inhabitants of the Bahama Islands. The sponges are found at a distance of 1,000 to 2,000 yards out at sea, on banks of rocks formed by molluscous débris. The finest specimens lie at a depth of from twelve to twenty fathoms, those collected in shallower waters being of inferior quality.

Sponges are not fit for economical purposes in the state in which they are taken from the sea, inasmuch as the animal matter which secretes them must be got rid of, and to effect this they are buried for some days in the sand, and are then soaked in water, and washed in some instances by stamping with the feet until all the animal matter is thoroughly got rid of. Thus far we have only spoken of the sponge of commerce. There are, however, many other varieties, and the sponge family has been grouped by naturalists into three orders—namely, the Calcareous or Chalky Sponges, the Siliceous or Flinty Sponges, and the Keratose or Horny Sponges.

These terms bear reference to the *skeleton* of the sponge; for instance, the keratose or horny sponge is the sponge of commerce of which we have been speaking.

Let us now consider what secretes or builds up the skeletons. When any variety of sponge is brought alive from sea- or fresh-water it is found to have a large amount of jelly-like substance, called *sarcode,* surrounding and enveloping the skeleton. Upon examining a small portion of this substance with the microscope, it is found to resemble in many respects that low type of animal life known by the name of *Amœba,* the typical genus of the Amœbina, found both in salt- and fresh-water, frequently among decaying vegetable matter.

The *Amœba* appears under the microscope to be something like a piece of jelly, and if watched for a short time is found to have the power of slow movement; in fact it is a gelatinous contractile body capable of locomotion by expansions of the sarcode or fleshy matter thrown out from any point of the body. These expansions insensibly glide along the surface of glass like a drop of oil, and the enclosed granules of the main body are seen to run into them; thus the whole mass moves from place to place. Should an *Amœba* come in contact with starch granules, naviculæ, vegetable débris, etc., the sarcode opens out at any part and absorbs such substances, and probably, by some form of digestive process, nutrition may be obtained from them. This species, known as *Amœba diffluens*, does not secrete any covering or solid tissue, but other forms of Rhizopoda, or root-footed animalcules, secrete a lorica or case, which may be frequently seen to be tinted orange, yellow, or brown. These cases appear to consist of a material resembling parchment, and have a pitcher-like form, sometimes globular, at other times oblong or spiral, and either smooth or sculptured; sometimes the lorica is covered with grains of sand similar to that of the caddis.

Advancing another step, we find vast numbers of calcareous shells of beautiful forms, both recent and fossil, known as Foraminifera, or shells with numerous openings; they are very various in their forms, and are secreted by the same jelly-like substance as the Amœbina are composed of.

Chalk, with which we in this district are so well acquainted, is found to consist chiefly of these foraminiferous shells or their débris; and when I tell you that the Chalk formation immediately beneath us is about 500 feet thick, as was proved last year by the New River Company in boring for water between Hertford and Ware,* and that it extends from the Isle of Wight to Flamborough Head, with a maximum thickness of about 1500 feet, you may form some slight conception of what we owe to this low form of animal life. Moreover, by deep-sea soundings made for the purpose of finding a bed for the Atlantic cable, and still more recently by the *Challenger* expedition, it has been found that at the present time vast deposits of these shells are being made in every quarter of the globe, so that it has been said that we are still, geologically speaking, in the Cretaceous age.

There is yet another class of shell formed by this jelly-like sarcode, viz. the Polycystina. These shells are built up of silex or flint, and, as in the case of the Foraminifera, they are very various and very beautiful. Like the calcareous Foraminifera, they are found in great abundance both recent and fossil; the well-known bed of Polycystina in the Barbadoes is an instance of them in their fossil state, and recent specimens may be obtained from great depths in most seas, from the Mediterranean to the Sea of Kamschatka.

Thus we have this jelly-like substance, or *sarcode*, known as the *Amœbina*, when it secretes no shell or case; the *Arcellina*, when it

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 245.

secretes a horny case which it covers with grains of sand; the *Foraminifera*, when it secretes a calcareous case; and the *Polycystina*, when it secretes siliceous cases or framework; and this brings us back to sponges, for, as we have already seen, we have the chalky sponge, the flinty sponge, and the horny sponge, and all these varieties of sponges are secreted or built up by a similar form of fleshy matter, called sarcode.*

Sponges obtain their food, and the horny, calcareous, or siliceous matter necessary for the production of their frame-work, or skeleton, by inhaling the surrounding water through pores in the dermal membrane or skin; and exhaling the same through large orifices known as osculæ. During this process of inhalation and exhalation the sarcodous matter of the sponge is supposed to assimilate the food necessary for its growth, in the same manner as do the more simple amœboid animalcules which we have been describing.

It is very difficult to discover the mode by which this inhalation and exhalation of water is effected; but, inasmuch as in a species called *Grantia compressa* ciliary action has been satisfactorily made out, it is inferred that ciliary action takes place in all cases, otherwise it would be very difficult to comprehend how such very strong currents of water could be forced through spongès as is known to be the case.

I have seen a freshly-gathered marine sponge, placed in a shallow dish of water, produce a considerable elevation on the surface of the water by the excurrent stream, the sponge being at a depth of from half to three-quarters of an inch beneath the surface, and notwithstanding the presence of this very powerful action, upon subjecting the sponge to the microscope no cilia could be perceived.

I find that in a paper in 'Science for All,'† Dr. J. Murie states that the cilia in sponges "are not promiscuously dispersed, but are confined to minute, deeply-situated chambers or dilatations of the canals." These chambers are, he says, of very diminutive capacity, and "are encircled with a closely-set series of flask-shaped cells or bladders, sunk in the gelatinous, fleshy substance, a single lash-like cilium protruding from each." I think it is very probable that the reason so many microscopists have failed to observe the cilia is the presumption that they lined the whole of the canals, and thus these ciliary chambers were overlooked. Again, Mr. J. Fullagar, writing in 'Science Gossip,'‡ says that it is impossible to detect cilia in living sponge, but when he examined a portion which was torn off "cilia were plainly shown." He, however, says nothing about ciliary chambers.

There is, however, one stage in the life of sponges in which cilia may be universally observed, viz. in those little buds or gemmules by which the species is propagated. Here we find ciliary action

* The sponge-structure is really built up by a number of very minute individuals which have a close resemblance to some of the simpler flagellate Infusoria; and the Spongida may, perhaps, be most correctly considered to be a class of the Protozoa nearly allied to the Infusoria, but lower, or simpler in organisation.—Ed.

† Vol. i, p. 59. ‡ Vol. xvi, p. 4.

and the cilia themselves well defined, more especially when the gemmule leaves the parent, and swims freely in the water, after a time settling down and producing a new sponge.

Sponges are also propagated by spontaneous division of the sarcode.

Great discussion has taken place in former years as to whether sponges were animals or vegetables, but from the foregoing remarks you will readily understand how it comes to pass that they are now classed among animals, though of a very low type. It may be interesting to note in further confirmation of the theory of the animality of sponges that from chemical analysis the composition of their elastic fibrous skeleton is found to be very similar to that of silk. Lehmann* says that Mulder considers from the researches of Croockwit that the common sponge consists of twenty atoms of fibroin, one atom of iodine, three atoms of sulphur, and five atoms of phosphorus, and that "Its chemical constitution affords one of the arguments why the *Spongia* should be classed amongst animals and not amongst plants, since in the vegetable kingdom we nowhere meet with a substance in the slightest degree resembling fibroin."

Let us now turn to the fossil sponges commonly called flints. There are two sources from which we obtain flints in our neighbourhood, viz. the chalk and the gravels; there is, however, no doubt but that all our flints came originally from the chalk, and that our gravel beds chiefly consist of flints which, having been washed out of the chalk by the action of rivers, glaciers, or the sea, have also by the same agents been more or less broken up and worn down by attrition.

That most of these flints owe their origin to sponges or allied forms of animal life, I gather to a great extent by their outward appearance, in very many instances greatly resembling recent sponges, and also from the fact that if a thin fragment of any flint properly prepared be subjected to microscopic examination, either a foraminifer or the spore of an alga, or some other organism, is sure to be found in a similar manner to that in which such organisms are found in recent sponges.

The flints which I exhibit show in a remarkable manner that they are simply silicified sponges. As has been already stated, sponges have, at a certain stage of their existence, the power of locomotion—viz. at the time the gemmules leave the parent, when, by the action of cilia, they freely swim about until they meet with some obstacle and settle down upon it, or get into some quiet cranny of a rock or some empty shell. Of the latter we have many examples among these flints. Here is a piece of *Inoceramus*, a shell very abundant in the Chalk, about three inches and a half long by two inches wide, with a small flint attached to it, having an oval base, with a diameter of half an inch by a quarter, and a height of half an inch. This small specimen shows one large excurrent orifice

* 'Physiological Chemistry' (Cavendish Society's edition), vol. i, p. 401.

or osculum, and is evidently very young; had it obtained its full development it would probably have entirely inclosed the fragment of *Inoceramus*, as is the case in our next specimen. Here we find that the sponge has grown to greater dimensions, and wherever it has covered the shell we have flint, and there only. In like manner the empty shells of sea-urchins or echinites have afforded favourable resting-places for sponge-gemmules; in some instances the sponge has partly filled the shell, and in others wholly filled it and even crept round the exterior. But, again, wherever the sponge has extended, we have flint, and there only.

In further proof of these echinoderms having been inhabited by sponges which subsequently became fossilized, we may note the rows of depressions or pits found in the flints, which I consider to be due to the fact of the inhalation of water by the living sponge through the ambulacral foramina. We can well understand that when a sponge has completely or to a great extent filled the shell of an echinite, it should make use of these openings for the purpose of inhalation, and that a corresponding depression on the surface of the sponge should be the result. On the contrary, we often find, instead of depressions, small columns of flint filling up these ambulacral pores. In such cases I infer that the sponge has had a sufficient supply of water without making use of the ambulacral foramina, and this supply may frequently be traced to a crack in the shell of the echinus.

Layers of thin flint exist in many chalk-pits, which, having no external appearance of sponges, have been cited by the opponents of the spongeous origin of flints as proving that sponges were not the nuclei of flints; but from the discoveries of Wallich, Carpenter, and others, it appears that a layer of protoplasm or sarcode exists at the bottom of the present ocean, and thus a clue to the formation of these flint-layers becomes apparent, for doubtless the decomposition of this layer of sarcode precipitated the silex of the ocean in the same way that the decomposition of the sarcode of the sponges would do, and thus produced those extensive layers of flat flints to which I have referred.

Mr. Frederic Kitton, of Norwich, writing on the "Spongeous Origin of Flints,"* says that silica under certain conditions is soluble in water to a considerable extent, and that in the earlier epochs of the world, silica might have been present to a larger extent than at this time. "The presence of silica in a state of solution being," he says, "an ascertained fact, there is nothing improbable in the hypothesis that sponges should have formed the nuclei of these flinty concretions. . . . . Another and still more effectual cause of the elimination of silica would be the decomposition of the sarcode and keratode material; as this goes on certain gases are produced, and the silex precipitated from the solution."

A paper on the process of silicification of animals, read before

* 'Trans. Norfolk and Norwich Naturalists' Soc.,' vol. i, p. 57.

the Geologists' Association by Mr. H. M. Johnson, bears upon this point. The author points out how a crop of sponges, invested with their gelatinous flesh, and living at the bottom of a deep ocean, might have been suddenly buried in a thick stratum of white mud, consisting of the minute shells of Foraminifera; that they would then die, and that while in the process of decomposition an interchange of materials might take place—the nascent carbonic-acid parting with its carbon in exchange for the silica of the silicate of soda which sea-water is known to contain. To illustrate the power possessed by decomposing organic matter, Mr. Johnson produced two tadpoles, or rather one and the remainder of a second. The first had been placed in a solution of silica, and after the lapse of a few hours was submitted to the action of nitric acid without any apparent injury. The other, which had not been submitted to the silicifying process before being placed in the nitric acid, was instantly destroyed.

From such observations as these it is inferred that during the decomposition of the sarcode of sponges a similar interchange of carbon and silicon may have taken place in the Cretaceous seas, thus producing those flints which in this neighbourhood are almost the only stones which we find beneath our feet, and which, as I have already mentioned, we use for building, and also as a material for making roads and paths.

I regret very much that at this season of the year the fresh-water sponges of our rivers and ponds are not in such a vigorous condition as to admit of showing the process of inhalation and of exhalation under the microscope, which I have had the pleasure of exhibiting on many occasions since 1855, when I first found a small variety in the moat surrounding Brickendon Bury, the history of which my late friend Dr. Bowerbank has given in his "Further report on the vitality of the Spongiadæ," * wherein he describes at length the opening and closing of the pores in *Spongilla fluviatilis*, and the imbibition and ejection of the surrounding water. "In the performance of these instinctive acts," he says, "*Spongilla* possesses the same degree of control over these actions that I have described in my former report as existing in the marine sponge."

Such a decided statement as this, attributing volition to sponges, is very remarkable, and very likely to be received with scepticism, but it is highly interesting to us, inasmuch as it is founded upon the examination of a living sponge from our own neighbourhood.

* 'Report Brit. Assoc. for 1857,' p. 121.

XI.

THE POST-TERTIARY DEPOSITS OF HERTFORDSHIRE.

By J. Vincent Elsden, B. Sc. (Lond.), F.C.S.

Read at Watford, 16th March, 1880.

Under this title I propose to consider those superficial accumulations of gravels, sand, and clay which cover up nearly the whole of our county.

The systematic mapping and description of these deposits being perhaps the most important geological work our Society can undertake,* it has occurred to me that it would be useful, as a preliminary step, to lay before it some account of the views generally held concerning their age, origin, and general influence.

It will be convenient to divide the subject into three parts, viz.:—(1) General description, (2) Mode of formation, (3) Economic importance.

I. General Description.

The deposits under consideration are usually subdivided as follows:—

Post-Glacial	Sub-aërial. Fluviatile. Marine.
Glacial . .	Upper Glacial. Middle Glacial. Lower Glacial.

It will be endeavoured, as far as possible, to keep to this arrangement, though in ascending order.

Lower Glacial.—There may be seen at Queen Hoo Hall, Bright's Hill Wood, Hertford Heath, Brickendon Green, Bayford, Little Berkhamstead, Essendon, and Hatfield Park, generally capping the Tertiary hills, a pebble-gravel, composed chiefly of flint and quartz pebbles, which has been referred to Pre-glacial times. From its position on the higher ground Professor T. McK. Hughes has called it the Gravel of the Upper Plain.† It is very distinct in its composition from the gravels in the lower grounds, and is presumed to be of marine origin, from its great extent, persistent character, and uniform level. (See Fig. 1.)

Mr. S. V. Wood, jun., is inclined to class these beds with the Middle Glacial, thinking they are not older than the gravels of the Lower Plain, but intermediate between them and the Boulder-clay.‡ Mr. Whitaker suggests the possibility of these gravels

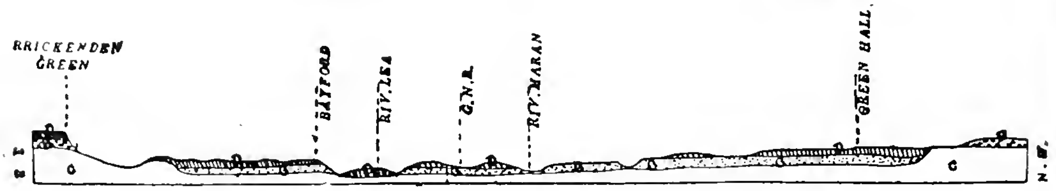
* For suggestions as to a method see "A scheme for the Examination of the Glacial Deposits of the Midland Counties of England," by W. J. Harrison. 'Midland Naturalist,' Sept. 1878.

† 'Quart. Journ. Geol. Soc.,' vol. xxiv, p. 283.

‡ 'Mem. Geol. Survey on Sheet 47,' and Whitaker's 'Guide to the Geology of London,' p. 51.

representing some part of the Lower Glacial drift; but all that is certainly known of them is that they are the oldest drift of our district.* Beyond these gravels of doubtful age there are no other deposits in our county of the Lower Glacial period.

Fig. 1.—*Gravels of the two Plains of Hertfordshire.*

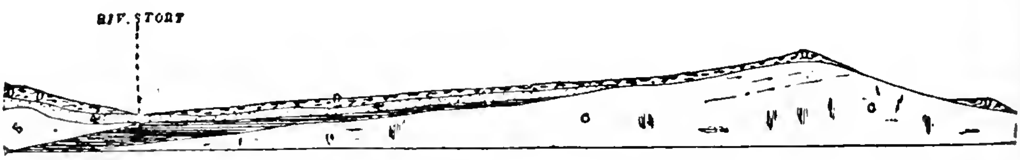


D. Boulder-clay. G. Gravel of the Lower Plain. H. Gravel of the Upper Plain. C. Tertiaries and Chalk.

Middle Glacial.—The beds of this age, called by Prof. Hughes "Gravels of the Lower Plain," vary far more in composition and arrangement than those previously described. They contain very many sub-angular flints, looking broken and weathered, as if derived from an exposed flinty soil. Occasionally flints occur scarcely rolled or broken at all, as if derived directly from the Chalk or Boulder-clay. There is often much false-bedded sand, and about the middle of the deposit there is generally a bed of brown loam and clay, passing sometimes into Boulder-clay, with drifted Oolitic fossils, and rolled and ice-scratched lumps of chalk.† Many of the valleys, running south and east from the chalk escarpment, cut through boulder-clay and expose beneath it these Middle Glacial sands and gravels, which extend probably over nearly all the county between the Chalk and Boulder-clay. But in no instance do they run up to the top of the chalk escarpment or occur on the north-west face of it.‡ While the Boulder-clay extends right over the chalk escarpment, the Mid-Glacial gravels end a few miles lower down. (See Fig. 2.)

Fig. 2.—*Section from the Valley of the Stort, through the Chalk Escarpment, to the Valley of the Cam.*

S N

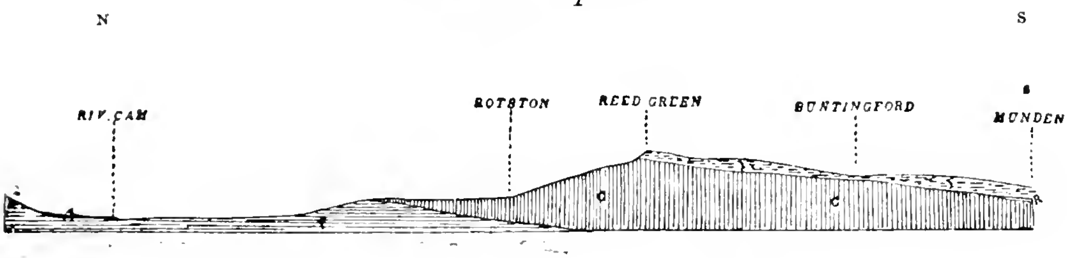


D. Boulder-clay. R. Mid-glacial. E. London Clay. M. Reading Beds. C. Chalk.

* 'Quart. Journ. Geol. Soc.,' vol. xxiv, p. 464.
† *Ib.* p. 285.
‡ 'Mem. Geol. Survey on Sheet 47,' p. 34, and 'Quart. Journ. Geol. Soc.,' vol. xxxii, p. 191.

These deposits are exposed and may be examined in nearly all the valleys south of the chalk escarpment. They may be seen in the railway-cutting north of Hatfield, and in a pit on the hill-side east of Horns Mill. They can be traced all along the hill-side from that place to Hatfield, near Cole Green Station, and south of the Mimram near Tewin. In the road-cutting south of Broad Oak End Farm, and along the west side of the Beane between that place and Hertford, some boulder-clay, with glaciated stones, occurs at the base of the gravels. In the gravel-pits near Ware, some finely laminated brick-earth, belonging to the Mid-glacial series, is seen to be folded and crumpled up and then covered by horizontal beds in the way usually ascribed to ice-action. At Camp's Hill there is also a brick-earth in the Mid-glacial beds, beneath which bones of reindeer, mammoth, and rhinoceros have been found.* Mr. S. V. Wood found at Stevenage, in the brick-earths intercalated in the Middle Glacial formation, several specimens of *Ostrea edulis*, a non-arctic shell.† Messrs. Wood and Harmer have obtained 26 species of Mollusca from this middle division in other parts; but I know of only this one instance of fossils being found in the Mid-glacial of our county. Some of the clays in the midst of the gravels prevent the passage of surface-water to the gravels beneath, which therefore keep their grey colour, the top gravels being stained red.

FIG. 3.—*Section showing the Boulder-clay on the top of the Chalk Escarpment.*



X. Post-glacial. Y. Upper Glacial (Boulder-clay). R. Mid-glacial. C. Chalk.‡ P. Gault.

Upper Glacial.—As will be seen from the sections, there is, overlying the beds previously described, the Boulder-clay, which is a clayey deposit full of pellets or pebbles of chalk, containing also chalk-flints and blocks of various rocks, transported from distant localities and scratched and grooved by ice-action. Fossils, where found, are derived chiefly from the Lias and Oxford Clay. This deposit formed one continuous sheet through which the present valleys have been cut in post-glacial times. It spreads alike over

* 'Quart. Journ. Geol. Soc.,' vol. xxiv, p. 287.

† *Ib.* p. 468, and Woodward's 'Geology of England and Wales,' p. 312.

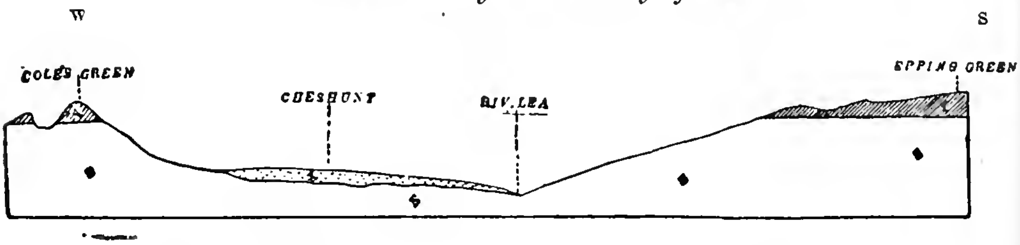
‡ The Chalk here is nearly horizontal, not vertical as might be inferred from the section.—ED.

high and low ground, being found high up on the top of the chalk escarpment (see Fig. 3) and low down nearly at sea-level. Beds of sand and gravel are sometimes interbedded with the clay.* Sections of Boulder-clay may be seen at Haileybury, Little Berkhamstead, Bayford, Buntingford, and at Bricket Wood, near Watford.

Post-Glacial beds—Marine.—Under this head are classed a number of small patches of brick-earth and loamy gravel, occupying slight depressions in the Boulder-clay, and supposed to have resulted from denudation of the Glacial beds during emergence from the sea. They will presently be again referred to as *denudation gravels.* Good examples may be seen in the kiln at Reed and in the brick-yards near Barkway.

Post-Glacial beds—Fluviatile.—We should consider here all those old valley-gravels, terrace-gravels, sands, and brick-earths which owe their origin to existing rivers. (See Fig. 4.) Hertford, Ware, and Rye House stand upon flats formed of these old river-gravels.

FIG. 4.—*Section through the Valley of the Lea.*



X. Post-glacial. Y. Upper Glacial. E. London Clay.

There are likewise the more recent deposits of alluvium, consisting of silt and peaty earth, bordering most of the streams, and occasionally forming large spreads, as at the confluence of the Stort and Lea. It is not always easy to distinguish some of the river-gravels from the Glacial deposits, as they consist of the same material re-arranged. For example, the old gravel-terraces north of Essendon Hill, and in Hatfield Park, south of the house, and the pebble-gravel and brown clay north of St. Albans, are doubtful as to their age and origin.† In these Post-glacial fluviatile deposits land and fresh-water shells sometimes occur, together with the bones and teeth of Mammalia; while occasionally is found here a flint implement, the earliest record of pre-historic man.

Post-Glacial beds—Sub-aërial.—These beds, which have been formed on land in most recent times, include surface soils and vegetable mould. The characters of soils vary chiefly according to contours, and their classification upon any other basis than their origin is impossible.

* 'Memoirs Geol. Survey,' Sheet 47, p. 59.
† 'Quart. Journ. Geol. Soc.,' vol. xxiv, p. 287.

II. Mode of Formation.

*Prof. T. McK. Hughes' views.**—The high ground near Hertford Heath, Brickendon, Bayford, Essendon, and Hatfield Park, north-west of Bramfield, and north of St. Albans, forms part of a great plain, extending as far as the eye can reach. This plain Prof. Hughes considers was formed by the denudation of a sea, which also deposited upon it a pebble-gravel, the Gravel of the Upper Plain. During the emergence of that plain from the sea, a great valley was scooped out of it, the bottom of which forms another plain, upon which stand Bayfordbury, Hertingfordbury, Bengeo, Bramfield, Cole Green, Welwyn, and the lower part of Hatfield Park. Then followed a second submergence beneath the sea; old valley-deposits were re-sorted and Boulder-clay deposited under, in, and on them. On the final emergence from the sea, the smaller valleys of the Rib, Beane, Mimram, and Lea were excavated out of the lower or valley plain. (See Fig. 1.)

Mr. W. H. Penning's views.—In a paper on the Physical Geology of East Anglia during the Glacial Period,† it is maintained by Mr. Penning that during the Lower Glacial period the land was submerged gradually to a depth of not less than 400 feet. During this submergence the advancing shore-line gave rise to the pebbly sands, which form the base of the whole glacial series,‡ and indicate shore conditions and the first setting in of the great glacial subsidence. Arctic conditions of climate then began to prevail, and patches of clay were dropped here and there by icebergs.

By the time of the Middle Glacial period all the land around here was below water except the chalk escarpment in the north of the county, which, as a long narrow ridge, stood well above the sea and formed a barrier opposing itself to the strong current sweeping round from the North Sea to the Atlantic. By this current was brought down the material of the Middle Glacial sands and gravels, derived from the rocks of the north and east coast and from the chalk barrier itself. Icebergs occasionally brought down heavy loads of boulder-clay, which, dropping heavily on the gravels, distorted them and became intercalated with them.§ In the mean time the submergence went on until the lower parts of the chalk escarpment had sunk beneath the sea. Then, the waters having admission to a larger area, the strong current was weakened, and its power of transporting gravels lessened, until at last, as submergence went on, it was entirely lost. Hence the reason why, as was shown before, the Middle Glacial gravels are found running not quite up to the lower levels of the chalk

* 'Quart. Journ. Geol. Soc.,' vol. xxiv, p. 287.

† *Ib.* vol. xxxii, p. 191.

‡ Wood and Harmer, 'Outlines of the Geology of the Upper Tertiaries in East Anglia,' p. 16.

§ This explains the occurrence at Bishop's Stortford of a number of bones of *Pliosaurus*. These were transplanted by icebergs in a large mass of Secondary rock from the north.

escarpment. (See Fig. 2.) Generally speaking the deposits themselves testify to the truth of this theory, for the coarser gravels are found nearest the ridge, where the current would be strongest, and the most distant deposits, as at Hertford, where the current would be weakest, generally take the form of brick-earth.

In the Upper Glacial period the submergence still went on, and the strong current was replaced by a more open sea. The bottom of this sea now became covered with a thick deposit of ice-transported clay, the Boulder-clay, which was brought down from the north on icebergs and dropped in masses over the Middle Glacial beds, capping the highest hills, and occupying the deepest valleys, except where recent denudation has removed it.

At length, in the Post-Glacial period, the land began to rise, and every part in turn, as a receding shore-line, was subjected to the action of the waves. Thus the surface of the Boulder-clay was eroded and reconstructed, causing a clayey loam to accumulate, These *denudation gravels* are often found filling hollows in the Boulder-clay, although most of them have been swept away by subsequent erosion.

Mr. S. V. Wood's views.—In their paper on the Later Tertiary Geology of East Anglia,* Messrs. Wood and Harmer agree with the views just given on the gradual submergence of the land. They find reason, however, to infer that the North of England became at the same time enveloped in a great ice-sheet, which may have been more than 1,000 feet thick. A branch of this gigantic glacier advanced until it reached the borders of Hertfordshire, which by this time had sunk beneath the ocean. The sand and gravel of the Middle Glacial was produced by powerful currents washing out the *moraine profonde* of this glacier, and distributing it over the sea bottom. This would account for the limited extension of these gravels, which could not be deposited over those parts covered by ice.

By the time of the Upper Glacial period the ice began to recede. As recession went on, the moraine matter, no longer washed out and distributed as gravel over the sea-bottom, was left behind as unstratified glacial clay. Some of it was carried off at the bottom of icebergs, as they broke off, and was dropped over the Middle Glacial gravels.

Whichever of the views just given may be the nearest in truth, in each of them the borders of our county formed an important feature in the physical geography of the period, being in one case the termination of a great glacier, in the other case providing a barrier, which caused a strong current in the glacial sea.

Origin of Post-Glacial deposits.—The origin of the denudation gravels has already been explained, and of the fluviatile Post-glacial gravels something has before been given in our 'Transactions.'† It is unnecessary, then, to do more here than recall the fact that they owe their origin to existing rivers, and that their varying level, in connexion with the level of present rivers, has

* 'Quart. Journ. Geol. Soc.,' vol. xxxiii, p. 113. See also vol. xxvi, p. 102.
† 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 198.

led to their classification into Low-level or Valley-gravel and High-level or Terrace-gravel. Whether the High- and Low-level gravels are of the same age, the result of excessive rainfall in what Mr. Tylor calls the Pluvial Period; * or whether the occasional insensible passage from a glacial gravel into a river-gravel in the lower part of a valley points to an older age for some river-gravels, is not in all cases well made out.

It remains now to give a brief account of the origin of the subaërial deposits. That soils have resulted mainly from the disintegration of subjacent rocks is sufficiently well known.† This disintegration is the result of the last denudation of the country, the present wearing action of frost, rain, and rivers, together with the deposits from organic agencies. Perhaps some of this disintegration may have occurred at the time of emergence from the glacial sea, as in the case of the strong loam, which often occurs upon the Boulder-clay in a thin coating. Amongst the causes which contribute to the formation of vegetable mould the common earthworm has played an important part. Mr. C. Darwin has said‡ that probably every particle of earth forming the bed from which the turf in old pasture-land springs has passed through the intestines of worms. Ants, likewise, are very efficient mould-makers in dry soils, and no insignificant part must be played by other animals, which bring to the surface new supplies of mineral matter from below, and, mixing it with vegetable fibre, thus contribute to form a fertile soil.§

III. Economic Importance.

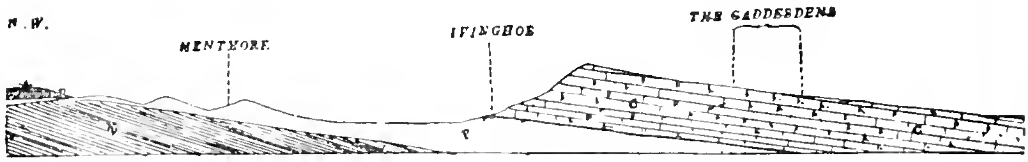
In considering briefly what has been the practical influence of these Post-tertiary deposits, forming as they do in our county an almost complete covering, sometimes of considerable depth, over the older rocks, I shall confine myself to a discussion of that influence upon Land-valuation, Climate, and Public Health.

Influence on Land Valuation. (*a*) *Agricultural Influence.*—A comparison of a geological map of Hertfordshire with an agricultural map will show how independent of the older substratal rocks is the distribution of surface soils. The distribution of those substratal rocks will be shown on the geological map; while the agricultural map ‖ will give a view of the general distribution of soils over the county. If a third map showing the Post-tertiary deposits were examined, it would be seen how very close the agreement is between the distribution of the drift beds and the agricultural soils. Had it not been for the covering of drift, the main portion of our county, being on the Chalk forma-

* Tylor, "Quaternary Gravels," 'Quart. Journ. Geol. Soc.,' vol. xxv, p. 57.
† Morton, 'Nature and Property of Soils.'
‡ 'Humble Creatures,' p. 23.
§ 'Quart. Journ. Science,' April, 1876.
‖ See Map in Young's 'Report to the Board of Agriculture,' and Map in Dean's 'Improvement of Landed Estates.'

tion, would have consisted of bare sheep-pastures and open fields, without trees. Instead of this we find that about 40 per cent. of the total acreage of Hertfordshire is given to corn crops, 12 per cent. to green crops, 6 per cent. to rotation grasses, and 4 per cent. is bare fallow. Out of a percentage of cultivated land of 84·5 the total arable land is 61·5 and permanent pasture 23·0.* Now, within our limited area, differences in climate and contour are not of sufficient importance to have any effect upon the proportion of pasture-land to corn-land, which must therefore be owing to conditions of soil.

Fig. 5.—*Section through the West of Hertfordshire showing the bare Chalk Escarpment.*



X. Post-glacial. R. Mid-glacial. C. Chalk. P. Gault. Z. Oolites.

The influence of the drift covering is well seen in the strip of land from Royston through Baldock and Hitchin, where the chalk comes to the surface. Of this part Mr. Evershed says: "The strip of thin chalk-land, with its wide open fields, and its turnip- and sheep-farming, is so suggestive of Cambridgeshire that the boundary of the counties at Royston may well be passed without being remarked. The natural division is in the hills near Therfield, when you plunge at once into Hertfordshire proper, with its woods, small enclosures, and heavily timbered fences."† Again, in the south-west of the county, the boundary line of the London Clay is everywhere defined by a verge of grass, which terminates with the outcrop of the Chalk. It is the more marked because the drift deposits covering the Chalk are gravelly loams unsuited to pasture.‡ It is not always, however, that the drift furnishes a fertile soil; although it generally affords facilities for improvement by admixture and draining. The richest tract in the county is said to be the valley of the Lea from Hoddesdon to Cheshunt, and the worst land is the district east and south-east of Stevenage and the gravels around Hatfield, North Myms, and Northaw. But even on the most sterile soil the hedges and timber are thrifty, owing to a favourable subsoil.§ The distribution of timber is also to some extent dependent upon the nature of the drift, for where chalk is near the surface beech woods prevail. In a zone south of this, oak

* Topley, "Comparative Agriculture of England and Wales," 'Journ. Roy. Agric. Soc.,' 1871, p. 270.

† 'Journ. Roy. Agric. Soc.,' vol. xxv, p. 271.

‡ *Ib.*, p 283.

§ Trimmer, "Agricultural Geology of England and Wales," 'Journ. Roy. Agric. Soc.,' vol. xii, p. 482; and Evershed, "Agriculture of Hertfordshire," 'Journ. Roy. Agric. Soc.,' vol. xxv, p. 271.

and ash abound. Still further south the elm is common. The elm and oak flourish much better where the Chalk is covered by Tertiaries, but if drift gravel is present we find only larch and fir.*

(*b*) *Mineral Value.*—The economic products obtained from the Post-tertiary beds are not numerous. Some of the sands can be used for mortar, metal-moulding, glass-making, and tempering pottery and brick-clays; while the gravels are useful for footpaths, roadways, filter-beds, and concretes. The clays and brick-earths are manufactured into bricks, tiles, and drain-pipes; the drift flints are calcined for pottery admixtures; and the chalky Boulder-clay was once extensively used for marling fields.

Influence on Climate.—We have seen that it is to the drift that we owe the well-wooded appearance of our county, and thus the drift exerts an indirect influence upon our climate. Trees exert a most important local influence on climate, acting, according to Becquerel,† as frigorific causes in three ways—

(1) By sheltering the ground against solar irradiation.
(2) By the cutaneous transpiration of their leaves.
(3) By the multiplication, by their branches, of radiating surfaces.

Trees also affect the distribution of rainfall, by causing precipitation of moisture when cooling saturated currents of air passing over them. By their roots, also, they have a powerful action on springs, facilitating percolation, and thus draining the surface soil, and removing moisture beyond the reach of evaporation. This insures the permanence and regularity of natural springs in or near woods.‡ But the drift has also a more direct influence upon atmospheric humidity. The Mid-glacial sands and gravels form a natural drainage for superficial soils and thus lessen evaporation and consequent refrigeration, and contribute to the dryness and warmth of the air.§

Sanitary Influence.—Fuller said of Hertfordshire: "It is the Garden of England for delight; men commonly say that such as buy a house in Hertfordshire pay two years' purchase for the aire thereof." This salubrity, says Mr. Clutterbuck, is due to the geological condition of the greater part of the county, gravel upon chalk.‖ That such is the truth is further proved by the labours of Mr. Whitaker and Dr. Buchanan, who found a very marked connexion between wetness of soil and the consumption death-rate, and noticed the great importance of the coverings of permeable drift-gravels upon such impervious soils as the London Clay.¶

Nor must we forget here the importance of the drift in connexion with water-supply. Although as water-bearing strata the

* Clutterbuck, "Agriculture of Hertfordshire," 'Journ. Roy. Agric. Soc.,' vol. xxv, p. 314.

† 'Des climats et de l'influence qu'exercent les sols boisés et non-boisés.'

‡ Boussingault, "Economie Rurale," 'Zeitschrift des Oest. Ingenier und Architekten Vereins,' 1875, pp 157-165.

§ 'Quart. Journ. Science,' Jan. 1871.

‖ 'Journ. Roy. Agric Soc.,' vol. xxv, p. 303.

¶ 'Geol. Mag.,' Nov. 1869.

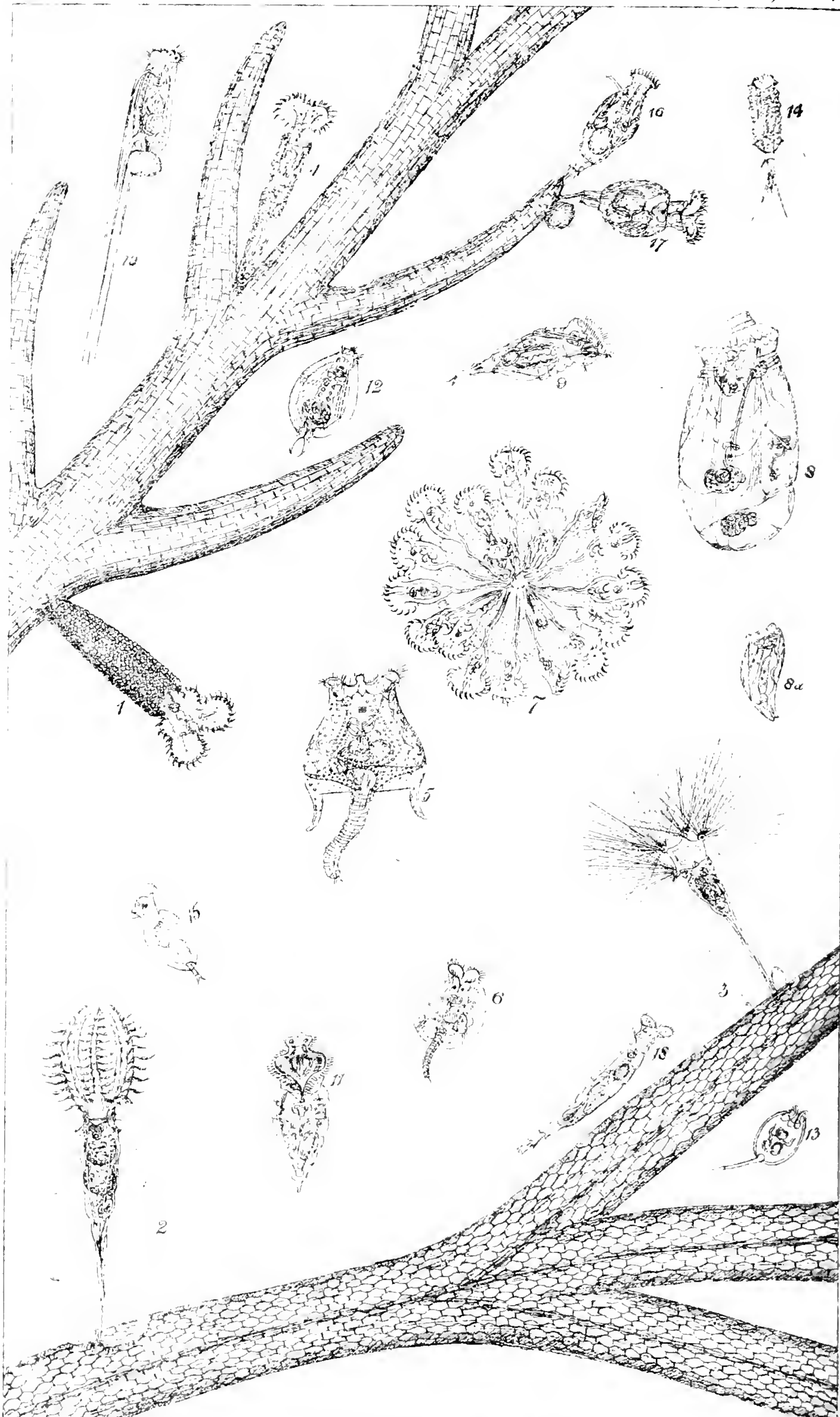
drift gravels seem insignificant in comparison with the great Chalk water-system, yet it would appear that even the water in the chalk is to some extent influenced by overlying deposits. Not only does the quality seem to be affected in a remarkable way, but the amount of percolation into the chalk is also largely influenced by extensive coverings of impervious boulder-clay, and permeable sands and gravels. Concerning the influence on quality, analyses show that water from chalk covered by clay contains less calcic carbonate and more soda-salts than from chalk not so covered.* As to its influence on quantity, while beds of sand and gravel absorb the rainfall and remove it from the influence of evaporation, the impervious clays throw off the water into the natural drainage-channels. Some idea of the amount thus thrown off, including what issues from springs, may be got from the fact that, with an annual rainfall of about 26 inches, the total discharge of waters from the Lea, Beane, Rib, and Mimram at Hertford is estimated at 6159 cubic feet per minute.† Turning now to the middle sands and gravels as water-bearing strata in themselves, we cannot but be struck with their influence on the distribution of population. Mr. Prestwich has pointed out that the site of ancient London coincided with the beds of gravel resting on London Clay, and many of the suburban villages were grouped around a spring of water or a bed of gravel whence water could be got by shallow wells.‡

In conclusion, I have only to express a hope that, although much must necessarily have been omitted, yet enough has been said to give some idea of the interest which attaches itself to those deposits which, under the name of drift, are so often dismissed from further consideration.

* 'Proc. Inst. Civ. Eng.,' vol. xlvii, pt. 1.

† *Ib.*, vol. xiv, p. 42.

‡ "Anniversary Address, Geol. Soc., Lond. 1872," 'Quart. Journ. Geol. Soc.,' vol. xxviii, p. liii.



F. W. Phillips, del.

Rotifera.

XII.

OBSERVATIONS ON ROTIFERS, WITH SPECIAL REFERENCE TO THOSE FOUND IN THE NEIGHBOURHOOD OF HERTFORD.

By F. W. Phillips.

Read at Hertford, 23rd March, 1880.

Plate II.

A Rotifer may be briefly described as an animalcule, having one or more lobes at the anterior extremity of the body, which bear upon their edge a row of long, vibratile cilia, which, when in motion, appear, by an optical illusion, like revolving cog-wheels, and from these most striking and peculiar organs the class derives its name, *Rotifera*, or wheel-animalcules.

Of all the classes of animalcules, the Rotifera, or rotifers as they are more commonly called, have ever excited the greatest interest and wonder in the minds of both learned and unlearned. Much discussion has arisen at various times as to what place they should occupy in the animal kingdom; their affinities being divided between the classes Crustacea and Annelida, but perhaps the greater part of their characteristics leans towards the worm side of the question.

They are very small, the maximum size which they attain being about $\frac{1}{30}$th of an inch, and some of them are as small as $\frac{1}{400}$th of an inch. Yet the majority may be easily distinguished by the aid of a pocket lens, sometimes sailing through the water with an easy rolling motion, like a small boat upon the waves, sometimes quietly browsing amongst the green threads of the Algæ, or else attached by the tail to a piece of weed.

For the sake of convenience we will divide the rotifers into two groups, viz. those which attach themselves by the foot to a weed and live in a case or tube, and those which habitually swim freely through the water; this latter division comprising by far the larger number.

The number of species is, however, so great, that in giving an anatomical sketch, we must confine ourselves to one rotifer belonging to the latter class, which we will take as a type of the others, viz. *Rotifer vulgaris*. First of all I must call your attention to the so-called "wheels," which consist of two disc-like lobes or projections furnished all round the margins with long cilia, which move in such rapid and well-timed succession as to appear like revolving wheels; and so perfect is this illusion that you cannot but feel how appropriate is their name. The cause of this illusion is that the forward stroke of each cilium is so quick that it cannot be perceived, while the backward stroke is much slower, and therefore perceptible. Other opinions on the subject have been given by Dujardin, Dutrochet, and Ehrenberg; but I am inclined to accept the theory of Faraday which I have given you, because I have repeatedly observed this motion with a high power and by the aid of a compressorium. But we will leave this, and all other disputed points, for the consideration of specialists. This wheel-like motion does not exist in all rotifers, for the movement of the cilia is often confined to short quivering vibrations. When the creature is at rest, or is alarmed, it withdraws its head and tucks its wheel into its body, and then assumes a spindle shape; its movements are now very much like those of a leech, groping about in all directions: but after a time the head issues forth again and the wheels resume their action.

Few things are more strikingly beautiful than this ciliated wreath in full activity. Sometimes it is used as a locomotive organ, propelling the creature rapidly through the water; and when the rotifer moors itself to a piece of weed, it is used as a feeding organ, making a vortex in the surrounding water, and thus causing all particles to rush into its mouth. The food, which is thus drawn in, passes down an alimentary canal into the gizzard. This canal has unfortunately received a variety of names: œsophagus, pharynx, vestibule, infundibulum, and buccal funnel; but we will select the word "pharynx," as being the most suitable. The pharynx terminates at, and partially embraces, the masticating apparatus, or "mastax" as it is called, which consists of a muscular bulb, containing a pair of organs called "mallei," from their resemblance to hammers working on an anvil. Each malleus is divided into two parts, the "manubrium" and the "uncus"; these are articulated together by a hinge-joint, and are placed nearly at right angles to each other; the former, as its name implies, serves the purpose of a handle, and the latter grinds and crushes the food. This is done by several finger-like processes at the extremity of the unci, which are placed parallel to each other, something like the teeth of a comb; the food then, after passing down the pharynx, is received by the unci, which reduce it to atomic particles. The motion of these jaws, which, owing to the extreme transparency of the creature, may be clearly seen, is so regular and constant that they cannot fail to impress the observer with a sense of mechanical power, and, as some writer has observed, "one might easily imagine that the sound of the jaws could be heard." The refuse of matter which is thus digested passes down an intestinal canal, and is voided by a very distinct anal orifice. In one genus (*Asplanchna*) this is wanting, and the effete matter is ejected through the mouth. Just below the wheels are two bright red spots, which are now admitted by most naturalists to be the eyes. In some species their colour changes to a violet or black as the creature grows older. The eyes vary in number from one to eight, sometimes they are entirely wanting and sometimes very prominent.

Mr. Bedwell, referring to *Rhinops vitrea*, says: "The eyes, when seen on a black ground, are simply diabolical, they glare at you like two railway lamps sailing about." Just beside the eyes may be seen a mass of matter which is supposed to be nervous, and the analogue of a brain, but observers are very much divided in opinion with regard to these nervous ganglia, some denying their existence altogether. Some time ago Sir John Lubbock contrived to tame a wasp, and that wicked 'Punch,' commenting upon the subject, recommended him to try his hand upon a *Rotifer* or a *Vibrio*. This has always seemed to me to be a simply magnificent extravagance. Until lately I was extremely sceptical as to the presence of nerves, yet, when watching a *Hydatina* the other day, I noticed that it made a succession of darts in different directions, and in each case it secured a particle of food, in a manner that conveyed the idea that the action was the result of predetermination.

Projecting from the back of the neck may be seen a tubular organ, armed at the tip with minute bristles; this was thought by Ehrenberg and Siebold to be a siphon for the admission of water for the purpose of respiration, but subsequent research has made this theory untenable, and it is now admitted by all to represent the antennæ of more highly organized creatures. There is no heart or special circulating apparatus, but in place of this exists what is called a "water-vascular system," which consists of two long flexuous tubes, one on each side, to which are attached several vesicles, which, by their undulatory and flickering motion, keep up a constant circulation in these aquiferous tubes.

Another very important organ is the articulated tail-like foot or pseudopodium. This is capable of great elongation and contraction, sometimes on the sliding principle of the telescope (e.g. *Philodina*), and sometimes by contracting in wrinkles (e.g. *Brachionus*). At the extremity there are usually two or three spines, which in the different species vary very much in length. When they are two in number, they look like a pair of scissors; when there are three, the middle spine is short. This organ is used as a means of attachment, and it is able to take firm hold of the most slippery substances, glass for instance. This tail is also used as a rudder to steer with when the rotifer is in the act of swimming.

The body is protected externally by an integument which is sometimes flexible and sometimes hard; in the former case it is shaped like a vase, pitcher, shield, or spindle; whereas in the latter it is of a hard horny consistence, and strongly resembles the shell of a tortoise; in this case it is termed the lorica, and is shaped triangularly, or like a boat, and not unfrequently it is armed with spines, or decorated with various markings.

With regard to reproduction, comparatively little is known. It was asserted by Prof. Ehrenberg that the Rotifera were hermaphrodite, and for a long time this was accepted as a fact; but during the last few years much has been done to elucidate matters. Distinct sexes have been discovered in several genera by Mr. Gosse, Mr. Brightwell, and Dr. Hudson. The male differs so completely from the female in organization, size, and appearance, that it is frequently supposed to belong to a different species. On two or three occasions I have met with rotifers which I had supposed to be undescribed, but subsequent investigations have convinced me that they were males, and I have regretted that I did not give more time to tracing their career. Those who advocate "Women's Rights" may perhaps be gratified to learn that the male is undoubtedly the inferior sex. It is a curious fact that the males are always smaller than the females, and that the digestive apparatus is entirely absent; they are consequently short-lived, generally dying within a few hours after their birth. The female produces two kinds of eggs. The summer eggs, which are quickly hatched, and the winter eggs, which are preserved against the cold by a peculiar shell until they are hatched in the following spring. It is remarkable that each batch of eggs are either all female, or all male, the latter being about one-third the size of the former. The Rotifera illustrate the theory of Parthenogenesis. The rapidity with which they multiply and develope is truly wonderful. The *Hydatina*, for instance, lays about four eggs a day; the eggs are extruded within a few hours from the time in which the rudiments are first visible within the ovary, and within twelve hours after this the shell bursts and the young rotifers come forth. These young ones, when two days old, lay a like number of eggs. Professor Ehrenberg calculated that sixteen millions may be produced within twelve days from one single female; there is, however, an error in his calculations; it should be nearly seventeen millions within twenty-four days.

An account of the Rotifera would be incomplete if I were to omit to mention one remarkable fact in connection with them, and that is their power of revivification after being dried up. They may be exposed to the heat of a broiling sun, or placed in the exhausted receiver of an air-pump, heated gradually up to 200° Fahr., and reduced to such a state of brittleness that they break when touched with a needle, yet, when moistened, they will speedily revive. Taking advantage of this property, microscopists sometimes keep by them stocks of desiccated rotifers. According to Mr. Slack, the Rotifera, when drying, give off a slimy secretion that forms an impervious casing which prevents them from being *entirely* dried up. When they are heated too much or too suddenly, they lose their vitality. Taking these facts into consideration, it is not so difficult to account for their sudden appearance in unexpected places. We can readily comprehend how they are borne upon the wind and scattered broadcast upon the meadows, the ditches, and the housetops.

The Rotifera are easily procured; there is scarcely a ditch, pond, or puddle in which some members of this family may not be found; indeed they are not entirely confined to fresh water, some few species being found in the sea.

Rotifer vulgaris has often been found in the cells of bog-moss (*Sphagnum*), and *Albertia vermicularis* is found parasitic within the intestines of earthworms and slugs. The habitat, however, in which they may be looked for with most success is in accumulations of standing water which are tolerably free from decomposing matter. About a year ago one of the best ponds in the neighbourhood was completely spoilt by the introduction of a dead cat. The fastidious rotifers refused to associate with it, and rapidly disappeared, leaving the cat to the care of the *Paramecia* and *Monadinæ*.

In the early days of my microscopical studies I tried unsuccessfully to induce the growth of rotifers in infusions of decomposing matter; but the only animalcules which rewarded my labours were the *Paramecia* and a few sickly Vorticellidæ. My want of success was certainly not due to want of perseverance, for I filled a quantity of gallipots and glasses with all sorts of vegetable matter; but the odour which arose from them was adjudged by several members of the household to be decidedly offensive, and I was requested to transfer the scene of my labours to the outbuildings. I thought it rather hard at the time that such obstacles should be placed in the way of experimental science; but subsequent reflection has caused me to think that perhaps the protest was not entirely without foundation.

Having thus given you some idea of what the Rotifera are like, I will proceed to describe some of the species found in the neighbourhood, giving the localities from which they have been obtained. We will take them in the order of "thecated" and "free" rotifers.*

1. Foremost in the first group stands our celebrated friend *Melicerta ringens*, or "the building rotifer," which is remarkable for its architectural habits. It inhabits an urceolus, or sheath, of a conical form, composed of brownish-red pellets which the creature secretes and deposits. I have never seen it build, but will give you the substance of an elaborate paper written by Mr. Gosse ('Trans. Micros. Soc.' 1851). Beneath the ciliary wreath there is seen a special rotating organ of a cup-like figure, which causes a vortex and draws all particles into its cavity, where they are whirled round and round and formed into pellets of a lenticular figure, which the animalcule deposits by bending over towards the margin of its sheath, to which they adhere by a viscid secretion, which in time grows hard; the first few rings are formed round the middle of the body, and then pushed downwards towards the weed which the creature adheres to; each pellet takes about three minutes and a half to make and deposit. Mr. Gilbertson tells me that this operation extended to five in a specimen he observed. The young *Melicerta*, after it escapes from the egg, swims freely about for a time; but after having sown its wild oats, it comes to the conclusion that "there's no place like home," and forthwith attaches itself to a weed, builds a tube, and then, like a sober matron, spends the remainder of its days in tranquillity. The male never builds a tube, but spends the whole of his brief existence in making morning calls at the different tubes in his vicinity. I have

* The numbers prefixed to the following paragraphs refer to the figures on Plate II, all of which are highly magnified.

obtained *Melicerta ringens* from ponds in Balls Park, Mangrove Lane, and Hoddesdon.

2. The next species, *Stephanoceros Eichornii*, has been deservedly called the "beautiful rotifer." It lives in a hyaline sheath of extreme delicacy; its "crown of glory," as Mr. Slack calls it, consists of five splendid tapering tentacles, furnished all along their edge with delicate tufts of long cilia. These do not exhibit the regular rhythmical vibration of most rotifers, but only an occasional twitching, whipping action. Found at Hoddesdon.

3. *Floscularia ornata*, remarkable for the extreme length of its cilia; being well known, it needs no description. Like the *Stephanoceros*, it needs considerable skill in illuminating to show the cilia in their full length and beauty. Localities: Mangrove Lane, Ware Meads, Hertford Heath, and Hoddesdon.

4. *Œcistes crystallinus* has a simple rotatory wreath of extreme beauty, and inhabits a crystalline tube, but this is soon rendered opaque by the flocculent matter which adheres to its viscid surface. The genus is limited to two species, but I believe it is only half worked out. I hope to show you a living specimen to-night which differs considerably from the illustrations given in Pritchard's 'Infusoria,' and Slack's 'Marvels of Pond Life.' Found in abundance in Mangrove Lane pond.

5. This is a species of *Brachionus* which I believe to be either a variety or an undescribed species. The *Brachioni* are all free swimmers; they are inclosed in a hard horny lorica, armed at its anterior extremity with six or eight spines, and sometimes with two at the posterior extremity; they have a great, red, square eye, and a gizzard and stomach of aldermanic proportions; they generally carry their eggs (from one to four in number) attached posteriorly. The species in my illustration was found last June at Hertford Heath, occurring in such vast numbers as to render the water turbid. It most resembles *B. Bakeri*, but differs in the arrangement of the granules, and the position and shape of the spines. I do not say that these points are of sufficient value to constitute a specific difference, but nevertheless, I think them worthy of notice.

6. *Pterodina patina*, a relation of *Brachionus*. It is characterized by having a shield-shaped lorica, which being flexible can be wrinkled and folded together at the will of the animal; it is very lively, and when swimming about has very much the appearance of an animated soup-plate. Localities: Hertford Heath and Broxbourne.

7. *Conochilus volvox*, a magnificent object consisting of a colony of rotifers aggregated together in a gelatinous sphere, which revolves like the *Volvox;* when the creature is alarmed, it retreats within its sphere. Pritchard describes the colony as consisting of from ten to forty animalcules, but I caught a specimen in August at Hertford Heath which measured $\frac{1}{8}$th inch in diameter and contained seventy-three individuals.

8. *Asplanchna priodonta*, another very handsome rotifer of large

size; it is very transparent, and the whole of the muscles and internal arrangements can easily be seen. The stomach is hemispherical; it has three eyes, and is destitute of foot, intestine, and anus, the excrementitious matter being discharged through the mouth. This genus was the first in which the male (fig. 8*a.*) was discovered. It is hardly ¼th the size of the female. Locality: Hertford Heath.

9, 10, 11. *Hydatina senta*, *Triarthra longiseta*, and *Rhinops vitrea*, all members of the large family Hydatinæ. They are all voracious feeders, devouring the *Euglena* and Protophytes of all kinds at a fearful rate; their habits are extremely restless; and if you want to examine them, you must exercise considerable patience or gentle persuasion in the shape of a squeeze in the live-cage; this must be done with great nicety, or a rupture of the integument is the consequence. Localities: Hertford Heath and Hoddesdon.

12, 13, 14, and 15. Members of the family Euchlanidota; their names are *Euchlanis triquetra*, *Monostyla quadridentata*, *Dinocharis tetractis*, and *Stephanops lamellaris*,—little creatures, with very long names. In *Stephanops* the lorica is extended into a beautiful hood or diadem, and in *Dinocharis* it is elegantly marked with delicate granules. *Monostyla*, as the name implies, has but one styliform tail, but it moves so constantly backwards and forwards as to create an optical illusion, and appear double. All these species I have found in the ponds in Hertford Heath.

16 and 17. A species of *Philodina* I found in great abundance in one of my aquaria in 1878. I am unable to name it.

18. *Rotifer vulgaris*. This species, which is of common occurrence, I have already described as a typical representative of its class.

Perhaps a few words on the collection and maintenance of the Rotifera may be of interest to our members.

The apparatus that is required for their collection is very simple, consisting only of a walking-stick, a few wide-mouthed bottles, and a piece of fine muslin. Choose a bright sunshiny day, and on arriving at a pond walk to the windward side and take dippings from the surface, the middle, and the bottom of the water, and strain these dippings through the muslin, which will retain all but very minute animalcules. After this has been done several times, the strainer should be well rinsed in one of the bottles, and a little piece of weed out of the pond should be placed in the bottle. It is a good plan to take a handful of weed and squeeze the water from it into the bottle, a greater variety being obtained by this means. Never mix the water from one pond with that from another, as a desperate fight might result.

I would most strongly recommend those who wish to make a study of the Rotifera to keep by them two or three aquaria. The square cases are the best, but an inverted bell-glass will make a very good substitute. It is advisable to keep one in a dark corner of a room, another in a stronger light, and another out of doors. All should have a plate of glass laid over the top to exclude the dust, which soon accumulates and is very difficult to get rid of. They should have for soil one inch of river-mud covered with half an inch of sand. It is best to plant only such plants as have fine leaves, as *Myriophyllum*, for this renders easy the examination of those species which attach themselves to leaves permanently or temporarily. A small quantity of the starwort, *Lemna minor* and *L. trisulca*, may float on the surface, and a few stalks of hay should be placed in the water to favour the growth of monads, which form the principal food of the Rotifera.

The greatest enemies of an infusorial aquarium are the Entomostraca (especially the genus *Cyclops*), which should be carefully eliminated; but this is sometimes a difficult task owing to their great activity and the rapidity with which they multiply. I always keep a few minnows which I turn in when Entomostraca gain ground, and take out again when their numbers are thinned. Care should also be taken to remove all snails, as when browsing on the Confervæ they are apt to disturb the eggs which are frequently deposited thereon.

The tube-bearing rotifers thrive best in a shady position, whereas most of the free-swimmers love light, and *Conochilus* (the most delicate of all rotifers) may be kept for a long while if exposed to the open air in a place where it receives plenty of light without coming under the influence of direct sunlight.

Many species of Rotifera, besides those I have mentioned, have come under my observation, but I have been unable to make sketches of them, and I fear also that I have already trespassed too much upon your time and patience; but I should like to draw your attention to two localities peculiarly productive. The first is the marsh land at the back of the College Arms at Hertford Heath; this is extremely rich in Desmidieæ, Diatoms, Protophytes, and all light-loving animalcules. The other is a pond in the "Woodlands," Hoddesdon (rich in Polyzoa and all thecated Rotifera), from which I have at various times received collections of Infusoria through the kindness of Miss Warner; and it is to her courtesy that I am indebted this evening for many of the living specimens shown under the microscopes.

In conclusion, I would urge upon all our members who study pond-life to make systematic notes of all species found, recording the localities from which they are obtained, and the dates of capture. I see no reason why we should not have the same accurate records of the microscopic fauna as we have of the geology and botany of the county. We are fairly strong in microscopical observers, the field is new, and it offers attractions of the most fascinating kind.

XIII.

METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, DURING THE YEAR 1879.

By John Hopkinson, F.L.S., F.M.S., etc., Hon. Sec.

Read at Watford, 20th April, 1880.

No alteration having been made since the previous year in the method of observation, and the instruments used being the same as before, it will suffice to give in this report the following brief summary of the fuller information previously given:*—

Longitude of station, 0° 23′ 40″ W.; Latitude, 51° 39′ 45″ N. Ground-level at thermometer-stand and rain-gauge 223 feet, and cistern of barometer 233½ feet, above Ordnance Datum.

Barometer, a "Fortin." Thermometers, dry-bulb, wet-bulb, "Negretti" maximum, and "Rutherford" minimum, 4 feet above the ground in a "Stevenson" screen, over grass. Rain-gauge, "Snowdon" pattern, 5 inches in diameter, rim 1 foot above the ground. Wind-vane, about 25 feet above the ground, 4 feet above ridge of roof of stable, and 105 feet distant from nearest object of equal height.

Observations taken at 9 a.m. Reading of minimum thermometer entered to same day, of maximum thermometer and rain-gauge to previous day. Readings corrected for index-errors of instruments, and readings of barometer reduced to 32° and sea-level.

The accompanying tables (pp. 122, 123) give the monthly means of the daily observations, and of other results deduced from them. They scarcely require any explanation. The "adopted mean temperature" is the mean of the readings of the dry-bulb (9 a.m.), the maximum, and the minimum thermometer. It will be found, as in the previous year, to differ but slightly from either the 9 a.m. or the mean of the maximum and minimum in any month. For the year the adopted mean is only 0°·3 lower than the 9 a.m. temperature, and only 0°·1 higher than the mean of the maximum and minimum. The column headed dryness gives the difference between the temperature of the air and the dew-point temperature at 9 a.m.; and that headed relative humidity, the per-centage of aqueous vapour in the air to its complete saturation. With a relative humidity of about 70 per cent. the air will feel very dry, and when it is from 95 to 100 very damp.

From these tables the following summary of the principal results for the different seasons is deduced, the means for December, 1878, being taken from the previous report. December to February are here considered as Winter months; March to May, as Spring; June to August, as Summer; and September to November, as Autumn.

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 217, and Vol. II, p. 209.

Results of Meteorological Observations taken at Wansford House, Watford, in 1879.

Months.	Pressure of Atmosphere.	Tension of Vapour.	Temperature of the Air.										Dryness.	Relative Humidity.
			9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.						
				Min.	Max.			Min.	Date.	Max.	Date.			
	ins.	in.	°	°	°	°	°	°		°			°	%
January	30·041	·145	31·3	26·3	34·2	30·6	7·9	15·3	12th	47·0	1st		4·7	82
February	29·545	·191	36·8	33·8	41·8	37·5	8·0	20·5	24th	52·3	9th		3·4	87
March	30·003	·203	39·1	32·8	47·6	39·8	14·8	25·2	2nd	62·8	19th		4·2	85
April	29·715	·228	42·6	35·3	50·2	42·7	14·9	26·4	12th	59·7	26th		4·7	83
May	30·033	·258	48·4	39·2	55·4	47·7	16·2	30·4	3rd	65·3	21st		7·3	76
June	29·824	·385	57·9	49·1	63·7	56·9	14·6	38·2	4th	70·4	14th		6·1	80
July	29·802	·406	58·5	50·6	65·1	58·1	14·5	45·0	10th	76·9	29th		5·3	83
August	29·866	·439	61·2	53·5	67·5	61·2	12·5	44·1	10th	76·3	13th		5·8	81
September....	29·998	·374	56·3	46·0	62·4	54·9	16·4	36·3	1st	69·4	6th		5·3	82
October	30·147	·303	48·5	42·5	54·7	48·6	12·2	32·0	17th	63·2	6th		3·2	89
November	30·233	·194	37·4	32·2	43·1	37·6	10·9	17·9	16th	54·3	18th		3·6	87
December	30·324	·148	30·1	24·1	37·5	30·6	13·4	7·8	7th	53·3	31st		2·9	88
Year..............	29·960	·273	45·7	38·8	51·8	45·4	13·0	7·8	Dec. 7	76·9	July 29		4·8	83

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, IN 1879—*(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow		Clear Sky.	Over-cast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	3·37	1·08	1st	14	10	7·9	3	16	1·2	3	15	3	4	1	0	1	1	3
February	4·16	·59	10th	24	11	7·6	1	15	1·6	5	5	1	5	4	4	2	1	1
March	1·03	·32	30th	15	4	7·0	7	18	1·7	3	9	2	1	2	10	0	3	1
April	3·16	·60	6th	21	4	7·5	2	15	1·7	3	8	5	6	3	3	1	1	0
May	3·26	1.03	28th	18	2	6·6	5	10	1·8	6	10	3	4	2	4	0	2	0
June	5·68	·79	11th	24	0	7·7	0	13	1·3	1	1	3	8	4	10	2	2	0
July	4·24	·55	14th	19	0	8·0	0	16	1·8	1	0	2	6	4	8	4	5	1
August	5.80	1·20	2nd	16	0	6·9	3	8	1·7	1	1	4	4	1	12	3	1	4
September	3·13	·73	23rd	14	0	6·0	3	13	1·1	5	3	4	2	4	9	0	2	1
October	·78	·29	24th	11	0	7·4	5	19	1·6	1	9	4	2	1	4	4	5	1
November	·57	·19	20th	9	4	6·5	6	13	1·8	7	7	0	1	0	2	3	6	4
December	·80	·33	31st	8	3	7·9	2	20	1·6	6	4	5	2	1	4	3	3	3
Year	35·98	1·20	Aug. 2	193	38	7·2	37	176	1·6	42	72	36	44	27	70	23	32	19

WATFORD.

Seasons 1878-79.	Mean Pressure.	Tension of Vapour.	Mean Temperature.	Mean Daily Range.	Relative Humidity	Rainfall.
	ins.	ins.	°	°	°/o	ins.
Winter	29·772	·167	33·5	8·6	86	9·29
Spring	29·917	·230	43·4	15·3	81	7·45
Summer	29·831	·410	58·7	13·9	81	15·72
Autumn	30·126	·290	47·0	13·2	86	4·48

For comparison the results of observations at the Greenwich Observatory are computed as before.

GREENWICH.

Seasons 1878-79.	Mean Pressure.	Tension of Vapour.	Mean Temperature.	Mean Daily Range.	Relative Humidity	Rainfall.
	ins.	in.	°	°	°/o	ins.
Winter	29·766	·174	34·6	7·9	85	7·60
Spring	29·898	·228	44·3	16·3	79	6·60
Summer	29·818	·406	58·3	16·4	83	13·20
Autumn	30·106	·295	47·9	13·0	86	4·50

The year 1879 is chiefly remarkable for the extremely low temperature which generally prevailed, and for the excessive rainfall of the first nine months. The mean temperature of each month throughout the year was lower than that of the corresponding month of the previous year; and that, with the exception of the winter with which it commenced, was also a cold year. The cold was remarkable rather for its long continuance than for its severity, and the absence of high maximum temperatures is a more exceptional feature than the occurrence of low minimum temperatures. While the lowest reading registered at Watford was but 1° below the lowest in 1878, the highest was as much as 7°·7 below the highest in 1878. Again, the highest of the monthly minimum readings was 4°·4 below the highest in 1878, and the lowest of the monthly maximum readings was 4°·1 below the lowest in 1878. The year was also marked by the prevalence of north-easterly winds in the winter and spring months, and the comparative infrequency of south-westerly winds in those months; and by the small amount of sunshine, the sky having been completely overcast at the time of observation (9 a.m.) for nearly half the days in the year, and clear for little more than one-tenth. The prevailing character of the year may, in fact, be summed up in three words—cold, wet, and sunless. In the following notes I shall refer but very briefly to the principal *changes*, chiefly of temperature, in each month, believing that the tables show the *general character* of the weather sufficiently fully.

JANUARY.—The unusually cold December of 1878 closed with a few warm days, but this mild weather ceased after the 1st of January, and with the exception of this day, and the 13th, 14th, and 15th, the temperature was low with occasional severe frosts. Only on the days named did the maximum exceed 38°·4. Easterly winds prevailed, the direction being N.E. to S.E. from the 7th, and due N.E. for the last ten days.

FEBRUARY.—The frost continued to the 5th, a warm period commencing on the 6th with only two nights of slight frost to the 20th. From the 21st to the 27th the temperature was again low, with a maximum under 40° and frost every night. The prevailing direction of the wind for the first half of the month was S. or S.E., and for the last half N. or N.E. Much sleet and hail fell on the first four days. From the 5th to the 11th (inclusive) rain fell continuously, and from the 13th to the 20th, rain or snow. There was no longer interval without either than a single day. Barometric pressure, generally low, fell on the 10th to 28·974 ins.

MARCH.—On the last day of February the weather became warmer, remaining about the same to the 5th of March, when the temperature again rose (about 10°). On the 22nd, a colder period set in, having a mean temperature a little below that of the first four days; but on the 29th there was again a rise (about 12°). The wind was generally westerly until the 17th, when easterly winds set in (N.E. 19th to 26th), but on the three warm days at the end of the month it was S.W. A high wind prevailed from the night of the 22nd to the morning of the 24th, with some sleet, followed by snow. On the 8th, in the middle of a dry period, when there was the only really fine weather for any considerable time for the first nine months in the year, the mercury stood at 30·621 ins.

APRIL.—A change from warm to cold weather occurred on the 10th, followed by several days of snow, after which temperature rose slightly to the 23rd, when a more decided rise took place, the remainder of the month having about the same mean temperature as the first ten days. The wind varied much in direction, but was easterly (N.E. to S.E.) after the 18th.

MAY.—The only decided change in temperature was a rise on the 12th, but with it came more rain, and the weather was not any more genial after than it had been before this change. The wind was almost persistently N.E. before the warm period commenced, and varied much after it. The last fall of snow of the *Winter*, for it cannot be said that there had been any *Spring*, was on the 7th. The wind was very high on the 15th, after a thunderstorm with hail in the night, and there was also a thunderstorm on the night of the 27th, with much rain.

JUNE.—The mean temperature of the month was but little departed from on any single day. The wind, generally southerly, during the last ten days varied only from S.W. to S.E. Barometric pressure was unusually equable. Little in fact can be added to the information given in the tables, the weather being so equable in every respect—so universally dull, wet, and gloomy.

JULY.—The temperature continued about the same as in June, only the last four or five days showing a decided rise. The wind was almost persistently south-westerly for at least the first half of the month, and S. to S.E. for the last week. Pressure was again equable. July indeed was almost a counterpart of June, and if anything was even more gloomy.

AUGUST.—From the 11th to the 15th the temperature was higher than at any other time during the month, and this was the longest period of hot weather in the year. During this period the wind was easterly, and after it was S. to S.W. There was a terrific thunder-storm on the night of the 2nd. The rain recorded in the table fell, partly as hail, in about three hours, from 0·30 to 3·30 a.m. The vivid and for some time continuous lightning, appearing almost simultaneously in S.W., N.W., and N., loud crackling thunder, high wind, and heavy hailstones, which sounded to us like a few large stones occasionally thrown as in handfuls at our windows, combined to render the storm one never to be forgotten. It is remarkable that on the morning of the 2nd barometric pressure was at the highest point in the month (30·162 ins.).

SEPTEMBER.—Beyond the values given in the tables nothing calls for special remarks. The heavy fall of rain on the 23rd was preceded by the only rapid change in pressure, a fall of nearly half an inch from the previous day.

OCTOBER.—This was the first month in the year, excepting March, without excessive rainfall. Temperature was a little lower after the 9th than it had hitherto been, but rose again after the 23rd. The wind was easterly (S.E. to N.E.) the first half of the month, then westerly, and E. or N.E. the last week.

NOVEMBER.—Winter may be said to have begun, in the midst of a two days' gale of wind, on the 13th, the first of four cold days followed by three warm ones. On the 20th, when temperature again fell, there was the first fall of snow. Pressure was remarkably high and steady, being least, 29·822 ins., on the 21st, and greatest, 30·620 ins., on the 7th.

DECEMBER.—The first twelve days were excessively cold, from the 13th there were a few rather warmer days followed by another cold period lasting to the 27th, while the last four days were so warm as to make the mean of the month considerably higher than it would otherwise have been. The wind was northerly to the 19th, and E. by S. to W. to the end of the month. Pressure, while higher even than in November, varied more, from 29·629 ins. on the 4th to 30·819 ins. on the 23rd, the highest point reached since I commenced my observations in 1876.

J. Hopkinson, del. 1880.

XIV.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1879.

By John Hopkinson, F.L.S., F.M.S., etc., Hon. Sec.

Read at Watford, 20th April, 1880.

Plate III.

There are very few changes to record for this year in the stations from which returns of the rainfall have been received. For Watford we have again the return from Watford House, omitted in 1878, and we have a new station in the neighbourhood, Bushey Heath, also added—the only additions to the 1878 returns. Against these we have to record the loss of one station, Aspenden Rectory, near Buntingford, so that we have returns from one more station than in 1878.

On referring to the report for 1878 it will be seen that the districts for which observers are still required are the same as those there enumerated.*

The map which I then mentioned my intention of giving with some future report accompanies the present one. It shows the position of the rain-gauges in the county, and the river-basins in which they are situated. The limits of the river-basins are taken, with some slight modifications, from Mr. Pryor's map, published some years ago in our 'Transactions,'† in illustration of his proposed botanical districts. Every station for which returns of the rainfall in 1879 have been communicated to me is shown,‡ and in order that the map may also illustrate the next report I have added the only rainfall station that I am aware of as having been started in 1880—Throcking Rectory, Buntingford.§

It will be seen from the map that the area for which rainfall observers are most urgently required is the district to the south-east of St. Albans, the basin of the Upper Colne, which has not a single observer; that the next in need is the adjoining area to the east, the basin of the Lower Lea, with but one observer near Barnet; and that the other basins without observers are the Stort

* 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 223. † *Ib.* Vol. I, Plate I.

‡ In addition to the rainfall stations all the principal towns and villages in the county are given in such a way that if gauges are at any time started at any of them, their position can be indicated (by a dot of ink in the open circle), no place having at least 2000 inhabitants being omitted. The names in italics indicate places of too little importance to have been given had they not been rainfall stations, these in some cases being only the names of the residences of the observers.

§ Since the Map was lithographed and this Report was sent to press I have heard that at the end of 1880 two other rain-gauges were set up by members of the Society; one at Hoddesdon, where we lost an observer in 1878, and the other at Odsey not far from the gauge at Odsey Grange. As, however, returns from these stations will only date from the year 1881, they could not correctly have been inserted in the map.

Hertfordshire Rainfall Stations.

District.		Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.
Colne.	Lower Colne	Bushey Heath	Forrester Scott	51 38 0 N	0 20 0 W	5	1 0	480
		Watford—Bushey Station	Robert Savill	51 38 50 N	0 22 50 W	5	0 8	220
		,, Watford House	Alfred T. Brett, M.D.	51 39 25 N	0 23 35 W	8	1 3	240 T
		,, Wansford House	John Hopkinson	51 39 45 N	0 23 40 W	5	1 0	224 ↑
		,, Oaklands	Edward Harrison	51 40 5 N	0 24 20 W	5	5 6	273 T
		Rickmansworth—Moor Park	Lord Ebury	51 37 30 N	0 26 20 W	5	2 0	340
	Ver	St. Albans—Gorhambury	The Earl of Verulam	51 45 20 N	0 23 0 W	6	2 6	
		Harpenden—Rothamsted	Drs. Lawes and Gilbert	51 48 10 N	0 21 30 W	5	2 0	420 T
		,, ,, (2nd gauge)	,, ,,	51 48 10 N	0 21 30 W	*	0 9	420 T
		Kensworth	Miss Grace Jones	51 51 30 N	0 30 0 W	5	1 0	900 ?
	Gade and Bulborne	Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 44 0 N	0 26 40 W	12	3 9	237 T
		Great Gaddesden	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426
		Berkhampstead	William Squire	51 45 40 N	0 33 30 W	8	1 6	370 B
		Tring—Cowroast	Hubert Thomas, C.E.	51 47 0 N	0 36 30 W	10	4 2	345 L
Lea.	Lower Lea	East Barnet—Southgate	H. F. Church	51 37 40 N	0 8 0 W	6	0 8	240 T
	Upper Lea	Hatfield—Brocket Hall	Hon. H. F. Cowper, M.P.	51 48 0 N	0 14 0 W	8	1 0	
		Hertford—Bayfordbury	W. Clinton Baker	51 46 30 N	0 5 30 W	8	0 4	250
		Ware	James Muir, C.E.	51 48 20 N	0 2 0 W	12	3 0	114 T
	Mimram	Welwyn Rectory	Rev. C. L. Wingfield	51 49 50 N	0 12 30 W	5	0 4	
		Datchworth	Rev. J. Wardale	51 51 20 N	0 9 50 W	6	1 0	357 T
	Beane	Knebworth	Rev. F. G. Jenyns	51 52 30 N	0 12 30 W	5	1 0	417 T
		Stevenage	Rev. J. O. Seager	51 55 5 N	0 11 40 W	8	2 0	319 L
	Rib	Therfield	Rev. J. G. Hale	52 1 0 N	0 3 0 W	5	4 3	500 ?
	Ash	Much Hadham	Rev. H. S. Mott	51 51 20 N	0 4 40 E	5	1 0	200 B
Cam. Ivel.	Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238 ↑
		,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422 T
	Rhee	Odsey	H. George Fordham	52 1 25 N	0 6 40 W	5	1 0	263 ↑
		Royston	Hale Wortham	52 2 30 N	0 1 0 W	8	0 6	269 ↑

* Area 1 of an acre

RAINFALL IN HERTFORDSHIRE IN 1879.

	Stations.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Days.
		ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	
Colne.	Bushey Heath	3·21	4·25	1·03	3·15	3·15	5·14	4·06	5·85	3·37	·80	·57	·87	35·45	196
	Watford—Bushey Station	2·33	4·69	·84	2·99	3·72	4·99	4·51	5·19	2·98	1·21	·62	·55	34·62	
	,, Watford House	2·44	4·28	·99	2·98	3·18	5·55	4·01	5·97	2·50	·79	·39	·65	33·73	162
	,, Wansford House	3·37	4·16	1·03	3·16	3·26	5·68	4·24	5·80	3·13	·78	·57	·80	35·98	193
	,, Oaklands	2·99	4·30	·98	2·81	3·40	6·06	4·06	6·07	3·09	·88	·44	·74	35·82	186
	Rickmansworth—Moor Park	3·57	5·43	1·09	3·66	3·90	6·54	4·78	6·63	3·80	1·33	·63	1·20	42·56	215
	St. Albans—Gorhambury	2·77	3·18	·99	2·67	3·29	4·43	4·02	4·98	3·11	1·01	·59	·79	31·83	164
	Harpenden—Rothamsted	2·46	3·74	1·09	2·61	3·46	5·49	4·17	5·84	3·07	·76	·71	·78	34·18	207
	,, ,, (2nd gauge)	2·85	3·80	1·18	2·79	3·48	5·55	4·24	6·56	3·13	·82	·81	·82	36·03	209
	Kensworth	1·54	3·22	·54	2·52	2·94	5·34	4·36	5·80	3·30	·84	·45	·76	31·61	178
	Hemel Hempsted—Nash Mills	2·88	3·33	1·05	2·40	2·97	5·94	4·38	6·39	3·01	·79	·46	·63	34·23	180
	Great Gaddesden	2·71	3·04	·97	2·40	3·45	5·22	4·44	5·84	2·93	·68	·63	·58	32·89	
	Berkhampstead	3·38	3·70	1·09	2·63	3·37	5·18	3·96	6·32	3·19	·84	·51	·73	34·90	178
	Tring—Cowroast	1·80	3·53	1·05	2·35	3·25	3·98	4·26	5·62	2·60	1·11	·52	·71	30·78	139
Lea.	East Barnet—Southgate	3·10	3·54	1·18	3·18	2·93	4·33	4·02	5·54	3·32	·60	·91	·87	33·52	235
	Hatfield—Brocket Hall	2·41	3·19	1·05	2·90	4·35	3·72	4·29	4·10	2·33	·59	·77	·21	29·91	169
	Hertford—Bayfordbury	2·87	3·53	·87	2·53	2·90	4·62	3·46	4·44	2·77	·61	·65	·69	29·94	169
	Ware	2·20	2·65	·75	2·40	2·59	4·17	3·47	3·66	2·73	·77	·48	·48	26·35	166
	Welwyn Rectory	3·45	3·70	1·23	2·65	2·10	4·94	3·69	4·52	2·00	·70	·93	·49	30·40	208
	Datchworth	2·45	3·20	·81	2·33	2·65	4·52	3·41	4·17	2·51	·79	·66	·54	28·04	153
	Knebworth	2·60	3·14	1·27	2·55	3·20	4·30	4·28	5·07	2·30	1·24	·85	·58	31·38	172
	Stevenage	2·53	2·98	·90	2·16	3·59	5·25	3·92	4·37	2·54	·78	·93	·65	30·60	184
	Therfield	1·89	3·64	·93	2·11	3·54	4·94	4·77	4·77	2·58	·69	·80	·58	31·24	150
	Much Hadham	2·93	3·06	·98	2·64	2·93	4·02	4·24	3·38	3·38	·67	1·03	·65	29·91	193
Ivel.	Hitchin	2·57	2·65	·62	2·33	2·77	5·22	3·78	4·61	2·71	·61	·75	·51	29·13	202
	,, High Down	1·84	2·86	·85	2·58	2·70	4·80	3·37	5·22	2·37	·98	·64	·44	28·65	
Cam.	Odsey	2·03	3·19	·71	2·56	2·79	4·42	4·34	4·01	2·25	·60	·78	·56	28·24	187
	Royston	2·40	3·11	·78	2·59	3·00	5·10	3·46	5·44	2·28	·59	·73	·58	30·06	164
	Mean	2·63	3·54	·96	2·66	3·17	4·98	4·07	5·22	2·83	·82	·67	·66	32·21	182

on the east, the Upper Brent on the south, the Chess on the south-west, and the Upper Thames on the west of the County.

Particulars of the gauges, with the names of the observers, etc., and the monthly and annual rainfall (including melted snow), and number of days on which 0·01 inch of rain (or snow) fell at each of these stations, are given in the accompanying tables (pp. 128, 129). The symbols used are the same as before, $\overline{\uparrow}$ signifying that a series of levels has been taken to the gauge from an Ordnance bench-mark, T that levels have been taken to the gauge from some datum other than Ordnance mean sea-level, and B that the height has been taken by the barometer.

The distribution of the rainfall over the year will be seen to have been very remarkable. In the first three quarters the fall was excessive; in the last it was almost unprecedentedly small. In the first three months the mean fall in the county was 7·13 ins.; in the second, 10·81 ins.; in the third, 12·12 ins.; and in the fourth, only 2·15 ins.; the fall in the third quarter being thus nearly six times that in the last. Comparing the months with each other we find that March, October, November, and December were unusually dry, averaging 0·78 in., and ranging from 0·66 in. to 0 96 in.; that January, April, May, and September were wet, though not much above the mean of the year, their average being 2·82 ins. and their range from 2·63 ins. to 3·17 ins.; and that February, June, July, and August were excessively wet, averaging 4·45 ins. and ranging from 3·54 ins. to 5·22 ins.

In the arrangement of the river-basins a slight alteration has been made in this report. The main watershed in Hertfordshire divides it into two very unequal portions, by far the greater part of the county being drained by rivers flowing into the Thames, and a small district in the north being drained by tributaries of the Ouse. These tributaries, the Ivel and Cam, are therefore here raised to the same rank as the Colne and Lea, which flow into the Thames. For the basin of the Thames the mean fall in the county was 32·00 ins., and for that of the Ouse 29·02 ins., the distribution in their tributaries being as follows:—

Thames	Colne	34·04	Lower Colne	36·36
			Ver	33·41
			Gade	33·20
	Lea	30·63	Lower Lea	33·52
			Upper Lea	28·73
			Mimram	30·40
			Ash	30·01
			Beane	31·24
			Rib	29·91
Ouse	Ivel	28·89	Hiz	28·89
	Cam	29·15	Rhee	29·15

The relative proportion of the rainfall in the larger divisions will be seen to have been the same as during the three previous years, the basins of the Ivel and Cam having the least fall, the basin of the Lea having the next, and that of the Colne having the greatest.

Of the 27 observers 24 give the number of days in each month on which 0·01 in. of rain, or more, fell, and also the greatest amount which fell on any one day in each month. The mean number of rainy days in each month is as follows:—

Jan.	10·6	April	18·7	July	20·6	Oct.	11·4
Feb.	21·2	May	16·6	Aug.	16·0	Nov.	9·8
March	12·2	June	22·9	Sept.	13·4	Dec.	9·0

giving a mean for the year of 182·4 days, being about 9 days more than in 1876, 12 days more than in 1878, and 11 days less than in 1877. The least number of rainy days were at Tring (139), Therfield (150), and Datchworth (153); the greatest, at Rickmansworth (215) and East Barnet (235); the numbers nearest the mean were at Kensworth (178), Berkhampstead (178), Hemel Hempstead (180), Stevenage (184), Oaklands, Watford (186), and Odsey (187).

The station at which there was the greatest fall of rain in 24 hours in each month is now given, with the day of the month and the amount of the fall.

Jan. 1.—Welwyn	1·61	July 1.—Gorhambury	1·00
Feb. 11.—Therfield	·83	Aug. 2.—Royston	3·00
Mar. 30.—Cowroast	·40	Sept. 23.—East Barnet	1·30
Apl. 6.—Bayfordbury	·87	Oct. 24.—Moor Park	·41
May 28.—Moor Park	1·25	Nov. 21.—East Barnet	·42
June 11.—Gorhambury	1·27	Dec. 31.—Moor Park	·40

The days on which the greatest fall of rain is recorded in each month at these 24 stations are next given, with the number of stations at which this maximum monthly fall occurred. The days on which the greatest rainfall in the month occurred at any one station, as shown above, are indicated by italics.

January—*1st, the wettest day at 17 stations*; 2nd at 5; 14th at 1; 17th at 1.
February—2nd at 1; 10th at 20; *11th at* 3.
March—10th at 1; 14th at 1; *30th at* 22.
April—*6th at* 17; 7th at 1; 12th at 6.
May—15th at 1; *28th at* 23.
June—1st at 4; 2nd at 2; 17th at 3; 10th at 1; *11th at* 12; 13th at 2.
July—*1st at* 6; 14th at 3; 19th at 4; 20th at 4; 21st at 5; 31st at 2.
August—*2nd at* 18; 19th at 5; 27th at 1.
September—13th at 2; *23rd at* 16; 28th at 5; 29th at 1.
October—1st at 1; 13th at 1; 19th at 1; *24th at* 19; 25th at 1; 29th at 1.
November—19th at 2; 20th at 6; *21st at* 9; 22nd at 2; 23rd at 1; 24th at 4.
December—5th at 7; 12th at 1; 19th at 2; 29th at 1; 30th at 3; *31st at* 10.

The following falls of an inch or more are recorded on the days of maximum monthly fall.

January 1—Bushey Heath, 1·06; Wansford House, Watford, 1·08; Berkhampstead, 1·20; East Barnet, 1·18; Bayfordbury, 1·10; Welwyn, 1·61; Stevenage, 1·00; Much Hadham, 1·11; Hitchin, 1·00.

May 28—Bushey Heath, 1·10; Watford House, 1·02; Wansford House, Watford, 1·03; Oaklands, Watford, 1·06; Moor Park, 1·25; Bayfordbury, 1·01; Stevenage, 1·02.

June 10—Nash Mills, 1·16.

June 11—Gorhambury, 1·27.
July 1—Gorhambury, 1·00.
August 2—Watford House, 1·10; Wansford House, Watford, 1·20; Oaklands, Watford, 1·16; Gorhambury, 1·54; Rothamsted, 2·37*; Kensworth, 2·34; Nash Mills, 2·50†; Berkhampstead, 2·50; Cowroast, 1·40; Brocket Hall, 1·54; Welwyn, 1·44; Datchworth, 1·19; Knebworth, 1·70; Stevenage, 1·78; Therfield, 2·03; Hitchin, 1·94; Odsey, 1·81; Royston, 3·00.
Aug. 19—Moor Park, 1·14.
September 23—Much Hadham, 1·05; East Barnet, 1·30.

Although in 1879 the number of heavy falls of rain (exceeding one inch in 24 hours) was not so great as in 1878, the remark applied to that year—that it was characterised by "the number of heavy falls of rain and snow, and the excessive amount of some of these falls"—is also applicable to this. On three occasions a fall exceeding an inch is seen to have been pretty general over the county—viz. on the 1st of January, the 28th of May, and the 2nd of August. About half the amount recorded on the 1st of January was due to snow, and the falls on the other two days were due to thunderstorms, that on the night of the 2nd of August, lasting from about midnight to 3·30 a.m., being very severe and accompanied by heavy hail-stones. The flood which this fall caused will, I believe, form the subject of a paper which will shortly be communicated to the Society by Mr. Littleboy, and therefore only needs a passing mention in this report. It was perhaps as exceptional in its character as any on record, and its sudden rise must have been due to the immense amount of rain which fell in a short time on ground already fully saturated, from four-tenths of an inch to one inch per hour falling in the county in three successive hours.

The closing paragraph in the previous report, as to the rainfall in recent years having been much above the average, might also be repeated in this, adding one year to the number there given, for we have now had five years in succession of excessive rainfall, and in the last of the five the fall has been the greatest in excess.

* The observers add the following note:—"Aug. 2. Owing to the enormous rainfall during the night of this date the large gauge-collectors were swamped and overturned. The small 5 inch gauge registered only 2·37 inches, but as there was much hail, and the rain was very heavy, no doubt some would bounce out of this 5 inch funnel; and as as much as $3\frac{1}{2}$ inches or more is said to have been registered not many miles distant, 3 inches is adopted as the rainfall on that occasion." As, however, the majority of the gauges of our observers are 5 inches in diameter, I have thought it best to adopt for comparison with the amounts recorded by them, the fall actually collected in the small gauge, viz. 2·37 ins.

† Note by the observers:—"Gauge upset during the flood of Aug. 2."

XV.

REPORT ON PHENOLOGICAL OBSERVATIONS IN HERTFORDSHIRE IN 1879.

By John Hopkinson, F.L.S., etc., Hon. Sec.

Read at Watford, 20th April, 1880.

The number of localities at which Phenological Observations have been taken again shows an increase, but not to such an extent as in 1878, when the number was more than double that of the previous year, the only additional centre of observation this year being Sawbridgeworth.

Observations for the localities before represented have been contributed by the same observers as in 1878.* The most complete record of the time of flowering of plants is again that of our observer at Harpenden, Mr. J. J. Willis. For Hertford we have also a very full record from Mr. R. T. Andrews, who commenced to observe in 1878. For Watford we have still to rely entirely on our own observations. For the district between St. Albans and Redbourn we have again observations from Mrs. Arnold of Redbourn Bury; for the neighbourhood of Ware, from Mr. R. B. Croft, F.L.S., of Fanhams Hall; and for Odsey, from Mr. H. George Fordham, F.G.S., of Odsey Grange. For our new locality, Sawbridgeworth, observations of the time of flowering of plants have been contributed by Miss C. Donagan. A few observations of birds have been taken at Watford by Mr. Jonathan King, of Wiggenhall; at Kimpton, near Welwyn, by the Rev. Thomas D. Croft, M.A.; and at Hertford, by Mr. H. C. Heard, of Hailey Hall. I have also incorporated in this report a few observations of the species in our list recorded in Mr. Littleboy's "Notes on Birds observed in 1879," already communicated to the Society †

Regular observations, chiefly of the time of flowering of plants, are therefore now taken at seven localities, and occasional observations of birds at several others. In the Meteorological Society's Report, drawn up by the Rev. T. A. Preston, 32 localities are represented, 8 of which are in Hertfordshire, the records for these localities being from copies of the returns of our observers already named which I have forwarded. To these may be added the return for Cambridgeshire, that being from our observer at Odsey on the borders of Hertfordshire and Cambridgeshire. But one other county, Lincolnshire, is represented by as many as three phenological stations, and many counties are yet without a single observer.

It is therefore seen that the Meteorological Society is indebted to our Society for a large proportion of its observers—certainly a very satisfactory indication that we are by no means behindhand

* 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 229.

† 'Trans. Herts. Nat. Hist. Soc.,' Vol. I, p. 70.

DATES OF FLOWERING OF PLANTS OBSERVED IN 1879.

No.	Species.	Watford	St. Albans	Harpenden	Hertford	Ware	Sawbridgeworth	Odsey
1.	*Anemone nemorosa* (wood anemone)	Apl. 3	Apl. 5	Apl. 10	Mar. 24	Mar. 28	.....	.....
2.	*Ranunculus Ficaria* (pilewort)	Mar. 16	Mar. 17	Apl. 7	Mar. 13	Mar. 15	.....	.....
3.	*Ranunculus acris* (upright crowfoot)	May 11	.....	May 8	.....	.....	.....	.....
4.	*Caltha palustris* (marsh marigold)	Apl. 24	.....	Apl. 26	Apl. 16	Apl. 7	.....	.....
5.	*Papaver Rhœas* (red poppy)	Apl. 14	.....	.....	Apl. 18	Apl. 19	Apl. 16	Apl. 16
6.	*Cardamine hirsuta* (hairy bittercress)	.....	.....	Apl. 21	Mar. 24	.....	.....	.....
7.	*Cardamine pratensis* (cuckoo-flower)	May 4	May 9	May 4	Apl. 30	Apl. 26	.....	.....
8.	*Draba verna* (whitlow grass).....	.....	.....	Apl. 19	Apl. 6	.....	.....	.....
9.	*Viola odorata* (sweet violet)	.....	Mar. 7	Feb. 14	Mar. 10	.....	.....	Mar. 15
10.	*Polygala vulgaris* (milkwort).....	.....	.....	June 20	June 10	.....	June 23	June 7
11.	*Lychnis Flos-cuculi* (ragged Robin)	June 14	June 10	June 20	June 6	.....	.....	.....
12.	*Stellaria Holostea* (greater stitchwort).....	May 4	May 9	May 4	May 11	May 8	.....	.....
13.	*Malva sylvestris* (common mallow)	July 1	June 16	July 2	June 27	July 3	June 27	July 3
15.	*Hypericum pulchrum* (upright St. John's wort)	.....	.....	July 13	.....	.....	.....	.....
16.	*Geranium Robertianum* (herb Robert)	May 20	May 28	May 30	June 1	.....	May 28	June 5
17.	*Trifolium repens* (Dutch clover)	June 1	June 1	June 8	June 6	June 12	June 19	.....
18.	*Lotus corniculatus* (bird's-foot trefoil)	June 7	June 6	June 9	June 16	June 28	June 11	.....
19.	*Vicia Cracca* (tufted vetch)	July 12	.....	July 12	July 8	.....	July 7	.....
20.	*Vicia sepium* (bush-vetch)	May 23	May 12	May 29	May 31	.....	.....	.....
21.	*Lathyrus pratensis* (meadow vetchling)	July 1	.....	July 1	June 16	June 17	June 22	.....
22.	*Prunus spinosa* (blackthorn)	May 3	May 2	May 1	Apl. 30	Apl. 28	.....	Apl. 27
23.	*Spiræa Ulmaria* (meadow sweet)	July 12	.....	July 23	July 12	.....	July 18	.....
24.	*Potentilla anserina* (silver-weed)	June 3	June 2	June 1	June 12	May 28	June 11	May 30
25.	*Potentilla Fragariastrum* (barren strawberry)	Mar. 16	Apl. 5	Apl. 11	Mar. 12	Apl 8	.....	.....
26	*Rosa canina* (dog rose)	June 20	.....	June 28	June 21	June 26	June 27	June 24
27.	*Epilobium hirsutum* (great hairy willow-herb)	.....	.....	Aug. 6	.....	.....	.....	.....
28.	*Epilobium montanum* (broad willow-herb)	June 29	.....	June 27	June 18	.....	.....	.....
30.	*Anthriscus sylvestris* (wild chervil)	May 4	May 9	May 1	May 17	May 8	.....	May 11
31.	*Hedera Helix* (ivy).....	.....	.....	Oct. 7	.....	.....	.....	.....
32.	*Galium Aparine* (cleavers)	May 25	June 2	June 13	June 6	June 7	.....	.....
33.	*Galium verum* (yellow bedstraw)	July 28	.....	July 15	July 24	.....	.....	July 26

35.	*Scabiosa succisa* (devil's bit)	.....	Aug. 18	.....	.....	.....	.....	.....
36.	*Petasites vulgaris* (butter bur)	.....	Apl. 8	.....	Mar. 24	.....	.....	.....
37.	*Tussilago Farfara* (coltsfoot)	Mar. 1	.....	.....	Mar. 14	Mar. 1	.....	Mar. 3
38.	*Achillea Millefolium* (milfoil)	July 12	July 11	July 14	.....	.....	.....	.....
39.	*Chrysanthemum Leucanthemum* (ox-eye)	June 5	June 8	June 13	June 12	June 5	June 12	.....
41.	*Senecio Jacobæa* (ragwort)	July 18	.....	Aug. 4	July 12	.....	.....	July 15
42.	*Centauria nigra* (black knapseed).....	.....	.....	July 9	July 10	.....	.....	.....
43.	*Carduus lanceolatus* (spear thistle).....	.....	.....	June 39	July 24	.....	.....	.....
44.	*Carduus arvensis* (field thistle)	.....	July 17	July 22	July 10	.....	.....	.....
45.	*Sonchus arvensis* (corn sow-thistle)	Aug. 2	.....	July 30	July 24	.....	.....	.....
46.	*Hieracium Pilosella* (mouse-ear)	.....	.....	June 9	June 12	.....	.....	.....
47.	*Campanula rotundifolia* (hair-bell)	.....	.....	July 22	.....	.....	.....	July 24
49.	*Convolvulus sepium* (greater bindweed).....	.....	.....	Sept. 3	.....	.....	.....	.....
50.	*Symphytum officinale* (comfrey)	May 11	.....	.....	.....	.....	.....	.....
51.	*Pedicularis sylvatica* (red rattle)	May 28	.....	.....	June 12	.....	.....	.....
52.	*Veronica Chamædrys* (germander speedwell)	May 18	.....	May 26	.....	.....	.....	May 10
53.	*Veronica hederifolia* (ivy-leaved speedwell).....	.....	.....	Mar. 29	Mar. 18	.....	.....	Mar. 11
55.	*Thymus serpyllum* (wild thyme)	.....	.....	July 13	.....	.....	.....	June 15
56.	*Prunella vulgaris* (self-heal).....	....	.....	July 8	July 9	.....	.....	.....
57.	*Nepeta Glechoma* (ground ivy)	Apl. 19	.....	Apl. 18	Apl. 7	Apl. 17	.....	Apl. 18
58.	*Galeopsis Tetrahit* (hemp-nettle)	.....	July 7	July 23	July 2	....	.....	.....
59.	*Stachys sylvatica* (hedge woundwort)	June 22	.....	June 30	.....	June 19	.....	.....
60.	*Ajuga reptans* (creeping bugle)	May 23	May 31	May 17	June 1	.....	.....	.....
61.	*Primula veris* (cowslip).....	Apl. 13	Apl. 9	Apl. 18	Apl. 16	Apl. 17	.....	Apl. 13
62	*Plantago lanceolata* (ribwort)	May 18	May 19	May 18	May 19	May 21	.....	.....
63.	*Mercurialis perennis* (dog's mercury)	Mar. 30	Apl. 12	Apl. 2	Mar. 24	Mar. 28	.....	.....
64.	*Ulmus montana* (wych elm)	.....	.....	Mar. 31	Mar. 13	.....	.....	Apl. 1
65.	*Salix caprea* (great sallow)	Mar. 16	Mar. 21	Mar. 16	Mar. 18	Mar. 15	.....	Mar. 20
66.	*Corylus Avellana* (hazel)	Feb. 15	.....	Feb. 12	Feb. 12	Feb. 20	....	Feb. 16
67.	*Orchis maculata* (spotted orchis)	June 16	June 20	June 22	June 14	.....	June 19	.....
68.	*Iris Pseudacorus* (yellow iris)	June 19	June 21	.....	June 18	.....	June 23	.....
69.	*Iris Pseudo-narcissus* (daffodil)	Mar. 30	Apl. 5	Mar. 30	Mar. 23	Mar. 28	.....	Mar. 31
70.	*Galanthus nivalis* (snowdrop)	Feb. 6	....	Feb. 10	Mar. 11	Feb. 12	.....	Feb. 7
71.	*Endymion nutans* (bluebell)	May 18	May 9	May 9	May 17	May 24	.....	.....

as an association of observers of Nature. Yet comparatively few of our members assist in this work, and I am still wishful for more observers, that we may be pretty sure that few species of plants open their flowers, few birds arrive or commence their song, few insects appear, a day before they are observed somewhere in the county.

Of the 71 species of plants in the Meteorological Society's list, the time of flowering of 65 has been observed in Hertfordshire. Of these we observed 45 at or near Watford; 31 were observed by Mrs. Arnold at Redbourn Bury near St. Albans; 58 by Mr. Willis at Harpenden; 53 by Mr. Andrews in the neighbourhood of Hertford; 28 by Mr. Croft near Ware; 14 by Miss Donagan at or near Sawbridgeworth; and 23 by Mr. Fordham at Odsey.

The earliest dates, on the average, in proportion to the number of species observed, are those recorded for Watford and Hertford, and then follow, nearly equal, those for St. Albans, Ware, Odsey, Harpenden, and Sawbridgeworth, in the order in which the places are here given.

Comparing this year with the mean of the three previous years, as given in the table in the last report,* we find that 2 species are recorded as having come into flower earlier in 1879 than the mean date recorded for the years 1876 to 1878; 56 later than in those years; and 6 at about the same time as the previous mean date, showing that in 1879 vegetation was very backward. Of these 64 species (*Cardamine hirsuta* is omitted, not having been noticed before 1879), the average date of flowering throughout the year is 13 days later than the mean date for the three previous years; and the average date for 1879 of the 62 species which were observed also in 1878 is 22 days later than in that year, the seasons thus appearing, from the evidence afforded by the time of flowering of plants, to have been on the average throughout the year fully three weeks later in 1879 than in 1878, and about a fortnight later than the mean of 1876-78.

Comparing the different months in 1879 with the mean for the three previous years, it will be found that in February the mean date of flowering of three species observed is 12 days later in 1879; that in March observations of ten species give a mean of 12 days later; in April seven give a mean of 16 days later; in May thirteen give a mean of 16 days later; in June fifteen give a mean of 10 days later; and in July twelve give a mean of 7 days later. After July there is not a sufficient number of observations to carry on the comparison, but the general result brought out is that the retardation of the dates of flowering shows an increase from the close of winter to the middle of spring, and then a gradual decrease to beyond the middle of summer. Had observations been continued as in the earlier months, for the remainder of the year, the dates would most probably have continued to approximate those of previous years, the cold weather at the beginning of the year having the greatest effect in retarding vegetation in the spring.

* 'Trans. Watford Nat. Hist. Soc.,' Vol. II, pp. 234, 235.

Of the 26 species of insects and birds, etc., in the list, 17 have been observed during the year, the same number as in 1878, though the species observed are not all the same. The record of these observations is now given as before, the initials used referring to the names already mentioned.

72. *Melolontha vulgaris* (cock-chafer). Seen at Odsey, June 7—H. G. F.

74. *Apis mellifica* (honey-bee). Seen at Ware, Feb. 8—R. B. C.; Ashwell, Feb. 9—H. G. F.; Harpenden, March 6—J. J. W.

75. *Pieris Brassicæ* (large white cabbage-butterfly). Seen at Harpenden, April 22—J. J. W.; Watford, May 5—J. H.

76. *Pieris Rapæ* (small white cabbage-butterfly). Seen at Odsey, March 19—H. G. F.; Ware, April 26—R. B. C.; Watford, May 3—J. H.

77. *Epinephile Janira* (meadow-brown butterfly). Seen at St. Albans, May 2—Mrs. Arnold; Harpenden, May 4—J. J. W.; Hertford, June 16—R. T. A.

79. *Trichocera hiemalis* (winter gnat). Seen at Watford, Dec. 29 (1878)—J. H.; Odsey, Jan. 1—H. G. F.

81. *Muscicapa grisola* (fly-catcher). Seen at Odsey, May 23—H. G. F.

82. *Turdus musicus* (song-thrush). Heard at Harpenden, Feb. 10—J. J. W.; Odsey, Feb. 12—H. G. F.; Watford, Feb. 16—J. H.

83. *Turdus pilaris* (field-fare). Seen at Ashwell, Nov. 3—H. G. F.

84. *Daulias Luscinia* (nightingale). Heard at Watford, April 19—J. H.; April 23—J. King; Ware, April 19—R. B. C.; Hertford, April 22—H. C. Heard; Harpenden, April 23—J. J. W.; Kimpton, April 23—Rev. T. D. Croft; Odsey, April 24—H. G. F.; King's Langley, April 26—T. Toovey.

87. *Phylloscopus collybita* (chiff-chaff). Heard at King's Langley, March 18—T. Toovey; Watford, March 29—J. H.; Kimpton, April 14—Rev. T. D. Croft; Hunton Bridge, April 24—J. E. Littleboy.

88. *Alauda arvensis* (skylark). Heard at Odsey, Feb. 7—H. G. F.; Harpenden, Feb. 9—J. J. W.; Ware, Feb. 15—R. B. C.

90. *Corvus frugilegus* (rook). Building at Odsey, Feb. 26—H. G. F.; Moor Park, Rickmansworth, Feb. 28—Sydney Humbert; Rothamsted, Harpenden, March 1—J. J. W.; Hertford, March 1—R. T. A.; Ware, March 8—R. B. C.

91. *Cuculus canorus* (cuckoo). Heard at Watford, April 16—W. Copeland; April 21—J. H.; April 23—J. King; St. Albans, April 18—Rev. C. M. Perkins; Ware, April 22—R. B. C.; Hertford, April 23—H. C. Heard; April 26—R. T. A.; Harpenden, April 25—J. J. W.; Kimpton, April 25—Rev. T. D. Croft; Odsey, April 26—H. G. F.

92. *Hirundo rustica* (swallow). Seen at St. Albans, April 6—Rev. C. M. Perkins; Harpenden, April 7—J. J. W.; King's Langley, April 10—T. Toovey; Watford, April 11—Bernard Smith; Hunton Bridge, April 14—J. E. Littleboy; April 19—J. H.; April 20—J. King; Ware, April 13—R. B. C.; Boxmoor, April 17—J. E.

Littleboy; Sacombe, April 17—Abel S. H. Smith; Hertford, April 19—R. T. A.; April 21—H. C. Heard; Kimpton, April 25—Rev. T. D. Croft; Ashwell, April 25—H. G. F.; Odsey, April 27—H. G. F. Last seen at Odsey, Oct. 10—H. G. F.

93. *Cypselus Apus* (swift). Seen at Hunton Bridge, May 5—R. D. East; King's Langley, May 5—T. Toovey; Harpenden, May 14—J. J. W.; Ashwell, May 16—H. G. F.; Hemel Hempstead, May 18—J. E. Littleboy; Ware, May 19—R. B. C.; Odsey, May 23—H. G. F.

97. *Rana temporaria* (common frog). Spawn seen at Hertford, March 9—R. T. A.; Harpenden, March 10—J. J. W; St. Albans, April 9—Mrs. Arnold; Ware, April 10—R. B. C.

Selecting from these the phenomena noticed also in 1878, we find that the honey-bee was first seen in the county 38 days later than in that year, the large white cabbage-butterfly 11 days later, and the small white cabbage-butterfly 22 days earlier; that the fly-catcher was first seen 6 days later, the field-fare 5 days later, the swallow 3 days earlier, and the swift on the same day; that the song-thrush was first heard 36 days earlier, the nightingale 7 days later, the skylark 11 days later, and the cuckoo 1 day earlier; that rooks began to build 13 days later; and that frog-spawn was first seen 5 days later. These 13 species give an average date for 1879 of 5½ days later that 1878; and it would thus appear that animals are not so much affected by the seasons as plants are.

The appearance in unusual numbers of a species of moth, *Nudaria mundana*, at Harpenden, on the 13th of December, is noticed at page xvii of the present volume of our 'Transactions.'

XVI.

NOTES ON THE FLUKE IN SHEEP.

By Alfred T. Brett, M.D.

Read at Watford, 20th April, 1880.

The metamorphoses of insects is a subject that has much charm and fascination about it, and the metamorphoses of the Entozoa, or parasitic worms, are not less remarkable, nor are they less interesting than the metamorphoses of insects. It seems that many parasites require to go through the bodies of two animals to acquire their perfect growth. But it is not my intention to detain you with an account of the natural history of parasites in general or of flukes in particular, for the family of flukes is a numerous one, and has been estimated by some naturalists at from 400 to 500 species, all of which are supposed to pass through allied metamorphoses. I shall only briefly direct your attention to a few facts connected with fluke in sheep.

The subject is of great importance. The 'Times' says, in a leading article, on April 13th, 1880: "An insidious and protean creature, called the fluke, is causing losses actually exceeding, in the aggregate, the cost of many of the wars which have figured in the indictment against the Ministry." In 1861 there were 3,556,050 sheep in Ireland. Professor Fergusson, in reporting on the disease to the Irish Government, says: "It is my opinion that more than 60 per cent. of the sheep on the island are at present unsound, although not all to a fatal extent." A correspondent in the 'Echo' says: "The losses of sheep in the three counties of Somerset, Devon, and Cornwall may be counted by thousands; hundreds of farms in these counties are virtually denuded of sheep." I am informed that one farmer in Watford has lost 400 sheep at Pinner; and sheep have been sold in Watford Market for from three to four shillings each.

The fluke is called *Distoma hepaticum* or *Fasciola hepatica.* It belongs to the order Trematoda, which denotes that it is a suctorial worm. It is a matter of minor importance whether we speak of this entozoon as a liver-fluke, trematoid worm, *Distoma*, or *Fasciola. Distoma hepaticum* varies in size in the same animal according to the age of the entozoon. Although this is the case, it is a singular circumstance, hereafter to be explained, that none are found in long existing cases of rot so small as to warrant the belief that they have been hatched from ova deposited within the biliary ducts. The form is that of an oblong oval, flattened from side to side. It will often attain a length of an inch and a quarter, and a breadth of half an inch in its widest part. It reminds one of a flounder or some flat fish. It will live a few hours after the liver has been removed, and it can be seen to move about. The colour varies according to the amount of bile in the digestive system. If full, after a good meal, it is dark brown or brownish black; if nearly empty, yellowish brown. If taken from the liver, it turns pale and almost white. It has been calculated that the uterus of the fluke may contain 40,000 eggs, and some sheep may have 1,000 flukes, so that there may be 40,000,000 fluke's eggs in one sheep. The fluke is hermaphrodite. It seems that the eggs have a good deal of vitality; some have been kept for two years, and yet they retained their vitality. They are the one hundred and eightieth of an inch long, and three hundredths broad. It is thought that the eggs having passed from the sheep on the ground give rise to ciliated embryos. Each egg may contain five or six embryos, so that a sheep may contain two hundred millions of possible flukes. These embryos are ciliated and free swimming, and they exhibit the figure of an inverted cone. After the lapse of a few days the cilia fall off, the embryo then assuming the character of creeping larva (*Planulæ*—Cobbold).

Flukes are parasitic to mammals, birds, fishes, reptiles, and even to invertebrate animals. They have been found in the horse, more often the ass, the ox, and in some twenty instances in man. It is supposed that after a time the embryos of the fluke become encysted, in which state they have been called *Cercaria*, and that they may enter the bodies of some kinds of snails, or remain on the herbage, and be eaten by sheep; and as they do not in ruminants go into the true stomach at once, they have time to become developed, and then they go into the liver and become flukes. It seems to me that all the possible changes and metamorphoses that flukes may undergo are not fully known; and it is possible that there may be changed forms yet to be discovered.

If the microscopic object which has been seen in the muscle of rotten sheep proves to be a fluke in one of its forms, the knowledge of this fact will greatly add to our knowledge of the natural history of the *Distoma hepaticum*. My attention was first called to it by Dr. Mason, Medical Officer of Health for Pontypool, and perhaps I had better quote his words. He says: "It so happened that I heard that a lot of sheep had been bought in Monmouth market for 2*s*. 6*d*. and 3*s*. 6*d*. each, and that many would find their way to our town (Pontypool). I asked my inspector to watch the slaughter-houses, and give me word if he saw any suspicious-looking sheep. He informed me that forty 'dickey' sheep were to be found in one slaughter-house, and not one liver. (The livers had been removed by the butcher.) I visited the slaughter-house, and there saw the worst lot of mutton I had ever beheld. I ordered my inspector to seize the lot pending my investigation. I ordered each sheep to be numbered and a sample to be cut out of each, and to be numbered also. I then proceeded to find out if the microscope could not reveal to me something reliable and tangible to warrant me in condemning these sheep. After many specimens had been examined, I was astonished to find a peculiar-looking parasite in the muscular fibre, always having the same appearance, the worst-looking meat always having the most parasites, the best-looking having few or none. Out of thirty-two sheep examined I condemned eighteen, which were ordered by the magistrates to be destroyed. The parasite always lies in the sarcolemma of the muscular fibre, longitudinal with it, sometimes straight, sometimes curved. It has the appearance of being alternately segmented, and each segment cellular. I have examined much meat, and I have always found the parasite if fluke is found in the liver; consequently I associate the two. My opinion is that meat infested with this particular parasite is unfit for human food." Dr. Mason then adds a sketch of the parasite, and he mounted a specimen, which he has given to me; I have it here for you to inspect presently under the microscope. He obtained the specimen in this way. He took a small piece of the meat from the flank of the sheep, and with a penknife he cut a very small piece from it in the longitudinal direction of its fibres, and then placed it between two glasses, and looked at it with a quarter-of-an-inch object-glass. In appearance it very much resembles the parasite figured by Huxley, and called *Cercaria ephemera*,* only Mason's parasite is straight or wavy, and Huxley's is curled round in a sac like an ammonite.

The liver-fluke being called *Distoma hepaticum*, I propose provisionally to call Dr. Mason's parasite *Distoma musculum*.

Dr. Harley, in a letter to the 'Times' of April 20, 1880, refers to a letter from a "Dartmoor Farmer," who stated that small flukes had been discovered in a lamb only four weeks old. I am told that lambs only begin to eat at two to three weeks old, and it seems strange that the flukes should have been developed in such a short time. It seems probable that they may be developed in more ways than one.† Can it be possible that the ova of flukes can be developed in the muscle of the sheep, and that the parasite I have called *Distoma musculum* may be a fluke in one of its stages?

I fear I have taken up too much time, but before I conclude allow me to make a few practical remarks.

1st.—It seems possible to produce the rot in sheep at pleasure. "The late Mr. Bakewell was of opinion that after May-day he could communicate the rot at pleasure, by flooding and afterwards stocking his closes, while they were drenched and saturated with moisture."‡ I am informed that Mr. Bakewell constantly put this into practice, for two reasons. He had a valuable breed of sheep which he did not want to become too common. He therefore allowed some of his sheep which he wished to sell to acquire the

* Simonds' 'Rot in Sheep,' p. 57.

† I have been favoured by our President with the following remarks on this point:—"I quite agree with you that flukes may be developed (or, I should prefer saying, introduced into the sheep) in more ways than one. I do not believe that any species of *Limnæa* or pond-snail, much less slugs, which inhabit watery places and are the reputed nurses of the *Cercaria* or encysted flukes, would be eaten by sheep, because these molluscs live altogether on the ground and not on grass or plants of any kind. It is more probable that the embryo of the fluke may find its way into the sheep through the muscles of the sheep's foot or through its skin when it lies down.—*J. Gwyn Jeffreys.*"

‡ Harrison 'On Rot,' p. 36.

rot, well knowing that their death-warrant was then signed, and that in a few months they must either die of the butcher or of disease. Secondly, sheep which have the rot get fat five to six weeks earlier than other sheep. Perhaps the fluke at first makes them hungry and they eat more; but it is rather a dangerous experiment, because after a time the fluke causes disease of the liver, and of other parts, and the sheep will become lean.

2nd.—If it is possible to give the rot to sheep, it is equally possible to prevent the disease by following the opposite plan of treatment.

3rd.—The disease when once established in the liver of the sheep is incurable; no drug will get to the large vessels inside the liver of the sheep so as to destroy the flukes. The best remedy is the butcher.

4th.—The meat has not been known to produce any disease in man. If we were to eat the fluke in an early stage, our gastric juice would most likely destroy it. It must be remembered that our stomach differs widely from that of ruminant animals. The 'Lancet' says that the meat of a sheep that has fluke is not unwholesome. The fact is that rot in sheep is a disease that has been known for a great many years, and the meat of such sheep has been habitually taken, and no harm has been seen to result from it. But the question is only one of degree. In the early stages of the disease the muscles have not been diseased, and the meat may be eaten. When disease has advanced and produced general or constitutional symptoms, the meat must be refused. It is customary to eat the livers of sheep that have fluke in them. This in my opinion is wrong; such livers should be burnt; for as one sheep may have two hundred millions of possible flukes in it, the sooner the livers are destroyed the better for all. The meat of flukey sheep has been eaten in Watford by all classes, and such meat by good judges and epicures has been pronounced to be excellent.

This very imperfect sketch shows that there is still much to be learnt, and I strongly advise our members to study entozoic diseases.* Hitherto it has been too much the custom to look upon entozoa as an effect rather than as a cause of disease. Are they so in that condition of the flesh of the pig vulgarly called measled (mizzled) pork, or in gid in sheep, or in dyspnœa in calves and lambs, or in the gapes in chickens? If not, why should they be so considered in rot?

* Those who wish to study the subject would derive help from Dr. Cobbold's 'Entozoa,' Simmonds' 'Rot in Sheep, its Nature, Cause, Treatment, and Prevention,' and an article in the 'Pharmaceutical Journal' for April, 1880.

XVII.

MISCELLANEOUS NOTES AND OBSERVATIONS.

Read at Watford, 20th April, 1880.

Geology.

Section of Stanmore Brewery New Well and Boring.—The well, which has recently been sunk here for Mr. T. M. Clutterbuck by Messrs. G. Tidcombe & Son of Watford, the Engineers, and Mr. R. Paten of St. Albans, the Contractor, is carried to a depth of 316 feet to the bottom of the steining; from the bottom of the steining to the chalk it is continued for a further depth of 8 feet; and the cylinders are carried 4 feet into the chalk; total 328 feet. The bore pipe is carried into the boring 42 feet further, beyond which 193 feet of chalk has been bored into, making a total depth of 563 feet. The beds passed through are as follows:—vegetable soil with gravel and clay, 4 feet,—yellow clay, 5 feet 3 inches,—blue clay, 277 feet,—hard sand, 1 foot 6 inches,—mottled clay, 13 feet,—green sand, 4 feet,—hard mottled clay, 7 feet,—grey sand, 4 feet 6 inches,—sand and pebbles (a little water here), 3 feet,—stone bed with flints, 1 foot,—green sand and pebbles, 2 feet 3 inches,—flints, 1 foot 6 inches (total depth to chalk, 324 feet),—in chalk with flints and bed of hard chalk rock, 239 feet,—total, 563 feet.—*George Tidcombe, Jun., Bushey.*

Botany.

Plants not previously recorded as growing in certain districts near St. Albans.—I communicate the following list of plants which I have noticed in this neighbourhood, not so much on account of the rarity of all the specimens as because they are not recorded in the 'Flora Hertfordiensis':—

Cardamine sylvatica, in a ditch near Bricket Wood.

Erythræa Centaurium, very abundant on railway-bank near Bricket Wood.

Cheiranthus Cheiri has grown on the ruins of Sopwell Nunnery for a great number of years, but is not recorded.

Stellaria aquatica occurs in an osier bed, near Harpenden.

Parnassia palustris, near Harpenden.

Bidens cernua, *Pedicularis palustris*, and *Scutellaria galericulata*, on Hedges Farm, in a field bordering the Ver.

Lathræa Squamaria * is parasitical on the roots of some large elms near Harpenden (Great Northern) Station. Possibly this is the locality meant by Messrs. Joseph Wood and N. and W. Thrale, when they say: "Near Batford Mill, by the side of the road from Luton to Wheathampstead." (See 'Flora,' p. 206.)

* We recorded this species as found near Hedges Farm some years ago. See 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. xxxvi.—Ed.

Chrysosplenium oppositifolium.—With reference to this, the following note occurs in the 'Flora':—"I have been informed that a *Chrysosplenium* is to be found in some of the ditches on Bernard Heath, but I have not been able to ascertain which species it is.—C.H." I am happy to be able to confirm the above, only instead of *on* Bernard Heath it should read *near* Bernard Heath. It is flowering at present, and is very abundant.—*A. E. Gibbs, St. Albans.*

Ornithology.

Woodcocks carrying their Young.—I observed a short time since, in the 'Times,' an elaborate description, by the Hon. Grantley Berkeley, of the mode in which this operation, viz. of carrying its young from the nest to appropriate feeding-grounds, is effected by the woodcock. Mr. Berkeley has always been a zealous observer of nature, but by no means an accurate one, and this is not the first time that the 'Times' has aided the promulgation of glaring errors in natural history, merely because they have been vouched by writers who have managed to bring their names prominently before the public. I should not, however, have drawn your attention to the mistake above referred to, but that my attention has been called to a spirited sketch in the 'Zoologist,' depicting the bird in the act of carrying its young ones dangling from its claws precisely as described by Mr. Grantley Berkeley. Now, the thing is simply *impossible*. If an owl, a hawk, or any of the "Raptores" took to carrying their own young, instead of those of other birds, no doubt they would adopt this mode, as they do in the case of a mouse or a linnet, but Nature has provided *them* with *four* prehensile claws for the express purpose, one being in opposition to the others, thereby enabling them to grasp the object (as in the human hand the thumb affords like facility); but the foot of the woodcock is altogether different, he has but *three* toes, and, besides that, they are destitute of prehensile power, they are all anterior. You might as well try to carry a basin with your toes. How then does the bird carry its young? By a much safer and more simple method—she grasps it between her thighs, pressing it against her body, and I *think*, though I am not sure, steadying it at the same time by means of her long bill. This, as we all know, is always carried at something like a right angle with the body, and a very slight further depression would suffice. However, I merely suggest this. The only time I ever witnessed the operation was on the shore of Loch Awe, from a considerable distance; the bird flew very low, and I could not be certain about the bill, but of this I *am quite* sure, that the young bird was *not* dangling from the claws, as represented in my friend Mr. Harting's clever, but misleading sketch.—*George Rooper, Watford.*

XVIII.

A FEW WORDS ON TERTIARY MAN.

By John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.G.S., etc.

Abstract of a Lecture delivered at St. Albans, 26th October, 1880.

Our Secretary was anxious for some one to give a short address at this meeting; and on my consenting to do so, he has advertised me to give a lecture, while I really had not the slightest intention of saying more than a very few words. Before doing this, however, I may venture to congratulate the Society on two points: first, on its being something of a peripatetic Society, holding its meetings at various towns throughout the county; and, secondly, on the interest the inhabitants of St. Albans take in its doings. A more inclement evening than this, one could hardly imagine, and I am glad to see such a really good attendance notwithstanding this drawback. But these matters have nothing to do with the subject of my lecture, "A Few Words on Tertiary Man." Of course every member of the Society is perfectly aware of the meaning of the term "Tertiary Man," and of the questions which are involved in it; but as there are a certain number of strangers present, it may be necessary to give some explanation of the term as an introduction to the subject upon which I am about to speak. I need hardly enter into the question of what is meant by Man, taking the word in its wider sense, but I have this evening to speak not so much of the *homo sapiens*, or wise man, as of the *homo incipiens*, or early man; and assuming that man did exist in such remote times as are implied by the word "Tertiary," we have to consider whether we shall adopt the views of Mortillet and others, and speak of him rather as an intelligent being than as a man such as those of the present day. That, however, is a point to which we need but give a very small amount of attention at this time; but as to the meaning of the word "Tertiary," a considerably larger amount of explanation is necessary. All may have heard that the history of geological time is divided into three great periods—the Primary, or Palæozoic; the Secondary, or Mesozoic; and the Tertiary, or Cainozoic—the time of recent animals, or of those of the present day. These terms of division are only arbitrary, for time is continuous; they are merely convenient divisions, founded on breaks in the continuity of strata. It is true that there are often certain breaks between different strata, but there are more clearly-defined breaks between the greater divisions. Though the gaps between these divisions are gradually being filled up, there still remains a well-marked interval between them, at all events so far as the geology of Western Europe is concerned. We are in the habit of dividing the day into morning, noon, and evening; but these divisions have no very precise limits: and though the day is divided into twelve or twenty-four hours, there are really no such divisions in nature. In the same manner these geological divisions and subdivisions, though extremely convenient, are no doubt to a certain extent arbitrary.

I need not enter into all the details of the three main divisions, but may just state that the Primary beds, which include the Coal-measures and all rocks up to the Permian, are, when containing organic remains at all, characterized by a certain kind of vegetation, such as pines, ferns, gigantic club-mosses, and, so far as animal life is concerned, by molluscs and fishes, and a few reptiles. These, however, are found only in the upper part, and no such thing as a mammal is known. The Secondary beds comprise rocks from the Trias to the top of the Chalk, and there we find in the vegetable world a considerable number of conifers, cycads, etc., deciduous trees making their appearance at the close. So far as vertebrate animals are concerned, reptiles of a large size are abundant, and there are some few birds with teeth in their bills; but the only four-footed animals are small marsupials, or pouched animals; no mammals of a higher form being then known. When, however, we come to the upper beds—the Tertiary—which comprise all the rocks up to the Norwich Crag, we find that the vegetable world exhibits other forms, such as angiosperms, or those which have their seeds inclosed in a pod or pericarp like peas; and the reptiles have to a great extent given place to large land animals—placental mammals—and the birds are true birds. These, then, are the three main geological divisions; but in addition to them there is still another period more nearly approaching the present time. This is the Quaternary, or, according to Sir Charles Lyell, the Post-Tertiary, which he divided into the Post-Pliocene and Recent. This fourth period has been also divided into the Pleistocene, the Pre-historic, and the Historic. In respect to these divisions, I may mention an admirable book treating of the whole subject of the antiquity of man, and entering largely into details, lately written by Professor W. Boyd Dawkins, called 'Early Man in Britain and his Place in the Tertiary Period,' from which I have to some extent borrowed. This evening, however, we have not so much to do with this particular branch of the subject as with actual Tertiary times, and these are usually subdivided into three divisions—an arrangement for which we are indebted to Sir Charles Lyell, who noticed that in the early deposits there was only a certain small per-centage of living forms present, while in the later the proportions increased. He therefore divided the Tertiary Period into the Eocene, the dawn of recent species; the Miocene, that with a small number of recent species; and the Pliocene period, or that with more. These have been further sub-divided into the Lower, Upper, and Middle Eocene; the Lower and Upper Miocene; and the Older and Newer Pliocene. The succession of all these subdivisions, the one to the other, is perfectly established, but the chronology of all is extremely difficult. There are no means of judging what length of time these periods embrace; nor are there means of ascertaining how long the world remained in any of these stages of development. Perhaps the best means of estimating the length of time each occupied is by noting the changes in the fauna and by comparing the living forms of one period with those immediately preceding it, and these again with those of the present day. We thus find that great changes have taken place. The vertebrate animals existing in the early periods are all absolutely extinct, and although some forms of molluscs remain—a small per-centage, it is true—yet of vertebrate land animals there is no survivor whatever of the Eocene period. Of the Pliocene period, one animal, but only one, survives—the hippopotamus—an animal of a most respectable family, if antiquity be considered, and whose Pliocene ancestors cannot be distinguished from the hippopotami of the present day.

I have now briefly explained what is meant by the term "Tertiary," and have shown that, generally speaking, it is the period of time which succeeded the Secondary—from the Chalk to the formation of the Norwich Crag—and that it embraces at least three periods—the Eocene, the Miocene, and the Pliocene. It has never, as yet, been suggested that any remains of man have been found in beds of the Eocene period. I have heard it maintained that man, being an intelligent animal, is not liable to the changes which naturalists say have supervened to influence other animals, and, therefore, that when once created he has never varied, so that consequently, under certain conditions, his remains might be found in any period, however remote. I am not, however, prepared to accept this doctrine. It is supposed that traces of man have been found not only in the Pliocene beds (a time so very remote that hardly any of its mammalian fauna has survived), but even in the Miocene beds; and this brings me to that part of my subject when it is necessary to mention certain discoveries which are asserted to have been made of the remains of man belonging to these early times.

Taking first the Pliocene beds, I may refer to the discovery by Professor Cocchi, at Olmo, near Arezzo, Italy, of a skull, and flint implements, which, however, are undoubtedly Neolithic; next, to the discovery by M. Aymard of the fossil man of Denise—mentioned by Sir Charles Lyell—although there is considerable doubt whether these are the remains of a man who had been buried beneath the Pliocene lava. A more interesting, because better established, discovery is that of M. Desnoyers, at St.-Prest, near Chartres, of cut bones and worked flints, in gravel of Pliocene times, the bones being those of the southern elephant and the worked flints being presumed to have been found associated with them. Cut bones have also been found in Tuscany by Mr. Lawley and M. Capellini, but those which I have mentioned are the principal discoveries alleged to have been made in the Pliocene beds. When we come to the Miocene beds, the first discoveries are those of the Abbé Bourgeois at Thenay, near Pontlevoy, who there found calcined flints, and worked flints, and some cut bones. These were found in the middle Miocene beds, and the bones belong for the most part to the *Halitherium*, a marine animal. Other and similar discoveries were made at Pouancé, in France, in the Upper Miocene beds, of marine origin, both above and below fresh-water limestone. M. Roujou has found flint flakes in the Upper Miocene near Aurillac, and M. Ribeiro has found worked flints at Otta in the valley of the Tagus, in beds below those containing *Hipparion gracile*, *Rhinoceros minutus*, *Sus chœroides*, and *Mastodon angustidens*, and which have been indifferently regarded as Pliocene and Miocene. Perhaps the most renowned discovery is this in the valley of the Tagus, and I had an opportunity lately not only of seeing the objects collected at this place, but also of visiting the spot where they were found. Some few of these were flakes showing more than one trace of human workmanship on them, and they occurred here, according to the reports of the Portuguese geologists, not only in Pliocene, but in Miocene beds.

These, then, are the presumed facts, and they lead to the theory of man being found on the earth at a period far anterior to the Quaternary; but I will proceed to discuss the question of his assumed existence at somewhat greater length. The subject, however, is one full of difficulty, and requires to be approached with great caution, but that is exactly what I am afraid every one who has treated of this question has not done. In order to establish the existence of man at such a remote period, the proofs must be convincing. It must be shown, first, that the objects found are of human workmanship; secondly, that they are really found as asserted; and, thirdly, the age of the beds in which they are found must be clearly ascertained and determined. Unless this were done, the whole question would drop through, and be at an end. The cut bones, belonging to the Pliocene time, are in most cases those of the whale or of some marine animal, some of which have sharp cuts upon them, in one case at least the cuts appearing almost as if made with a steel knife. They are, indeed, so sharp that I doubt whether they could be produced by flints, and no tools have ever been found with the bones, except at St.-Prest. It has been suggested that the early man found the whales or other animals stranded, and cut off the fleshy parts from the bones, leaving on them the marks of where they had been cut; and it did appear that the cuts were where the muscles would be most firmly attached, and where they would most likely be made. On the other hand, it was suggested that these cuts might be made by the teeth of sharks or of the sword-fish. M. Delfortrie, of Bordeaux, found bones in the Upper Miocene of Leognan (Gironde), nearly all cut and scratched, but these beds are essentially marine, and contain carnivorous fishes, such as the *Sargus serratus*. If the cuts are of human workmanship, there is no trace of tools, and I can hardly accept the theory that these bones of animals should be cut and scratched by man, and yet no tools be found near them. The beds were, moreover, deposited in the sea, and unless the mermaids of that early time had very numerous families, it is difficult to realise who lived on the flesh of the whales and marine animals. In the same way, in respect to the bones found at St.-Prest, it has been suggested that the cuts might have been made by the shark or sword-fish, and certainly remains of *Conodontes*

Boisvilletti have been found in those beds. I think, therefore, that we may put on one side this question of cut bones, or carry it to a suspense account; and that we must wait for further evidence before accepting the theory of the existence of men whose principal occupation appears to have been to cut bones at the bottom of the sea, and destroy the tools they used. But when we come to the question of flints, we have to determine what are the signs of human workmanship. The principal mark is what has been called the bulb or cone of concussion.

By striking a flat surface of flint a sharp blow with a hammer (as I now do to illustrate my meaning), what is called a bulb or conoïd of percussion is formed, and if any of these bulbs or cones are present on flints dug out of the earth, there is at all events a probability that they have been caused by human hands, especially if a flint exhibits, as many specimens do, numerous bulbs of percussion, or depressions corresponding to such bulbs, showing that numerous blows have been administered. For, though it is possible for a single bulb of percussion to be formed on a flint by dropping it from a height on to a rock or stone, or by some other natural means, yet it is impossible for the numerous bulbs of percussion observable on a flint spear-head (such as the specimen which I now exhibit) to have been produced by other than human agency. Thus, isolated flints with single bulbs of percussion on them are of small value as evidence; while those with numerous bulbs may be far more readily and safely accepted as being the work of man, or of some intelligent being. When, then, one or two such marks are observed on a flint, the probability of its being a tool made by early man is great; but when a number are present, this probability becomes a certainty. That being the case, we may go on to consider the finding of such flints at different spots. The theory of the existence of man in the Miocene and other Tertiary beds depends on the statements that the tools were actually found in the particular beds mentioned; and I venture to say that in the case of St.-Prest and Thenay, where it was alleged they were found in the Pliocene, this is, in my opinion, doubtful. Though the age of the beds at these places is undoubted, the alleged finding of the tools in them can hardly be accepted as a fact. Mr. Franks, who is present here to-night, was one of a committee which was appointed to consider and report upon the genuineness of these alleged worked flints, and I will ask him to give his opinion upon them. At Aurillac the flint certainly appeared to be of human workmanship, but it was found in a conglomerate the age of which might be questioned; and at Otta the flakes as a rule only showed a single bulb of percussion, and, having been found on the surface, their evidence is of small value. I should, moreover, be very sorry to maintain that the beds in which they occurred are undisturbed strata belonging to the Miocene period. I am not sure that any of the presumed implements actually found in these early strata are implements at all, and so far as the theory of the existence of man in the Tertiary period is concerned, I must for the present recommend you to return the Scotch verdict of "not proven." At the same time, there is no reason whatever why man should not have been Pre-glacial, and the view of Professor Dawkins that during the deposit of the river-gravels of the south of Britain the northern part of this country was exposed to the action of glaciers may prove to be well founded. Although I am unable to accept the evidence of man having existed in the Pliocene period, it must not for a moment be forgotten that among all those who have paid any attention to this subject, there is an absolute conviction of the great antiquity of the human race. Even in this country man was living when the rivers were flowing 80 or 90 feet above their present level, before the channel between England and France was cut, and at a time when St. Alban's Head was continuous land with the Isle of Wight. Such facts give us some idea of the antiquity of Quaternary man. The fauna of that period was not essentially different from that of the present, and of the animals some are extinct, and some have migrated to other lands. But to say that man existed in the Pliocene period is very different. There is only one of the higher animals—the hippopotamus—that has survived from that period. And when we come to Miocene times, it is stranger still if such a being as man existed.

In the presence of our learned President, I will not express my views upon the doctrine of evolution, but will only say that from some cause or other certain changes have in the course of time taken place in the forms of animals. At the time when these implements are supposed to have been made, the horse was represented by the hipparion, which had on each foot two separate toes besides the central hoof. The mastodon was thriving, and there was living a series of animals, vastly differing in various characteristics from those of the present day, but still sufficiently allied to them to suggest the highest probability of their being ancestral forms. These facts afford a very strong argument against man alone remaining unchanged amongst all these other changes; but, whatever view may be held with regard to the question of the existence of man in these remote ages, it must not be imagined that it is in any way proved that Palæolithic man was the first human being that existed. We must be prepared to wait, however, for further and better authenticated discoveries before carrying his existence back in time further than the Pleistocene or Post-Tertiary period.

XIX.

RAINFALL IN HERTFORDSHIRE, 1840-79.

By the Rev. C. W. Harvey, M.A., F.M.S.

Read at Watford, 14th December, 1880.

One of the objects of our Society being the investigation of the meteorology of the county in which we live, it occurred to me that it might be both useful and interesting to lay before the Society a few facts connected with the rainfall of the County of Hertford; facts drawn from records furnished me by various local observers, whom I would here most cordially thank for their assistance.

I have endeavoured to effect my object by means of tables, because tables are concise, and, what is more, *speak for themselves*.

Table I.—This table gives the general distribution of the stations now in existence. Following a plan, devised I believe by the late Mr. Coleman, and elaborated by Mr Pryor, for the purposes of botanical research,* I have divided the county into 17 River Districts. The table gives the names of these districts, with the number of stations in each. Thus we see that our weak points lie in districts 1, 3, 6, 7, 14, and 16.

Table II.—This gives the particulars of the stations now in existence, the oldest of which has entered upon its 47th year, while two others are scarcely less venerable.

Tables III, IV, V, VI.—Dividing the period into four decades, I have in these tables deduced the mean monthly and annual fall in each decade; also the mean values of the wettest and driest years. In drawing up these tables I have only made use of the records of those stations which have been able to furnish *complete* returns for the decade. Comparing these four tables, it will be noticed that while the mean fall for the 5th and 6th decades of the century differs very slightly, and while the 7th is about the mean of the two preceding decades, the 8th decade shows a very marked increase.

Table VII.—The object of this table is to show in what percentage the rainfall was distributed throughout the year. By this we see that whilst the driest quarter in each decade was *alternately* the 1st and 2nd, the wettest quarter, with the exception of the 5th decade, was the 3rd. The first quarter in the 6th decade appears to have been an exceptionally dry one.

Table VIII.—What constituted a wet day was for some time a doubtful point. I have, therefore, in considering this part of my subject, gone no further back than the decade just completed. The stations upon the records of which this table is based are, Nash Mills, Berkhampstead, Hitchin, and Royston. There is no very great difference in the number of wet days per month, the mean

* See map, 'Trans. Watford Nat. Hist. Soc.,' Vol. I, Pt. 3.

varying from 13 to 16; nor is there much difference in the number of wet days per quarter. November, with 16 out of its 30 days wet, showing an average fall of 0·17 in. each wet day, appears to be on the whole the wettest month; whilst March, with its 13 wet days and mean of 0·10 in. per wet day, seems to be the driest month.

Table IX.—I have in this table attempted as far as I could to compare the mean rainfall of each district with the mean fall of the county. Moving across England in a north-easterly direction, you will find that the rainfall *decreases* as you proceed; and even within the limits of our own county this is clearly perceptible. Compare the mean rainfall of the Gade district in the S.W. with the mean rainfall of the Rhee district in the N.E., and you will find that while the former is 6 °/。 and 7 °/。 *above*, the latter is 10 °/。 and even 16 °/。 *below* the mean of the county.

Tables X, XI, XII.—These tables need no particular comment, only showing *extremes* of rainfall.

To conclude, I trust that these tables, which I have endeavoured to make as accurate as possible, may prove both of interest and of use to the numerous observers of rainfall; and I would fain hope that since I have followed out Mr. Pryor's system of river districts, comparing the rainfall of one district with that of another, they may not prove altogether uninteresting to our botanical members and friends.

Table I.—*Showing River Districts and Distribution of Rainfall Stations.**

No.	River Districts.			No. of Stations. 1860.	1870.	1880.
1	Thames.	Thame	Upper Thame	0	0	0
2		Colne	Lower Colne	0	1	6
3			Upper Colne	0	0	0
4			Ver	2	3	3
5			Gade	2	3	4
6			Chess	0	0	0
7		Brent	Upper Brent	0	0	0
8		Lea	Lower Lea	0	0	1
9			Upper Lea	1	1	3
10			Mimram	0	0	2
11			Beane	0	1	2
12			Rib	0	0	2
13			Ash	0	1	1
14			Stort	0	0	0
15	Ouse.	Ivel	Hiz	1	1	2
16			Upper Ivel	0	0	0
17		Cam	Rhee	1	1	2
				7	12	28

* The arrangement adopted is the same as in the map forming Plate III. of the present volume.

TABLE II.—*Giving particulars of the Stations now in existence.*

No. of District.	STATION.	OBSERVER.	Observations commenced.	Diameter of Gauge.	Height of Gauge. Above Ground.		Height of Gauge. Above Sea-level.
				ins.	ft.	ins.	ft.
	WATFORD—						
2.	Bushey Heath...	F. Scott	1879	5	4	3	480 T
2.	,, Station	R. Savill	1876	5	0	7	220
2.	Watford House	A. T. Brett	1876	8	1	3	240
2.	Wansford House	J. Hopkinson.........	1878	5	1	0	224 ⩚
2.	Oaklands	E. Harrison	1871	5	5	6	273 ⩚
	RICKMANSWORTH—						
2.	Moor Park	Lord Ebury	1876	6	2	0	340
	ST. ALBANS—						
4.	Gorhambury ...	Earl of Verulam......	1853	6	2	6	
	HARPENDEN—						
4.	Rothamsted......	Drs. Lawes & Gilbert	1853	72 × 87	0	9	420 T
	DUNSTABLE—						
4.	Kensworth	Miss Jones	1864	5	1	0	630 B
	HEMEL HEMPSTED—						
5.	Nash Mills	Dickinson & Co.......	1833	12	3	9	237 T
5.	Gt. Gaddesden ...	Rev. W. T. Drake...	1876	8	1	0	426 ⩚
5.	BERKHAMPSTED ...	W. Squire	1848	8	1	5	370 B
	TRING—						
5.	Cowroast	H. Thomas, C.E. ...	1868	10	4	2	345 L
	SOUTHGATE—						
8.	The Lawns	H. P. Church........	1876	6	0	8	240 T
	HERTFORD—						
9.	Bayfordbury ...	W. Clinton Baker ...	1859	8	0	4	250
9.	WARE	J. Muir, C.E.	1876	12	3	9	102 T
	HATFIELD—						
9.	Brocket Hall ...	Hon. H. Cowper, M.P.	1877	8	1	0	
10.	WELWYN	Rev. C. L. Wingfield	1872	5	0	4	
10.	Datchworth......	Rev. J. Wardale ...	1877	6	1	0	357 T
11.	STEVENAGE	Rev. J. O. Seager ...	1868	8	2	0	319 L
11.	Knebworth	Rev. T. G. Jenyns...	1876	5	1	0	407 T
	BUNTINGFORD—						
12.	Throcking	Rev. C. W. Harvey	1880	5	1	0	484 ⩚
	ROYSTON—						
12.	Therfield	Rev. J. G. Hale......	1877	5	4	3	500
	WARE—						
13.	Much Hadham	Rev. H. Mott	1866	5	1	0	222 B
15.	HITCHIN	W. Lucas	1850	8	1	0	238 ⩚
15.	High Down......	J. Pollard	1878	5	1	1	422 T
17.	ROYSTON	H. Wortham	1842	8	0	6	269 ⩚
17.	Odsey Grange ...	H. G. Fordham......	1877	5	1	0	264 ⩚

TABLE III.—*Showing Mean and Extreme Rainfall of One Station for 5th Decade.*

Name of Station.	Mean Rainfall, 1840-49.												
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.-Dec.
HEMEL HEMPSTED (Nash Mills)	2·24	1·92	1·51	1·54	2·08	1·71	2·12	2·30	2·45	3·34	2·85	1·76	25·82
Wettest Year, 1841	1·50	1·02	1·65	1·85	1·68	3·00	2·80	3·62	4·00	4·40	4·28	2·30	32·10
Driest Year, 1840	3·95	1·32	0·34	0·34	2·62	1·33	1·18	1·90	2·31	1·50	4·25	0·40	21·44

TABLE IV.—*Showing Mean and Extreme Rainfall of Two Stations for 6th Decade.*

Name of Station.	Mean Rainfall, 1850-59.												
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.-Dec.
HEMEL HEMPSTED (Nash Mills)	2·44	1·19	1·51	2·00	2·10	2·16	3·07	2·43	2·16	3·37	2·29	1·65	26·37
HITCHIN	1·96	1·20	0·99	1·75	2·34	1·96	3·23	2·68	1·84	3·06	2·18	1·44	24 63
Mean	2·20	1·19	1·25	1·88	2·22	2·06	3·15	2·55	2·00	3·22	2·23	1·55	25·50
Wettest Year, 1852	4·85	1·26	0·31	0·76	2·14	4·28	3·94	3·93	3·21	4·06	6·27	2·58	37·59
Driest Year, 1854	1·68	1·14	0·28	0·77	3·58	0·85	1·72	1·87	0·55	2·33	1·37	1·53	17·67

TABLE V.—*Showing Mean and Extreme Rainfall of Seven Stations for 7th Decade.*

NAME OF STATION.	MEAN RAINFALL, 1860-69.												
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.—Dec.
ST. ALBANS—Gorhambury	3·08	1·72	2·14	1·57	2·28	2·73	1·89	2·64	2·59	2·52	2·29	2·34	27·79
HARPENDEN—Rothamsted	2·92	1·66	1·93	1·78	2·27	2·66	1·99	2·71	2·46	2·60	2·04	2·08	27·10
HEMEL HEMPSTED—Nash Mills	2·88	1·59	1·98	1·45	2·25	2·48	1·84	2·58	2·61	2·34	2·07	2·22	26·29
BERKHAMPSTED	3·28	1·96	2·31	1·69	2·28	2·70	1·91	2·74	2·90	2·56	2·35	2·52	29·20
HERTFORD—Bayfordbury	2·60	1·69	1·96	1·39	2·08	2·16	1·78	2·30	2·39	2·31	2·17	2·18	25·01
HITCHIN	2·50	1·59	1·97	1·30	1·95	2·09	1·91	2·47	2·15	2·26	1·85	1·85	23·89
ROYSTON	2·37	1·49	1·97	1·30	2·15	1·88	1·69	2·42	2·18	2·15	1·94	1·93	23·47
Mean	2·80	1·67	2·04	1·50	2·18	2·39	1·86	2·55	2·47	2·39	2·10	2·16	26·11
Wettest Year, 1860	3·24	1·30	2·15	1·31	3·80	5·62	1·78	4·27	2·68	1·61	2·55	2·36	32·67
Driest Year, 1864	1·13	0·93	3·05	1·05	2·23	1·37	0·43	0·66	2·58	1·32	2·57	0·54	17·86

TABLE VI.—*Showing Mean and Extreme Rainfall of Twelve Stations for 8th Decade.*

NAME OF STATION.	MEAN RAINFALL, 1870–79.												
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.–Dec.
WATFORD—Cassiobury	2·48	1·75	1·85	2·01	1·87	2·52	2·71	2·74	2·37	2·55	2·66	2·12	27·63
ST. ALBANS—Gorhambury	2·73	1·91	1·72	2·28	2·32	2·27	2·78	2·62	2·75	2·66	2·74	2·23	29·01
HARPENDEN—Rothamsted	2·92	2·02	1·66	2·22	2·28	2·56	2·80	2·73	2·76	2·98	2·94	2·25	30·12
DUNSTABLE—Kensworth	2·53	1·79	1·59	2·27	2·30	2·34	2·87	2·83	2·99	2·83	2·89	2·33	29·56
HEMEL HEMPSTED—Nash Mills	2·72	2·01	1·67	2·13	2·14	2·44	2·70	2·53	2·69	2·59	2·74	2·23	28·59
BERKHAMPSTED	3·03	2·18	1·77	2·22	2·40	2·51	2·75	3·00	2·92	2·98	3·06	2·47	31·29
TRING—Cowroast	3·16	1·84	1·96	2·14	2·21	2·16	2·82	2·93	2·52	3·33	3·23	2·40	30·70
HERTFORD—Bayfordbury	2·58	1·84	1·61	1·97	1·91	2·41	2·31	2·72	2·62	2·42	2·58	2·13	27·10
STEVENAGE	2·28	1·70	1·55	1·97	2·08	2·24	2·71	2·29	2·50	2·24	2·64	2·05	26·25
WARE—Much Hadham	2·33	1·67	1·71	1·82	2·11	2·39	2·46	2·22	2·68	2·08	2·72	2·05	26·24
HITCHIN	2·22	1·59	1·48	1·95	1·98	2·13	2·70	2·27	2·47	2·17	2·60	2·05	25·61
ROYSTON	1·96	1·59	1·42	1·68	1·90	2·13	2·11	2·32	2·36	1·90	2·28	1·90	23·55
Mean	2·58	1·82	1·67	2·05	2·13	2·34	2·64	2·60	2·64	2·56	2·76	2·18	27·97
Wettest Year, 1872	4·30	1·33	2·23	1·90	2·88	3·22	2·98	2·10	1·18	4·31	3·91	4·19	34·53
Driest Year, 1870	1·46	1·87	2·07	0·44	1·14	0·82	1·14	2·03	1·92	3·74	1·41	2·78	20·82

TABLE VII.—*Showing Distribution of Rainfall throughout the Year.*

YEARS.	1ST QUARTER.	2ND QUARTER.	3RD QUARTER.	4TH QUARTER.
	%	%	%	%
1840—49	22	21	26	31
1850—59	18	24	30	28
1860—69	25	23	27	25
1870—79	22	23	28	27

TABLE VIII.—*Showing Mean Number of Wet Days and Mean Fall on each Wet Day*, 1870–79.

MONTH.	MEAN NUMBER OF WET DAYS.		MEAN FALL.
	Per Quarter.	Per Month.	Per Wet Day.
January		16	·16
February	45	15	·11
March		14	·10
April		13	·13
May	40	13	·13
June		14	·14
July		13	·16
August	40	14	·14
September		13	·16
October		15	·16
November	46	16	·17
December		15	·13

TABLE IX.—*Showing the Mean Rainfall in each District, and the Relation it bears to the Mean Fall in the County.*

DISTRICT NUMBER.	RIVER DISTRICT.		NO. STATIONS 1860.	NO. STATIONS 1870.	1860–69.		1870–79.	
					District Mean Fall.	± County Mean Fall.	District Mean Fall.	± County Mean Fall.
						%		%
2	COLNE	Lower Colne...		1			27·56	− 2
4	COLNE	Ver..............	2	3	27·49	+ 5	29·92	+ 7
5	COLNE	Gade	2	3	27·67	+ 6	30·24	+ 7
9	LEA	Upper Lea......	1	1	25·06	− 4	27·13	− 4
11	LEA	Beane...........		1			26·31	− 7
13	LEA	Ash		1			26·28	− 7
15	IVEL	Hiz..............	1	1	23·93	−10	25·96	− 9
17	CAM	Rhee	1	1	23·52	−10	23·59	−16

TABLE X.—*Showing Maximum and Minimum Yearly Fall in each Decade.*

Decade.	Maximum Fall.			Minimum Fall.		
	Station.	Date.	Amount.	Station.	Date.	Amount.
5th	Nash Mills	1841	32·10	Nash Mills	1840	21·44
6th	Nash Mills	1852	41·14	Hitchin	1854	17·13
7th	Berkhampsted...	1860	36·34	Royston	1864	16·62
8th	Moor Park	1879	42·56	Fieldes Weir ...	1870	16·83

TABLE XI.—*Showing Maximum and Minimum Monthly Fall in each Decade.*

Decade.	Maximum Fall.			Minimum Fall.		
	Station.	Date.	Amount.	Station.	Date.	Amount.
5th	Nash Mills...	Oct. 1846	6·36	Nash Mills...	May 1848	0·21
6th	Nash Mills...	Nov. 1852	6·95	Hitchin ...	Feb. 1857	0·11
7th	Rothamsted	Oct. 1865	7·35	Rothamsted	Sept. 1865	0·17*
8th	Bayfordbury	Aug. 1878	7·64	Cassiobury ...	April 1870	0·08

TABLE XII.—*Showing the Heavy Falls which have occurred in 24 Hours,* i.e. *Falls of 2 Inches or more.*

No.	Station.	Date.	Amount.
1	Berkhampsted.....................	1857, October 22nd	2·65
2	Stevenage	1868, August 19th...........	2·90
,,	Hitchin	,, ,, ...	2·22
3	Welwyn	1874, July 11th	2·50
4	East Barnet.......................	1878, April 10th..............	2·56
,,	Brocket Hall	,, ,, ...	2·11
5	Oaklands, Watford..............	,, June 30th..............	2·77
,,	Bayfordbury	,, ,, ...	3·68
6	Kensworth	1879, August 2nd	2·34
,,	Rothamsted.......................	,, ,, ...	2·37
,,	Nash Mills	,, ,, ...	2·50†
,,	Berkhampsted....................	,, ,, ...	2·50
,,	Great Gaddesden.................	,, ,, ...	2·36
,,	Therfield	,, ,, ...	3·03
,,	Royston	,, ,, ...	3·00

* A similar minimum occurred at Hitchin in July, 1864.
† Gauge upset.

XX.

THE FLOOD IN THE VALLEY OF THE GADE, 3RD AUGUST, 1879.

By John E. Littleboy.

Read at Watford, 11th December, 1880.

The year 1879 will long be remembered as remarkable for the unusual quantity of its rainfall, and it seems desirable that some particulars of the notable storm that passed over a portion of our county on the 2nd and 3rd of August should be preserved among the records of our Society. It appears to have approached our district, in a north-easterly direction, from the valley of the Thames. It commenced, in this neighbourhood, between the hours of 9 and 10 o'clock on the evening of Saturday, the 2nd of August, and from that time until nearly 5 o'clock on Sunday morning an extraordinary downpour of rain, accompanied by loud peals of thunder and almost incessant lightning, continued without perceptible intermission. The quantity of rain that fell during these six or seven hours has been recorded as under:—Berkhampstead, 2·5 in.; Harpenden, 3·0 in.; Great Gaddesden, 2·3 in.; Nash Mills, 2·5 in. It would be difficult to exaggerate the awful grandeur of the storm. It is spoken of in Symons' 'Meteorological Magazine' (vol. xiv, p. 97) as one of "excessive severity." Between 10 and 12 p.m. flashes of sheet and forked lightning occurred continuously or with only momentary intervals, and lighted up our rooms so completely that every object around us was distinctly visible. At about 3 a.m. the extreme violence of the storm began to moderate, and before 5 it had almost subsided.

At nine o'clock on Sunday morning the sky was clear, the atmosphere fresh, and at Hunton Bridge a somewhat swollen river was the principal remaining evidence of the past tempest. We hoped, and believed, that the worst was over; but it soon became apparent that such was not the case. The deluge of rain that had fallen during the night could not fail to leave its mark behind, and before the day was over it resulted in a flood such as, in the memory of the oldest inhabitant of the parish, had never before occurred.

It will be my duty briefly to describe the rise and progress of this remarkable flood, and I shall afterwards offer a few remarks on the causes that appear to have produced it.

I have not been able to obtain much information respecting the reaches of the Bulborne above Berkhampstead. At Berkhampstead the river joins for the first time the Grand Junction Canal, and the pound of the canal becomes the mill-head of the Lower Mill. At this spot it might be expected that the flood would make itself apparent, and I am informed that as early as four o'clock on Sunday morning the canal had overflowed its banks. The residence that adjoins the mill was surrounded by water, and a current about two feet deep rushed without let or hindrance through the rooms and passages on the ground-floor. The Lower Mill has been in the occupancy of my relations, until recently, for nearly a hundred years, and I can state with certainty that no such flood has ever occurred during that time. The flood gained volume as it proceeded onwards; a large portion of Boxmoor was under water; at Frogmore End the turnpike-road was flooded, and all the low meadows were in like condition. Along the Hempstead valley the pretty little Gade behaved itself in an equally unseemly fashion. I am informed by the Rev. W. T. Tyrwhitt Drake that, at Great Gaddesden, floods of water poured down the hills in such extraordinary volume that "the road was knee-deep," and that the "church-pool," through which the river passes, overflowed on both sides, a thing which no one ever remembered to have seen before. "Before noon the river had resumed its ordinary level," but on the hill-side "a gully 2 ft. 6 in. to 3 ft. deep, and 2 ft. to 3 ft. wide, was cut by the force of the water into the solid chalk." At Bury Mill End the flood washed away large portions of a long wall, and many cottages were flooded. A torrent of water rushed down the lane leading from the Hempstead Workhouse with such extreme violence that two gentlemen, who attempted to cross the Bury road, lost their footing; and a woman, who left her house in Queen Street, was carried by the flood down the surface-drain. The 'Hempstead Gazette' states that "she was rescued with considerable difficulty." At Nash Mills the water in the mill-tail rose about three feet, and flooded the lower rooms at the paper-mills. At Abbot's Hill water poured, literally in torrents, down the grass-meadows that slope towards Bunker's Lane; the farm-buildings were flooded, and a number of valuable Berkshire pigs only saved themselves by swimming.

By noon on Sunday the flood had fairly reached King's Langley, and the whole of the low meadows above Hunton Bridge were covered with water. At Hunton Bridge several cottages were invaded by the current, and exit could only be effected from some of them by ladders. The meadow immediately above the mill may be described as a species of *cul de sac,* drained only by a culvert that runs at the back of two cottages and thence at right angles under the mill-head. This culvert was quickly over-powered by the immense volume of water that pressed upon it; the meadows filled very rapidly; water rose to the height of 5 ft. in the sitting-rooms of the two cottages, and in some places the meadow was fully 8 ft. under water. The current next forced its way into the road, and a torrent, about two feet deep, continued to rush down it, between the mill and the farm-house opposite, until Monday morning. At about 4.40 p.m., a loud rolling noise, almost resembling thunder, announced the disagreeable fact that the culvert under the mill-head, to which I have before alluded, had been burst by the enormous power of the water, and it became more than probable that the embankment, under which the culvert passes, would shortly give way. Workmen were immediately sent for; a dam was thrown across the mill-head as rapidly as skilled hands could work; and when once it was completed all danger had ceased, but before this happy consummation was attained only about a yard and a half of the bank remained intact. Had this trifling barrier been washed away, an inundation, attended with considerable danger and great damage to property, must certainly have ensued.

Respecting the flood, I think that I have now said sufficient; it will not soon be forgotten by those who witnessed it. Allow me, in conclusion, to allude for a few moments to the causes that appear to have contributed to its occurrence.

During the year 1878, 34·27 inches of rain* had fallen over the Watford district; during the first seven months of 1879, more than 23 inches of rain had also been recorded. I give below particulars for this period received from a few neighbouring stations:—

Berkhampstead	23·31	Nash Mills	22·95
Great Gaddesden...	22·23	Watford (Wansford House)	24·90
Harpenden (Rothamsted) ...	23·89	Moor Park	28·97

I believe that in the Midland Counties a rainfall amounting to 58 inches in nineteen consecutive months is without a parallel. At the commencement of August, 1879, the soil of the lower portions of the valley was full to saturation, and this fact contributed, beyond doubt, an important item among the causes that produced the flood.

I think it may be considered that an area of one mile in extent, on either side of the river, drains into the valleys, and it must be remembered that both the Hempstead and Berkhampstead valleys alike contribute towards the supply of water to the lower reaches of the Gade. Accepting this estimate as about correct, a few measurements on the Ordnance Map enable me to compute the area of the water-shed that supplies our river as comprising about 34 square miles. I have stated that, during the short period of six hours, an average of 2½ inches of rain, a downpour almost tropical in its proportions, fell over this district. With these data before us, it is easy to calculate the weight of water that actually fell within the area of drainage on the night in question.

The next step in advance is surrounded with much difficulty. It is, unfortunately, impossible to estimate with absolute certainty the per-centage of water that would, under such circumstances, at once find its way into the streams. The numerous lanes that abound on both sides of the valley constitute, without doubt, the principal media for the outlet of surface-drainage. They convey to the valleys not only the rain that falls upon them, but they act as channels both for natural and artificial drainage supplied by the fields and meadows through which they pass. I am informed by Mr. John Evans that there are, in the parishes of Abbot's Langley and King's Langley, no less than 152 acres of these lanes. It is certain that the hill-sides would absorb, during the continuance of the storm, large quantities of water; but, on the other hand, it

* 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 213.

must not be forgotten that rain fell in almost unprecedented torrents, that it poured in rivers off meadows that usually absorb all that falls upon them, and, lastly, that atmospheric evaporation must, under such conditions, have been inconsiderable. After carefully considering the whole of the authentic information that I have been able to collect, and making every allowance for the effect of absorption and evaporation, I think it is reasonable to suppose that at least 25 per cent., or one-quarter part of the entire weight of rain that fell within the defined area, would reach the rivers within the first six hours subsequent to the storm.

I will now proceed to summarize my conclusions. I have estimated that the watersheds supplying drainage to the Bulborne and Gade comprise an area of about 34 square miles. It has been shown that 2½ inches of rain fell during the continuance of the storm, and it follows, as a matter of course, that somewhere about 5,500,000 tons of water must have fallen during the night, within the area of drainage. If I am correct in supposing that 25 per cent. of this enormous downpour found its way pretty directly into the streams, it is evident that an extra demand, equivalent to the accommodation of 1,375,000 tons, was made on their capacity. I shall assume that the whole of this extra quantity of water passed Hunton Bridge during the ensuing day, and when it is remembered that the average flow of water at that place does not exceed 192,000 tons in 24 hours, an easy calculation establishes the remarkable fact, that on the 3rd of August an extra volume of water, exceeding seven times the amount of the usual current, forced its way along the valley of the Gade.

I hope that these figures may sufficiently account for the occurrence of the unprecedented flood which I have now attempted to describe.

XXI.

ON THE IMPORTANCE OF RECORDING ERRATIC BLOCKS.

By H. George Fordham, F.G.S.

Read at Watford, 14th December, 1880.

A Committee of the British Association has now been in existence some years, for the purpose of "recording the position, height above the sea, lithological characters, size, and origin of the Erratic Blocks of England, Wales, and Ireland, reporting other matters of interest connected with the same, and taking measures for their preservation." As a member of this Committee, I am anxious to bring before the Hertfordshire Natural History Society a brief note on the work being carried on by the Committee, in the hope that I may thus be able to obtain such assistance as may enable me to compile a report, as complete as possible, on the erratic blocks, or boulders, of the County of Hertford.

The recording of scattered boulders is a work which it is particularly desirable should be taken up by local scientific societies, as it is only by the development of a wide-spread interest in the matter that anything like a complete catalogue and description of the erratic blocks scattered over the country can be hoped for. Obviously the value of the ultimate deductions from, and of the additions to, our knowledge of the Glacial period, depends, in a great measure, on the completeness of the records obtained, and their general extension over the whole of the area under consideration.

The title of the Committee to which I have referred expresses concisely its aims, but it will, perhaps, be useful if I a little further explain what those aims are, and indicate more generally the *raison d'être* of the Committee, and how we, in Hertfordshire, can best contribute to the advancement of science in this particular matter.

It must have come under the notice of the most casual observer, that we have in various parts, and spread over large areas in England, masses of gravel, sand, and clay, containing fragments of a great number of different rocks, otherwise unknown in the districts in which these fragments now occur. These beds lie high on the hills throughout Hertfordshire, and are found plentifully distributed over all the midland and northern counties of England. They are more ancient than our river-gravels and the sands and clays which we find along all our water-courses; for we find in the river-deposits, fragments of rocks, and other traces of these older beds. It does not, however, appear that, at the time when the older clays and gravels were deposited on our hills, the face of the country differed in any very material degree from its general configuration as we now see it. The valleys have been deepened and many minor changes have, no doubt, taken place; but, as a whole, there is no reason to believe that any great change has been made.

These beds of clay, sand, and gravel are the products of that part of the world's existence which we know as the Glacial period. At that time, as far as we know at present, man did not inhabit the earth, or if he did exist, no absolute evidence of his presence has remained to us. The climatic conditions were totally different from those which we now experience in these islands. During this period ice was a dominant power, and it has left clear and unmistakable evidence of its existence and work.

The Committee, whose cause I wish to put before you, is occupied in registering the more marked and definite evidence now existing on this subject. When England lay for long periods, during the Glacial epoch, more or less completely submerged below the level of the sea, when all the high land was capped and covered with ice-fields and glaciers, the limited shore-line encumbered with coast-ice, and the sea, either wholly or in part, ice-bound, or, where free, laden with ice in the shape of bergs and floes, these beds of clay and gravel were spread out over our hills, and portions of them remain to the present day as evidence of what has been. Contained in, and associated with, the glacial clays and gravels are large fragments of harder rocks, in some cases weighing several tons, and often rounded, worn, and scratched during their travels from the ice-bound hills of which they once formed portions. Carried along, frozen into ice-bergs, or drifting on shore-ice, they have been scattered far and wide over the country. At the present day they are collected in our villages as corner-stones, to protect the angles of houses or walls, are built into walls, and used in paving, or are destroyed. We can only regret that many boulders have been broken up without any note being taken of them; and this regret should remind us how necessary it is to have complete records of those that exist. By the identification of the materials of the erratic blocks with the rocks from which they have been derived, much may probably be added to our knowledge as to the direction and character of the ice-movements of the Glacial epoch; and the superficial characteristics of the blocks themselves, their localities, the heights above the sea at which they now rest, and other facts concerning them, will, when properly brought together and arranged, be of material assistance in the construction of the history of that period.

In recording boulders it is important to state whether they are found *in sitû*, or have been moved by man, and in the latter case any information that can be obtained as to the place from which they have been brought should be noted. Boulders should be accurately measured and described, particulars as to the character of the rock, and its external appearance, and as to whether it is angular, water-worn, rounded, or scratched, should be given. The heights above the sea (especially if unmoved), and the nature of the beds on which they rest, should be noted. Drawings or photographs of large boulders are valuable, and a fragment, sufficiently large for the identification of the rock, should be obtained. Where a boulder has any local name, or history, this should also be added to its description.

I trust the members of the Society will feel it to be their duty to add, as far as possible, to the general knowledge of the Glacial period, and to our knowledge of the relation of Hertfordshire to the ice-action of that time, by recording all the boulders within the county, or elsewhere, which come under their notice. I shall be glad of any information thus obtained, which can be published by this Society, and also included in the report of the Committee of the British Association.

XXII.

NOTE ON THE SCHWENDENERIAN THEORY OF LICHENS.

By R. B. Croft, R.N., F.L.S., F.R.M.S., Hon. Sec.

Read at Hertford, 25th January, 1881.

I cannot better describe the theory as to the nature of lichens which is variously styled "The Algo-Lichen Hypothesis," the "Dual-Lichen Hypothesis," and the Schwendenerian Theory of Lichens, than by quoting the commencement of a paper by the Rev. W. A. Leighton in 'Grevillea' (vol. ii, p. 122), in which periodical will also be found the arguments for and against the said theory.

Mr. Leighton says: "Much attention has been of late devoted, and is still devoted to the subject of the gonidia of lichens. Two theories or opinions have sprung from these researches, which are respectively supported by great and learned savans. Those whose studies are chiefly physiological maintain that the filamentous tissue of the thallus of lichens is a fungus which grows parasitically on an alga, which it envelopes and carries on with it in its growth so as to constitute the gonidia. On the other hand, true lichenologists, whilst admitting the apparent similarity of gonidia to certain algæ, do not consider them as such, but as special organs of multiplication or propagation of lichens."

Although Professor Schwendener propounded this theory in 1869, and although many experiments have been made by various observers to test its truth, opinion still is divided. Sachs, in his 'Text-Book of Botany' (p. 262), says: "There can no longer be any doubt that the lichens are true fungi of the section Ascomycetes, but distinguished by a singular parasitism. Their hosts are algæ which grow normally in damp places but not in water." As many introductory works on botany are founded on Sachs' work, this is repeated, learnt, and believed by many; while on the other hand Dr. Nylander, admittedly the greatest Lichenologist of the age, terms the hypothesis "absurd," and Dr. M. C. Cooke classes together the advocates of the theories of Table-turning, Tichborne, and Schwendener.

About two years ago I made my first attempt to build a lichen, or rather I found in a small phial that which advocates of the Schwendenerian theory would have no doubt claimed as such; and as I have just repeated the experiment with the same result, I will briefly describe the *modus operandi*, in the hope that other members may by their observations throw further light on the subject.

I placed a gathering of *Protococcus pluvialis** in a small phial in

* In both cases the *Protococcus* was from a cast-iron shell at the base of a fountain in the garden of Mr. C. W. Nunn, of Hertford. Mr. Nunn has had this *Protococcus* under observation for several years, and considers it to be a distinct red variety.

perfect darkness, and after some time found that mixed with the *Protococcus*-cells there were fragments of what appeared to be the mycelium of a fungus. After a further deprivation of light for some time, I found that the mycelium had greatly increased in quantity, and that it surrounded and imprisoned the perfectly healthy still cells of the *Protococcus*.

In this condition you will see it under my microscope this evening. At the October meeting of this Society I showed the *Protococcus*, then freshly gathered, when many of the cells were motile, now they are all stationary, though a few retain the hyaline envelope. You will observe that all or nearly all the cells are red, and that although under a high power (700 diameters) no connexion with the fungus can be perceived. Therefore we have what the advocates of the theory declare a lichen to be, viz. an alga surrounded and imprisoned by a fungus, only it is in water instead of air. Probably further study would prove that the presence of the fungus was accidental, and that though the *Protococcus* is apparently healthy, it is not increasing by either of its known methods of growth. As this inquiry can be easily prosecuted by any one possessing a microscope with a $\frac{1}{4}$-inch objective, I hope some of you will try the exceedingly simple experiment detailed above, and if you can get as far as I have got, that you will endeavour to induce the dual growth to flourish in air as well as water. I would also suggest that one phial be kept in the light and another in the dark, in order that we may find out whether that has anything to do with the fungal growth, or whether it is only a coincidence.

XXIII.

ON A SPECIES OF *CHÆTOSPIRA* FOUND AT HODDESDON.

By F. W. Phillips.

Read at Hertford, 25th January, 1881.

At the meeting held here last March, Mr. Henry Warner drew a rough sketch of an animalcule, and told me that he had found it many years ago in a pond at the Woodlands, Hoddesdon, but had never been able to identify it. I saw at once that it corresponded with the drawing of *Chætospira Mülleri* given in the last edition of Pritchard's 'Infusoria.' I had met with it about two years before, but unfortunately had given but little attention to it. I did not find it again until last October, and it was under the following circumstances. Last July I placed in a polype-trough what I judged to be the empty cœnœcium of a Polyzoon, and some *Paludicellæ,* obtained from the same pond, leaving them there in the hope that statoblasts might be deposited; about a month after I sent the trough and contents to Mr. Isaac Robinson. While it was in his possession some creature laid a number of eggs against the glass, and attention was from time to time directed to their development. One day Mr. Robinson reported the appearance of a strange creature adherent to this egg-case, which was now empty. The description of its movements convinced me that it was no other than the rather rare *Chætospira*; and on examining it, I found that it was so. The animalcule, which was extremely small, had built its tube or sheath in one of the depressions of the empty egg-case. Unfortunately the glass of the polype-trough was too thick to use the $\frac{1}{5}$-inch objective, therefore we used the $\frac{1}{2}$-inch objective and D eyepiece; a power which was insufficient to enable me to make an elaborate investigation. I have the creature still by me, but it is either dead, or encysted, as it has for some time past refused to come out of its tube. The genus appears to be so little known that it would perhaps be advisable to quote Pritchard's description.

Family *Vorticellina.* "Genus *Chætospira* (Lachmann).—The surface generally covered with cilia, like the genus *Stentor*, from which it is distinguished by having that part of the parenchyma of the body which bears the ciliary spiral and the anus (which in all the Stentorinæ lies on the dorsal surface of the body, close under the ciliary spiral, and not in a common pit with the mouth) drawn out into a thin process. This process is narrow and bacillar; the series of cilia commences at its free extremity, and only forms a spiral when in action, by the rolling-up of the lamina. The process bears the anus. The animalcules inhabit a sheath or tube, of a mucilaginous or even horny density." The genus was first described in 1856 by Mr. Lachmann, who found the two species of which it consists in fresh water near Berlin. They are described by Pritchard as follows :—

"*Chætospira Mülleri.*—Slender. The first cilia of the series upon the process are somewhat, but not remarkably longer and stronger than the rest; when rolled up, the ciliated bacillar process forms more than one turn of a spiral. Sheath flask-shaped and horny. Hitherto found only in the open cells of torn leaves of *Lemna trisulca*, growing in fresh water near Berlin."

"*Chætospira mucicola.*—Enclosing tube mucous in consistence; animalcule shorter and more compressed; the rolled-up ciliary process does not form a complete turn of a spiral; the first cilia are considerably larger than the rest, the first one especially being nearly twice as long as most of the others."

The animalcule we found does not altogether agree with either of these descriptions. It has, like *Chætospira Mülleri*, a horny sheath, to which are attached a great number of brown granular particles, as though they had been cemented to it. The case is not imbedded in, but built outside the cellular substance to which it adheres. The ciliary process resembles *C. mucicola* in not making a complete turn of a spiral. At the extremity of the process there appeared to be a small projection as though it had a slight tendency to be bilobed, like the allied genus *Freia*, but the animalcule maintained a very awkward position all the time we watched, so that it was impossible to get a clear view of it; therefore it is just possible that this appearance was due to a distorted view of the long terminal cilium characterising *C. mucicola*. On giving the stage of the microscope a sharp tap it would quickly withdraw within its tube, after the manner of *Vaginicola* and other sheathed animalcules; as soon as its alarm subsided, the process would be slowly extruded in a straight line, and then with a rapid and peculiar scythe-like motion it would be swung round into the spiral form. The movements of the cilia very much resemble those of *Stentor*, but have rather more of a vibratile character.

The only notices I can find of the occurrence of *Chætospira Mülleri* in England are, firstly in a paper by Mr. J. G. Tatem, read at the Quekett Club, March 27th, 1868, wherein he records it for the first time as a British species; secondly, in an article in 'Science Gossip,' July, 1868, by Mr. F. C. S. Roper, who states that he found it on the 28th of May, 1851, on Snaresbrook Common, which was five years prior to its having been described by Mr. Lachmann, and that he sent drawings of it to several naturalists, but none of them were able to identify it. Possibly the animalcule may not be so very rare, but its small size and extreme timidity or sensitiveness, which causes it to retire with the slightest shaking, is probably the cause of its being over-looked.

Since making the above notes, I have this morning had the good fortune to find another specimen quite close to the former; the sheath, which is imbedded in the cellular structure of the egg-case, is lageniform in shape, with a rather long narrow neck; it is almost identical with Mr. Tatem's figure, and the spiral makes two turns, thus determining it to be *Chætospira Mülleri*. The true species has therefore been found as well as the apparent variety.

XXIV.

ON THE OCCURRENCE OF RED SNOW IN HERTFORDSHIRE.

By R. B. Croft, R.N., F.L.S., F.R.M.S., Hon. Sec.

Read at Ware, 22nd February, 1881.

On the return of Captain Ross's expedition from the Arctic regions in 1819, red snow, which had been found extending over a range of cliffs on the shore of Baffin's Bay, in some cases 12 feet deep, was in its melted state subjected to careful examination, and was pronounced by the eminent botanist, Robert Brown, to contain a unicellular plant of the order Algæ, an opinion since confirmed by Greville and others, and now generally adopted, the plant being known by several names, amongst which that of *Protococcus nivalis*, given to it by Agardh, and *Palmella nivalis* given to it by Sir William Hooker, are most usually accepted. The following is a description by the authors of the 'Micrographic Dictionary' of the organism in red snow brought home by Captain Parry, R.N.:—"Frond, an indefinite gelatinous mass, densely filled with spherical cells, about 1-1200th part of an inch in diameter; cells with a distinct membrane, their contents consisting of numerous tolerably equal granules, red or green. Between the large cells lie patches of minute red granules, apparently discharged from the large cells. Bauer and Greville both describe this as the mode of propagation of the plant; but it is probable that the cells also increase by division when actively vegetating."

In a very pleasant little book called 'Footprints from the Page of Nature' I find the following: "If we place a portion of the snow coloured with this plant upon a piece of white paper and allow it to melt and evaporate, we find a residuum of granules just sufficient to give a faint crimson tinge to the paper. Placed under the microscope, these granules resolve themselves into spherical purple cells, from the 1,000th to the 3,000th part of an inch in diameter; each of these cells has an opening surrounded by serrated or indented lines, whose smallest diameter measures only the 1-5,000th part of an inch."

The same author says, further on: "The actinic power of the solar light, aided by some peculiar, and as yet unknown property belonging to the natural whiteness of the snow itself, is highly essential in the production of the beautiful crimson or rose colour by which the red snow is distinguished; but this colour gradually changes to green when secluded from the direct action of light and developed on dark or opaque objects."

Although the above is, as I have said, the generally accepted theory of red snow, yet examinations of red snow made near Grimsel, in Switzerland, in 1839, at the Glacier of Aar, in 1840, and other places, led Mr. Shuttleworth and Professor Agassiz * to conclude that the discolouration was due to an immense number of moving animalcules of various shapes and sizes, and to globules which were supposed to be the ova of *Philodina roseola*.

Professor Meyen † remarks that *Euglena sanguinea* and *Euglena viridis*, which greatly resemble *Protococcus*,‡ are the cause of the red and green snow which has been described by Martius, a naturalist, who had accompanied a French expedition to Spitzbergen. In this case also globules are mentioned.

From these researches it is evident that it is not proved that red snow is dependent on one form of organic existence, but that many species both of plants and animals may contribute to its production.

Having thus briefly noticed all that I can discover about red snow, I will give a short account of some that I found on the 28th of January. On the afternoon of that day, which was the first of decided thaw after the recent long and memorable frost, I noticed under the upper layer of ice on a large pond in my garden sheets of snow of a dark red colour; and as the position, condition of snow, etc., may be of important assistance to future searchers, I shall describe them at some length. The pond had been frozen for more than a fortnight (on the 15th we were skating on it). On the 18th came the violent snowstorm and gale, which covered the pond with nearly a foot of drift snow. On the 26th a man was employed clearing the snow off the pond, but the lower layer (about four inches thick) had apparently partly melted and frozen again; therefore the snow was only cleared away to the surface of this frozen layer, which I shall call frozen snow, to distinguish it from the true ice underneath.

On noticing the deep red colour which appeared to be above or in the true ice, I dug holes in the frozen snow and found that where it rested on the ice it was a deep rose colour; the water, which owing to the rapid thaw quickly filled the holes, became also rose-coloured, looking from a short distance like pools of blood. I collected a vase of the melting snow, which owing to its small quantity and the difference of background looked a lighter pink. On rapidly baling the water out of one of the holes, I noticed the ice beneath to be full of bright red specks like so many rubies. I cut several pieces out, and placed them in a separate vessel for examination. The water in the vases (at first a decided pink), gradually became paler and paler, and at the end of ten days the colour had entirely gone.

Microscopic examination of the melting snow showed frond-like patches of green matter, among which were many *Euglenæ*, apparently *Euglena acus* (I could in no case see any flagellum). Round green cells, which I took to be the resting form of the same *Euglena*, and a very great number of yeast-like bodies,

* 'Ann. Nat. Hist.,' Aug. 1841.
† 'Ann. Nat. Hist.,' Aug. 1848.
‡ See Cohn's Memoir "On the Natural History of *Protococcus pluvialis*" in 'Botanical and Physiological Memoirs' (Ray Society, 1853).

although they appeared in the microscope to be hyaline, were in my opinion the cause of the red colour. These bodies I take to be the "globules" of Meyen. As far as I could see, then and since, there was no *Protococcus*, or to speak more exactly, no body resembling *Protococcus* which might not have been some stage in the life of the *Euglena*.

I sent three specimens of the melted snow to Mr. Saville Kent, the talented author of 'A Manual of the Infusoria,' one taken from the bottom of my vase with a good deal of sediment, one taken from the surface, and the third with the sediment from the vase containing the pieces of solid ice, which you will remember I spoke of as being full of bright red specks. Mr. Kent tells me that the contents of the three phials are identical; that the green frond-like masses are decaying masses of *Euglenæ*, probably suddenly frozen, that the *Euglena* is *Euglena acus*, that he can detect *Protococcus*, and that the yeast-like bodies may be an abnormal form of that plant. Mr. Bolton, of Birmingham, and my co-secretary Mr. Hopkinson, who have examined the melted snow, both say that it contains *Protococcus*, so that I am alone in my opinion that it is not present. I think with regard to the yeast-like bodies we may come to the conclusion that they are not yeast; therefore the question arises, What are these bodies? Mr. Kent's suggestion that they are an abnormal form of *Protococcus* leads to an important train of thought; for may not *Protococcus* always assume this form when it colours snow red. But I venture to suggest that, considering the extraordinary resemblance between the plant *Protococcus* and the animal *Euglena*,* they may be a form of *Euglena*; and although I only throw out this as a possibility, yet my idea is strengthened by the fact that some years ago, while studying the *Euglenæ*, I found that during one portion of their life they assumed forms which I described in my note-book as "closely resembling the *torula* of the yeast plant."

* See Cohn's Memoir, previously referred to, for an accouut of this resemblance.

XXV.

ANNIVERSARY ADDRESS.

By the President, J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., Treas. G.S., etc.

Delivered at the Annual Meeting, 15th February, 1881, at Watford.

Ladies and Gentlemen,—

Another year has come round; and I have again the pleasure of meeting and addressing you as President of this useful and prosperous Society.

The Report of the Council, which has just been read, tells you that during the past year the number of members has increased from 231 to 270, and that a large amount of excellent work has been done. I have no doubt but that the present and following years will show an equally satisfactory rate of progress.

The Address which I now have the honour of presenting is, like my previous Address, in the form of a Lecture; and as it is longer than the last—notwithstanding the promise that I then made—I will lose no more time in giving it. The title is

DEEP-SEA EXPLORATION.

This subject is one in which I have for many years taken much interest; and I will give you the result of my experience and studies. It is highly fascinating to all persons of ordinary intelligence, although they may not be naturalists. Our best poets have not disdained to sing its praises; one of them says:

> "There is a magnet-like attraction in
> These waters to the imaginative power
> That links the viewless with the visible,
> And pictures things unseen."

Speculations of this kind were not unknown to the ancients. In the 'Halieutica' of Oppian, written nearly seventeen centuries ago, it is stated that no one had found the bottom of the sea, and that the greatest depth ascertained by man was 300 fathoms, where Amphitrite had been seen. But this grand discovery does not seem to have satisfied the poetical philosopher; and he enters into a long disquisition as to the many other wonderful things that may be concealed in the recesses of the boundless ocean, adding, nevertheless, what I will translate from the Greek:

> "But men have little sense and strength."

However, man has not degenerated in this kind of knowledge since the days of Oppian; for he has now not only explored the greatest depths of the sea, but has mapped out its main features with nearly as much accuracy as he has done with respect to the land.

It will be convenient to divide the subject into separate heads, viz.:—1, Historical; 2, Apparatus; 3, Fauna; 4, Food; 5, Light; 6, Temperature; 7, Depth; 8, Inequalities of the Sea-bottom; 9, Deposits; 10, Geological; 11, Incidental; 12, Concluding Remarks. I hope you will not be frightened at the number of these heads. Some of them you will find to be exceedingly short.

1. Historical.

Sir Wyville Thomson's 'Depths of the Sea' gives an excellent account of the origin and progress of deep-sea exploration up to a very recent period. To this work I would refer my audience, contenting myself with some supplemental remarks.

In 1868 commenced the systematic examination of the sea-bed at considerable depths in that part of the North Atlantic which surrounds the British Isles. I then took my yacht, the 'Osprey,' for an excursion to Shetland, and dredged off the most northern point of our isles. The greatest depth which I attained was 170 fathoms, or 1020 feet, each fathom being 6 feet. This depth, strictly speaking, is beyond the line of soundings, viz. 100 fathoms; and it may be a question whether the fauna of the sea-bed outside of that limit can be regarded as British, although adjacent to our coasts. If it be, we ought to take the "medium filum aquæ" (as the lawyers in the time of Coke called it), and extend the geographical limit of the British marine fauna halfway across to North America! But such boundaries are neither national nor rational. We cannot lay claim to so extensive a dominion. International boundaries, for the purpose of naval warfare or as defined by fishery treaties, are limited to a distance of three miles, irrespective of depth. Later in the same year (1868) Dr. Carpenter and Professor Wyville Thomson explored, in H.M. surveying-vessel 'Lightning,' the sea-bed lying between the Butt of Lewis and the Faröe Isles, and reached the depth of 550 fathoms. These tentative excursions showed that the sea-bed everywhere was full of life, not merely of a microscopic and uniform kind, and of a low degree of organization, but of a considerable size, great variety, and a high degree of organization. In the following year (1869) our Government placed a better vessel at the disposal of the Royal Society; and I undertook the first scientific cruise in H.M. surveying-ship 'Porcupine.' This cruise was off the western coast of Ireland, and the greatest depth dredged was 1476 fathoms. The second cruise was undertaken by Professor Wyville Thomson, and extended from the south of Ireland to what is probably the deepest part of the North Atlantic in the European seas. The greatest depth dredged by him was 2435 fathoms, or nearly three miles. The third cruise, under the charge of Dr. Carpenter, was in the same direction as the 'Lightning' Expedition, but embraced a larger area, including the Shetland Isles; the greatest depth was 867 fathoms. In the following year (1870) the 'Porcupine' was again placed at the disposal of the Royal Society for further exploration. This expedition was divided into two cruises, North Atlantic and Mediterranean. The former was assigned to me, and comprised the sea-bed lying between Falmouth and the Straits of Gibraltar, along the western coasts of Spain and Portugal. There were 38 dredging and sounding stations, at depths ranging from 81 to 1095 fathoms. The Mediterranean cruise was made by Dr. Carpenter, and extended round Sicily. There were 29 stations, at depths ranging from 51 to 1743 fathoms. Professor Wyville Thomson was unfortunately prevented by illness from taking part in this year's expedition. In all these cruises an abundance as well as a great variety of marine life occurred at every depth.

The 'Lightning' and 'Porcupine' Expeditions culminated in the celebrated voyage of H.M.S. 'Challenger' round the world, which commenced on the 21st of December, 1872, and ended on the 24th of May, 1876, having thus occupied a period of three years and five months. During this expedition about 30,000 nautical miles were traversed, 504 soundings were taken, and 132 dredgings and 150 trawlings were made. The depths of soundings were from 25 to 4475, of dredgings from 4 to 3875, and of trawlings from 10 to 3050 fathoms. The greatest depth reached was five statute miles. The Americans have recorded a greater depth, viz. five miles and a quarter, or 4620 fathoms. Even greater depths than this have been given; but they are not now considered reliable, by reason of the imperfect machinery which was formerly used for sounding.

The 'Proceedings of the Royal Society' for 1873-1877 contain many "Preliminary Reports" by Sir Wyville Thomson and the other naturalists attached to the 'Challenger' Expedition; so that all the scientific world were from time to time kept informed of the progress and results of this great national undertaking.

During the last of our arctic voyages, in 1875, I had, through the influence and energy of the Royal Society, another opportunity of exploring a part of the North-Atlantic sea-bed which was not within the limits of the 'Challenger' Expedition; and I was entrusted with the scientific charge of the sounding and dredging conducted in

H.M.S. 'Valorous' between Bantry Bay and Hare Island in Davis Strait. This ship accompanied the 'Alert' and 'Discovery' on their way northwards. After a voyage of three months, which was rendered more eventful by a cyclonic storm and a partial shipwreck on the coast of Greenland, we succeeded in working 16 stations, with depths of from 20 to 1785 fathoms. Here also, and even in the midst of icebergs, submarine life showed no diminution in number or extent.

To this short recital of our later expeditions I must not omit to add a notice of the valuable and suggestive researches which were accomplished under considerable difficulties by Dr. Wallich in H.M.S. 'Bulldog' in 1860, while she was engaged in surveying the North-Atlantic sea-bed for the purpose of establishing telegraphic communication between this country and North America. The results of these researches were published in Dr. Wallich's important work, entitled 'The North-Atlantic Sea-bed; comprising a Diary of the Voyage on board H.M.S. "Bulldog" in 1860, and observations on the presence of Animal Life, and the Formation and Nature of Organic Deposits at great Depths in the Ocean.' On the return voyage, about midway between Cape Farewell and Rockall, thirteen star-fishes came up from a sounding-line of 1260 fathoms, "convulsively embracing a portion of the sounding-line which had been payed out in excess of the already ascertained depth, and rested for a sufficient period at the bottom to permit of their attaching themselves to it."

A short voyage in H.M.S. 'Shearwater' through the Mediterranean in 1871 enabled Dr. Carpenter to have some dredging between Sicily and the northern coast of Africa, on the Adventure and Skerki Banks. This dredging was by no means unproductive; but the depths did not exceed 200 fathoms, which we are now inclined to call "shallow water"; Dr. Carpenter's word was "shallows." Fifty years ago such depths would have been regarded by naturalists as peculiarly "abyssal"!

The elaborate Report of my lamented friend Professor Edward Forbes on the investigation of British Marine Zoology by means of the dredge, which he submitted to the British Association for the Advancement of Science in 1850, and to which I contributed as a humble fellow worker, was preceded by his equally valuable "Report on the Mollusca and Radiata of the Ægean Sea, and on their Distribution, considered as bearing on Geology." The last-mentioned Report was published by the Association in 1844. Forbes's conclusion that the sea-bottom at a depth of 300 fathoms is lifeless, because he found that life diminished gradually, and almost ceased when he dredged at 230 fathoms, has certainly been proved to be inaccurate as regards the ocean in general. Dr. Carpenter, in his Report to the Royal Society on his biological researches in the Mediterranean during the 'Shearwater' cruise, expresses his belief that "in the Mediterranean basin the existence of animal life in any abundance at a depth greater than 200 fathoms will be found quite exceptional;" and he infers "that Edward Forbes was quite justified in the conclusion he drew *as regards the particular locality he had investigated*, and that his only mistake lay in supposing that the same conditions would prevail in the open ocean." But this eminent naturalist and physiologist, Dr. Carpenter, to whose opinions on such subjects all respect is due, admits that "the history of science is full of instances in which erroneous doctrines have been more *productive*, because more suggestive, than well-determined facts that open no access to the unknown beyond." With the greatest deference to Dr. Carpenter's opinion that animal life is scanty in the depths of the Mediterranean, I venture to point out that very little had previously been done to investigate the fauna of that sea beyond the shores and shallow water, to the extent which Forbes reached, viz. 230 fathoms.

Admiral Spratt in 1846 dredged, at a depth of 310 fathoms, 40 miles east of Malta, a number of living Mollusca, which I examined and found to be identical with species which I dredged at considerable depths in the North Atlantic during the 'Porcupine' Expeditions. Again, during the Mediterranean cruise of 1870 in the 'Porcupine,' no fewer than 14 species of Mollusca (also Atlantic), besides a pelagic or surface-water species and a small freshwater shell, which must have been carried out to sea by some river or stream, occurred at a depth of 1415 fathoms, between the coasts of North Africa and Spain. All these species were recent, and some were living, although most of them were known to me as also belonging to the Pliocene formation in Sicily. However, we shall, in all probability, know a great deal more of this matter if our good neighbours the French are able to carry out their idea of extending their investigation of the deep sea near their own coasts by another dredging and sounding cruise off Marseilles or Toulon.*

During the early part of the summer of last year (1880) our Admiralty placed at the disposal of Sir Wyville Thomson, H.M. surveying-vessel 'Knight Errant,' for a cruise off the Butt of Lewis, in prosecution of his researches in the 'Lightning'

* Since this Address was delivered I have been in correspondence with Professor Giglioli, of Florence, on the subject of a Deep-sea Expedition which will be undertaken by the Italian Government this year in the Mediterranean.

Expedition as to the "warm" and "cold" areas which were noticed in the Report of that expedition. Mr. Murray took the scientific charge of the cruise; but the weather was boisterous, and unfavourable for dredging and trawling. There were, however, some zoological results of an interesting kind, especially as regards the Mollusca; and it is hoped that the application which has now been made by the Royal Society for another Government vessel will be successful, and will enable Sir Wyville to continue the work and make further discoveries.*

Although we have of late years done a great deal to promote submarine researches, as shown by the expeditions of H.M.SS. 'Bulldog,' 'Lightning,' 'Porcupine,' 'Shearwater,' 'Valorous,' and 'Knight Errant,' our comparatively poor neighbours in Scandinavia have been earlier in the field and not less energetic. From the 'Notices sur la Suède,' published on the occasion of the International Congress of Geographical Sciences in 1875 at Paris, it appears that between the years 1837 and 1875 seventeen scientific expeditions were made from Sweden, fifteen of which explored the arctic regions. Professors Lovén, Torell, and Nordenskiöld, with other distinguished naturalists, took an active part in these expeditions. The sister kingdom of Norway has since engaged in the same course of discovery; and a well-equipped Government vessel, the 'Vöringen,' of the same size as the 'Porcupine' (about 400 tons), left Bergen in the beginning of June, 1876. Dr. Danielssen, Professors Mohn and G. O. Sars, Herr Friele, and other scientific men accompanied the vessel, and were engaged in the zoological and physical work. Through the kindness of my friend Prof. Sars, I am enabled to give the following particulars of these Norwegian expeditions. They occupied nearly three months in each of the years 1876, 1877, and 1878. The first expedition was divided into three cruises, and extended along the western coast of Norway to the Faröe Isles and Iceland. There were 24 dredging-stations, at depths of from 90 to 1862 fathoms, besides 5 shore stations in Norway, Faröe, and Iceland. The second expedition was divided into four cruises, and extended from Bergen to outside the Loffoden Isles, and from Tromsö to Jan Mayen; there were 28 stations, with depths of from 70 to 1760 fathoms, besides 6 shore stations in Norway and Jan Mayen. The third expedition was divided into three cruises, and extended to Vardö, and thence westward to Beeren Island, and afterwards to Spitzbergen in 80° N. lat. The last expedition had 36 stations, with depths of from 21 to 1686 fathoms, besides

* The application has, I believe, been granted.

7 shore stations on the arctic coasts of Norway, and in Beeren Island and Spitzbergen.

The United States have prosecuted this kind of research with their well-known activity and perseverance. From 1867 to the autumn of 1880 four Government steamers have been continuously employed in surveying the seas which border the coasts of Central and South America. Several hundred stations were investigated, at depths ranging from 6 to 2412 fathoms. Count Pourtalès, Professor Agassiz, and his no less eminent son, have been successively in charge of the scientific department. The results are both extensive and invaluable. In 1871 I was invited by the late Professor Agassiz to pay him a visit and examine the Mollusca which had been procured during the previous years. The collection was in the custody of the late Professor Stimpson at Chicago. It was extremely interesting to me, in connexion with the expeditions of the 'Lightning' and 'Porcupine.' I examined the collection in the Museum at Chicago; and, at the request of Professor Agassiz, I took home with me several of the shells for comparison with my own. On my return to England, after enjoying the kind hospitality of my scientific friends in the United States and Canada, I learnt that Chicago had been utterly burnt down; and I was fortunately enabled to restore the shells, which were the only specimens of natural history that had been saved from the fire. Through the kindness of Professor Spencer Baird, I had, during this visit to America, an opportunity of joining in a dredging-excursion on the coast of New England, which was conducted under the auspices of the Fishery Commission.

Like a giant refreshed, France has awakened from a rather long sleep; and, with its accustomed spirit, has now rivalled all other nations in deep-sea work. Last summer a scientific Commission was appointed, with the venerable Professor Milne-Edwards as its President; and a large and well-equipped Government steamer, the 'Travailleur,' explored the Bay of Biscay with most favourable results. I was obligingly asked to take part in this expedition; and I gave an account of it at the last Meeting of the British Association at Swansea, which is published in the Report of that Meeting.

Austria, Germany, and Holland have also not been last in the race of maritime voyages, although they have not contributed much to our knowledge of deep-sea life.

The harvest reaped in all the above-mentioned expeditions was most abundant and valuable.

But, after all, it must be borne in mind that if every civilized nation in the world were every year, during the next century, to send out similar expeditions, with improved appliances, for exploring the sea-bed, the field would be far from being exhausted. Every such expedition must be more or less tentative, and can only form the basis for a more complete investigation of "the deep bosom of the ocean." The area of investigation must be measured by many millions of square leagues; whereas all that has hitherto been effected has been to scrape in an imperfect manner the surface of a few scores of acres.

I here exhibit charts to show the tracks of the expeditions in which I have been personally engaged, as well as those of the 'Challenger' and Norwegian expeditions.

2. Apparatus.

The sounding-line, ropes, dredge, trawl, tangles, towing-net, sieves, accumulators, steam-engines, and other contrivances for deep-sea exploration have been so fully described and illustrated in the 'Depths of the Sea' and Captain Sigsbee's 'Deep-sea Sounding and Dredging,' that it is unnecessary for me to do more than mention those books. The latest improvements consist in the substitution of steel wire for line in sounding, and of galvanized wire-rope for hempen rope in dredging and trawling. Captain Sigsbee's new towing-net for ascertaining whether floating or swimming animals are found in any zone or belt of water lying between the surface and the bottom will be hereafter noticed. It is still a desideratum to invent a dredge for deep sea-work which shall scrape the surface instead of sinking into the ooze or mud.

3. Fauna.

This word is used by naturalists to denote animal life in contradistinction to "Flora," or vegetable life. All the recent exploring expeditions have established the fact that animal life of various kinds abounds everywhere in the deepest parts of the ocean. Nor is such life microscopic or minute only. In the 'Challenger' voyage was procured by the trawl, at the depth of 1600 fathoms, in the South Atlantic (S. lat. 46° 16′, E. long. 48° 27′), a living specimen of a magnificent shell belonging to *Cymbium*, or an allied genus, which is 6¾ inches long and 4 inches broad! I dredged other Mollusca from an inch and a half to nearly double that length in the 'Porcupine' and 'Valorous' expeditions. Willemöes Suhm mentions among the 'Challenger' discoveries a gigantic crustacean or sea-spider from 1375 fathoms, which measured nearly two feet across the legs.

Sir Wyville Thomson gives an eloquent description of life in the deep sea, when he says that the latter "is inhabited by a fauna more rich and varied on account of the enormous extent of the area, and with the organisms in many cases apparently even more elaborately and delicately formed, and more exquisitely beautiful in their soft shades of colouring, and in the rainbow tints of their wonderful phosphorescence, than the fauna of the well-known belt of shallow water teeming with innumerable invertebrate forms which fringes the land. And the forms of these hitherto unknown living beings, and their mode of life, and their relations to other organisms whether living or extinct, and the phenomena and laws of their geographical distribution, must be worked out."

It was formerly supposed that animals could not exist at great depths because of the excessive pressure to which they were subjected. Mr. Moseley says: * "The pressure exerted by the water at great depths is enormous, and almost beyond comprehension. It amounts roughly to a ton weight on the square inch for every 1000 fathoms of depth; so that, at the depth of 2500 fathoms, there is a pressure of two tons and a half per square inch of surface, which may be contrasted with the fifteen pounds per square inch pressure to which we are accustomed at the level of the sea." But it must be recollected that water is nearly incompressible, and that marine animals which are surrounded by such a fluid, and are to a certain extent filled with it, would not necessarily be inconvenienced by the superincumbent weight.

Animals from great or even from what may be considered moderate depths are nearly always brought up dead, the cause of death being unknown. This is another problem worthy of being worked out.

The migration or distribution of marine animals throughout the open sea is quite free, and is obstructed only by great or abrupt changes of level in the bed of the ocean, which operate as barriers. Even animals of a fixed or sedentary nature in their earliest state of growth swim on the surface, and are therefore unchecked in their onward course by any submarine barrier.

The doubt whether any life exists in the intermediate space or zone which lies between that of the surface and that of the bottom of the deep sea has now, I believe, been set at rest. The naturalists in the 'Josephine' Expedition believed that this intermediate zone was lifeless; and Sir Wyville Thomson seems to have been of the same opinion. The towing-net adopted by Mr. Murray in the 'Challenger' Expedition for such researches was to some extent successful; but Captain Sigsbee, of the U.S. Coast-Survey steamer

* 'Notes by a Naturalist on the "Challenger,"' p. 579.

'Blake,' invented a cylinder or machine, called the "gravitating trap," which completely answered the purpose of collecting at any particular depth the animals which occurred there. Professor Alexander Agassiz, in his communication to the Superintendent of the Survey made last August, and now published, records the experiments thus made, and says that they "appear to prove conclusively that the surface fauna of the sea is really limited to a comparatively narrow belt in depth, and that there is no intermediate belt, so to speak, of animal life between those living on the bottom, or close to it, and the surface pelagic fauna."

I am not aware that any deep-sea animals adopt or avail themselves of the same means that oceanic or land animals use for purposes of protection and concealment, chiefly by coloration or by what has been termed "mimicry." Many cases of this kind are known to occur in birds, fishes, molluscs, *Salpæ*, insects, crabs, shrimps, and worms.

None of the animals whose remains are found in geological formations older than the Pliocene or latest of the Tertiary strata have yet been detected in any exploring expedition. The late Professor Agassiz and Sir Wyville Thomson were disappointed in their enthusiastic expectation of finding ammonites, belemnites, and other old-world fossils in a living state. I have dredged Miocene fossils on the coasts of Guernsey and Portugal, the latter at considerable depths; but they were petrifactions, and must have come from some fossiliferous formation in the adjacent land, or perhaps in the sea-bed.

Sir Wyville Thomson, in his 'Report of the Scientific Results of the Voyage of H.M.S. "Challenger,"' has expressed his opinion as to the doctrine of evolution, that "in this, as in all cases in which it has been possible to bring the question, however remotely, to the test of observation, the character of the abyssal fauna refuses to give the least support to the theory which refers the evolution of species to extreme variation guided only by natural selection." I cannot understand how either "natural selection" or "sexual selection" can affect marine invertebrate animals, which have no occasion to struggle for their existence and have no distinction of sex.

4. Food.

The late Professor Sars, in his remarks on the distribution of animals in the depth of the sea, asks: "Whence do animals that live at depths far below the limits of vegetation obtain their food?" Bronn, Wallich, Wyville Thomson, and others have endeavoured to answer this question; but I do not think the problem has yet been satisfactorily solved. A considerable quantity of vegetable food is undoubtedly supplied from the Sargasso Sea and a similar area in the Pacific Ocean, as well as by the seaweeds which fringe every coast. But this supply is not sufficient for the indirect support of the countless host of animals that inhabit the depths of the ocean, all of which are necessarily zoophagous or subsist on other animals. Plant-life, except, perhaps, a peculiar kind, which will be presently noticed, appears to be absent in depths exceeding 150 fathoms.

But in all probability the chief supply of vegetable food is derived from the countless diatoms, coccoliths, rhabdoliths, and oscillatoriæ, which are plants of a low degree of organization and swarm on the surface of the sea; these are swallowed by pelagic animals (such as *Salpæ* and Pteropoda, or "sea-butterflies"), and the latter fall to the bottom after death, and form that flocculent or glairy mass which I have described, in the Report of the 'Porcupine' Expedition of 1869, as covering the bed of the North Atlantic at great depths.* The preservative effect of sea-water on animal tissues would stay decomposition for a long while; and Mr. Moseley ascertained by a curious experiment that it would take only about four days for a *Salpa* to reach the bottom at a depth of 2000 fathoms, and that the *Salpa* was not greatly decomposed after having remained in sea-water for a month in the tropics.

When we say that vegetable life does not exist at any considerable depth, we must not forget that some kind is said to occur in great abundance even in the benthal or deepest zone. The word "benthal" is applied to depths exceeding 1000 fathoms (see my Address which is referred to at p. 190 of this Lecture). Shells, corals, and other organisms are everywhere permeated by what are considered to be minute plants allied to fungi or confervæ, which form branching canals, like those of the *Cliona* or perforating sponge; and such canals have been also detected in all fossiliferous strata of a marine nature, from the Silurian to the present epoch. These plants, or Thallophytes, have been called "parasitic"; but they do not live on any other living thing. They can hardly serve as food for deep-sea animals, because they are never exposed. Whether they may not be a link to connect the animal and vegetable kingdoms may be a matter for further investigation.

Food is of course a very important factor as regards the size of all animals. I have noticed, in my work on 'British Conchology,' that Mollusca from moderate depths are generally larger than those of the same species from shallow water; but this does not seem to

* See 'Proc. Roy. Soc.' for 1870, p. 420.

be the case with a species of coral obtained in the 'Challenger' Expedition, which ranged from a depth of 30 to one of 2900 fathoms, and was very variable in size.

5. Light.

Milton tells us of the

"world of waters dark and deep."

One of the most interesting problems relating to the subject of this Lecture is whether the above is a poetical idea or based on fact, as regards the absence of light in the abysses of the ocean.

We do not know to what extent the sun's rays penetrate the sea, nor whether the bottom at all depths is absolutely devoid of light. An ingenious apparatus, which was contrived by Dr. Siemens for ascertaining the presence of light at different depths by means of highly sensitive photographic paper, has never yet been properly tried. An experiment of this kind, made by Professor Forel, proved that in the Lake of Geneva, even at a depth of only 30 fathoms, the paper was entirely unaffected after protracted exposure. But the water of that lake is peculiar; it is said to be rendered less transparent by suspended and floating particles of mica brought from glacier streams, and to have thus acquired its deep blue colour. I cannot believe that the only abyssal light, if there be any, is phosphorescent.

At all events we are certain that, as regards the sea, many animals at very great depths have eyes, and that there is no absence of colour.

Cuttlefishes, which have eyes not less highly organized than our own, have frequently been obtained from depths of many hundred fathoms; they do not eat phosphorescent polypes and such small deer. Nor are the deep-sea Mollusca blind. During the 'Porcupine' Expedition of 1869 an undescribed species of *Pleurotoma* from 2090 fathoms had a pair of well-developed eyes on short footstalks; and a *Fusus* from 1207 fathoms had its eyes at the base of the tentacles. The last-named molluscs chiefly prey on bivalves. I have taken at moderate depths, living on the same ground, closely allied species of univalve molluscs, of which some were eyeless or blind, and others were provided with the usual organs of vision. Numerous instances have been given by the 'Challenger' naturalists of apparently seeing as well as of apparently sightless animals taken at great depths. Professor Semper, of Würzburg, says, in 'The Natural Conditions of Existence as they affect Animal Life' (1881): "Many creatures furnished with well-constructed eyes live associated with the actually blind species, and which have been partly enumerated above." He mentions among the former five species of fish (one of a new genus) discovered in the 'Challenger' Expedition at depths of from 675 to 2040 fathoms, besides several Mollusca and Crustacea.*

Some land-slugs and molluscs (e.g. *Geomalacus maculosus* and *Achatina acicula*) are also blind. On the sea-shore and in shallow water most bivalves, as well as all the species of *Chiton*, are eyeless.

Some deep-sea animals are brightly and deeply coloured. In the 'Challenger' Expedition shrimps "of an intense bright scarlet colour" were obtained in very great abundance; and many holothurians or "sea-cucumbers" were of a "deep purple" hue. The same observation occurred to me in the 'Porcupine' and 'Travailleur' Expeditions.

6. Temperature.

The highest temperature of the sea-bottom observed in the 'Challenger' voyage at depths over 1000 fathoms was 50°·5 Fahr., in 2550 fathoms; the lowest was 32°·1, in 1950 fathoms. The average bottom-temperature at great depths does not much exceed the freezing-point; but life does not appear to be affected by that circumstance. In the Arctic Expedition of 1875 I found an abundance and variety of animals in icy cold water.

7. Depth.

The average depth of the ocean between latitudes 60° N. and 60° S. is nearly three miles, or 2500 fathoms. The greatest depth which has been ascertained by sounding is five miles and a quarter, or 4620 fathoms, and occurs in the North-west Pacific Ocean; it is nearly equal to the height of Mount Everest, the highest known mountain, the relation being in the proportion of 27,720 to 29,000 feet.

8. Inequalities of the Sea-bottom.

The operations of the Telegraph Construction and Maintenance Company have materially added to our knowledge of the shape and contour of the floor of the ocean. They have shown us that the bed of the sea is quite as uneven as the surface of the land, and that it represents the same mountains, hills, gorges, and valleys,

* In the Norwegian North-Atlantic Expedition of 1878, a fish was taken at the depth of 1280 fathoms (nearly a mile and a half), which is now described by Mr. Collett, and said to have been of a uniform bright red colour, with well-developed eyes. It was not only living when brought up in the trawl, but was kept some time alive in a tub of sea-water. It was about a foot in length. Temperature at bottom between 34° and 35° Fahr.

equally diversified in the one case by oceanic currents on the surface as well as on the bottom, and in the other by foaming rivers and gentle streams. I will give a few instances of such inequalities in the North Atlantic. In 1878, while repairing the Anglo-American cable, a tract of rocky ground, about 100 miles in length, was discovered, in the middle of the North Atlantic, between 33° 50′ and 36° 30′ West longitude, and about 51° 20′ North latitude. Within a distance of eight miles the shallowest sounding was 1370 and the deepest 2230 fathoms, a difference of 860 fathoms or 5160 feet; within four miles the difference was 3180 feet, and within half a mile 1380 feet. There are also the Laura Ethel Bank, with a depth of only 36 fathoms, and the Milne Bank, with 81 fathoms, both about 550 miles from Newfoundland, which is the nearest continental land. Other instances are the Josephine Bank, with 82 fathoms, and Gettysburg Bank, with 30 fathoms, the distance of the former from Cape St. Vincent being 250, and the latter 130 miles, with intermediate depths of from 1700 to 2500 fathoms. The soundings in the 'Bulldog' Expedition also gave 748 between 1168 and 1260 fathoms, and the 'Valorous' soundings gave 690 between 1450 and 1230 fathoms in another part of the North Atlantic and very far from any land.

A glance at the large series of the diagrams of the 'Challenger' soundings will at once serve to convince any one of the extreme unevenness of the sea-bottom everywhere in the Atlantic and Pacific oceans. It would be difficult to find a greater degree of unevenness in any diagrams of the earth's surface, the total extent of which scarcely exceeds one-fourth of that of the sea.

Diagrams to illustrate the inequalities of the sea-bottom in the case of the telegraph cable, and the irregularities of level in a similar extent of land in the Perthshire Highlands, are placed before you.

9. Deposits.

The floor of the ocean is covered by a more or less thick layer of ooze or mud, and clays of different sorts and colours, and is inhabited by various animals. One of these deposits is called "*Globigerina*-ooze," and is widely distributed over the bed of both the Atlantic and the Pacific. Another deposit is called "Red Clay," and is found at depths exceeding 2000 fathoms. Mr. Murray, one of the 'Challenger' naturalists, has carefully worked out the deep-sea deposits which were observed and collected during the expedition. According to him the *Globigerina*-ooze occurred in the North Atlantic at forty-nine stations, from depths of between 780 and 2675 fathoms; in the South Atlantic at six stations, from depths of between 1375 and 2150 fathoms; and in the Pacific Ocean at twenty-two stations, from depths of between 275 and 2925 fathoms. He also mentions other deposits, viz. Coral-mud, Radiolarian ooze, and Diatomaceous ooze. According to Mr. Murray, volcanic products, such as pumice, lava, and scoriæ, as well as the peroxide of manganese, are universally spread over the bottom of the deep sea; and, in consequence of copper, cobalt, and nickel having been detected in the clays, he was tempted to suggest the presence of meteoric or cosmic dust in those deposits.

An animated, but quite amicable, controversy has of late years taken place as to whether *Globigerina* (from which the first-mentioned ooze has taken its name) lives only on the bottom or only on the surface of the sea, or on both. You will doubtless ask, what is a *Globigerina*? It is a microscopic shell, consisting of a few globular cells, which are added together in the course of growth, the smallest cell being the original one or nucleus, and the largest being the last formed. All the cells are full of a protoplasmic substance called sarcode, which is amorphous or has no definite structure—no head, no limbs, no heart, viscera, muscles, or nerves. Its entire body is a stomach, and nothing but a stomach. The same kind of sarcode forms the living pulp of sponges, which have a horny or glass-like skeleton instead of a shell. The *Globigerina* is a member of an extensive and extremely variable class of Invertebrate animals called Foraminifera; and this class, as well as sponges, belong to a kingdom called Protozoa, the name of which imports not that it was the earliest form of life, but that its organization is of the very primary or simplest kind. The cells of the *Globigerina* are in their living state covered with the most delicate spines of comparatively great length, which are set outwards, and probably serve to keep at a respectful distance all predatory animals of an equally minute size. Between these spines some of the sarcode is occasionally, if not habitually, protruded at the will of the animal through very fine pores of the shell, which gave rise to the name Foraminifera. Such prolongations or expansions of the sarcode are called pseudopodia, and are used for capturing and taking into the body or stomach animal or vegetable particles which serve for food, and are engulfed in the internal sarcode. Having premised thus much, and in the hope that my description may be tolerably intelligible to those who have not, like myself, studied the Foraminifera, I will proceed with my account of the controversy. I have frequently taken with a towing-net on the surface of the sea a multitude of floating *Globigerinæ*, which were certainly alive and showed their pseudopodia as well as their long and thick-set spines. Major Owen and Lieut. Palmer, who especially studied the surface-fauna of the Atlantic, observed and have published the same facts.* Therefore when, in the joint report of my colleagues and myself to the Royal Society on the results of the first 'Porcupine' Expedition in 1869, it was stated or strongly inferred that the *Globigerinæ* really "inhabit the bottom on which they are found in such extraordinary abundance," and that the hypothesis accounting for such accumulation by their having fallen to the bottom after death, their lives having been passed at or near the surface, was conclusively disproved, I ventured to record my dissent from that conclusion. The observations of Mr. Murray, one of the naturalists in the 'Challenger' Expedition, have fully confirmed the hypothesis that *Globigerina* lives on the surface; and Sir Wyville Thomson now admits † it as an established fact. But Dr. Carpenter is not satisfied. He is of opinion that "whilst the *Globigerinæ* are pelagic in an earlier stage of their lives, frequenting the upper stratum of the ocean, they sink to the bottom *whilst still living*, in consequence of the increasing thickness of their calcareous shells, and not only continue to *live* on the sea-bed, but probably *multiply* there—perhaps there exclusively." ‡ I must say that I am not convinced by the instances and arguments which he adduces in support of his opinion. There is no question that a great many species of Foraminifera live always on the sea-bottom; but I do not know that any species of pelagic or surface-dwelling animal inhabits also the sea-bottom. Dr. Wallich found that the stomachs of starfishes which came up with the sounding-line from 1260 fathoms contained fresh-looking *Globigerinæ*, and that the latter were full of sarcode. This does not prove much; because sea-water is to some extent antiseptic or retards putrefaction. Many starfishes feed like earthworms, and swallow quantities of organic and inorganic matter for the purpose of extracting nutriment from it. Sir Wyville Thomson says, in his paper "On Dredgings and Deep-sea Soundings in the South Atlantic," § that the appearance of *Globigerina* and certain other Foraminifera, "when living on the surface, is so totally different from that of the shells at the bottom, that it is impossible to doubt that the latter, even although they frequently contain organic matter, are all dead." Mr. Murray adds: ‖ —"No living specimen of a *Globigerina*, an *Orbulina*, a *Pulvinulina*, or of the new genera

* 'Journal of the Linnean Society,' Zoology, vol. ix, p. 147.
† 'Proc. Roy. Soc.,' vol. xxiii, p. 34.
‡ *Ibid.*, p. 235.
§ *Ib.*, vol. xxii, p. 427.
‖ *Ib.*, vol. xxiv, p. 535.

found on the surface, which undoubtedly came from the bottom, has yet been met with. The foregoing observations appear to justify the opinion that these organisms live only in the surface and subsurface waters of the ocean."

I will not, however, presume to assert that Dr. Carpenter may not be right; but is he justified in taking for granted "that the *onus probandi* rests on those who maintain that the *Globigerinæ* do *not* live on the bottom"? It is rather difficult to prove a negative.

The colour of the "Red Clay" was attributed by Mr. Murray to the presence of oxide of iron.

Mr. Etheridge obligingly examined some of the pebbles and minerals which I had dredged in the 'Valorous' Expedition at depths of from 690 to 1750 fathoms. He reported that many of them were "most likely derived from Iceland." If this were the case, the pebbles and minerals might have been transported by a deep submarine current.

The deposits in very deep water, and beyond the range of fluviatile and tidal action, are so slight as to be almost filmy, and are chiefly composed of the skeletons or hard parts of *Globigerinæ*, diatoms, and *Radiolariæ*. The subjacent layer of mud or ooze, where it is beyond the scope of river-action, may have been formed from the ruins of a sunken continent.

The proportion of carbonate of lime contained in the deep-sea mud or ooze of the North Atlantic, which was procured in the first two cruises of the 'Porcupine' Expedition of 1869, slightly differed. In a sample from 1443 fathoms, dredged off the west coast of Ireland in the first cruise, the proportion given by the late Mr. David Forbes was only about one-half, while in another sample from 2435 fathoms, dredged off the south coast of Ireland in the second cruise, Mr. Hunter found a little over 60 per cent.

As to a mysterious deposit called *Bathybius*, Mr. Buchanan, who had charge of the chemical work on board the 'Challenger,' proved by careful and repeated analysis that this substance was not organic; and he "determined it to be sulphate of lime, which had been eliminated from the sea-water, always present in the mud, as an amorphous precipitate, on the addition of spirits of wine." Mr. Murray came to the same conclusion; and the lifeless and inorganic nature of *Bathybius* may now be considered settled. This gelatinous slime was once imagined to be primordial, and to constitute the basis of life. But the sea-bed is the tomb of past generations, not the womb of creation.

10. Geological.

The late Sir Charles Lyell says, in the sixth edition of his 'Elements of Geology' (1865): "That white chalk is now forming in the depths of the ocean, may now be regarded as an ascertained fact, because the *Globigerina bulloides* is specifically undistinguishable from a fossil which constitutes a large part of the chalk of Europe." He assumed that the *Globigerina* inhabited the ooze on the sea-bed. Edward Forbes and other geologists had initiated and adopted the same view that the Chalk was a deep-sea deposit. In my Presidential Address to the Biological Section of the British Association at the Plymouth Meeting in 1877, I ventured to question the validity of this theory, and especially that which my colleague and friend Sir Wyville Thomson started as to the "continuity of the Chalk" from the Cretaceous to the present period. I there endeavoured to show that the Chalk differed in composition from the Atlantic mud, and that the fauna of the Chalk formation represented shallow and not deep water. My view has, I am glad to say, been to some extent admitted by Sir Wyville Thomson in his 'Report on the Scientific Results of the Voyage of H.M.S. "Challenger,"' when he speaks (pp. 49 and 50) of the belt of "shallower water" during the Cretaceous period. At all events, Mr. Wallace has lately accepted and confirmed my view.* It is highly probable that the Gault which underlies the Chalk and is the lowest member of the Upper Cretaceous formation, was a deep-water deposit, because it abounds in small shells of the *Arca* and *Corbula* families, as well as in Ammonites and other free-swimming Cephalopods.

Mr. Sollas, indeed, in his paper "On the Flint Nodules of the Trimmingham Chalk,"† says that he believes that some deep-sea mud is analogous with the chalk. He is aware that the former contains siliceous organisms and the latter none; and he supposes that the flints had been in some way derived from these organisms. But how flints originated and were formed is still a vexed question. Mr. Sollas is, perhaps, the best authority on sponges; but he states (page 444) that "the bottom-water of the sea is remarkably free from organic matter." This statement does not agree with the analyses of the bottom-water of the sea which were made by Mr. Lant Carpenter, Dr. Frankland, and Mr. Buchanan, the chemist of the 'Challenger,' nor with the observations of Sir Wyville Thomson in his 'Depths of the Sea,' in which he says (page 46): "the bottom of the sea is a mass of animal life."

* 'Island Life.' † 'Ann. and Mag. Nat. Hist.,' Dec. 1880.

Several species of Mollusca which were previously known as fossil only, and were supposed to be extinct, have lately been dredged by myself and others from the bottom of the Atlantic. Some of these same species had been described and figured by Professor Seguenza, of Messina, from Pliocene beds in Sicily. I have no doubt that many more, perhaps all, of such fossil species will be hereafter discovered in a living state by means of deep-sea explorations.

Some geologists, and especially of late years, have advocated the theory that oceans have continued for an enormously long period to occupy the same areas that they still occupy. Mr. Darwin was, I believe, the first to broach this idea. He says, in the chapter "On the Imperfection of the Geological Record" ('Origin of Species'): "We may infer that where our oceans now extend oceans have extended from the remotest period of which we have any record; and, on the other hand, that where continents now exist large tracts of land have existed, subjected, no doubt, to great oscillations of level, since the earliest Silurian period." There does not seem to be any fact adduced or reason given for either of the above inferences.

If the present oceans and continents have remained unchanged since the Silurian period, how can we account for the widespread distribution of fossiliferous formations, Palæozoic, Mesozoic, Cainozoic or Tertiary, and Quaternary or Recent, miles in thickness, all over Europe, Asia, Africa, Australasia, and New Zealand? All oceanic islands are of volcanic origin; but some of them contain Miocene fossils. These formations are chiefly marine, and necessarily imply the presence of oceans in those parts of the globe which are now continents and dry land. All the "secrets of the deep" will probably never be revealed to man, nor is he likely to know what terrestrial formations underlie the floor of the mid-ocean.

In my paper "On the Occurrence of Marine Shells of Existing Species at different Heights above the Present Level of the Sea," which was published in the 'Quarterly Journal of the Geological Society' for August, 1880, I stated that many existing species of Mollusca which inhabit great depths only are found in a fossil state at considerable heights above the present level of the sea, so as to show an elevation equal to nearly 12,000 feet, and that such elevation must have taken place at a very late and comparatively recent stage of the Tertiary or Post-Tertiary epoch. In the face of facts like this, can we rightly assign to the present oceans that geologically remote antiquity which is claimed for them?

11. Incidental.

Clarence's dream of wrecks, corpses, wonderful treasures, and

> "reflected gems
> That woo'd the slimy bottom of the deep,
> And mock'd the dead bones that lay scatter'd by,"

has not yet, I believe, been realized by any dredger. I have in this way explored for between 40 and 50 years all our own seas, besides a considerable part of those on the coasts of North America, Greenland, Norway, France, Spain, Portugal, Morocco, and Italy, but I have never found any thing of value except to a naturalist, nor any human bone, although many thousands must have perished in those seas.

12. Concluding Remarks.

To give a better idea of the ocean and of its life in the depths as well as on the surface, let me strongly recommend my hearers to read Mr. Moseley's admirable volume entitled 'Notes by a Naturalist on the "Challenger."' His graphic account of this marvellous voyage far surpasses in interest (to say nothing of accuracy) every work of fiction or imagination, and it has not the melancholy dullness of most books on history and travels.

The subject of this Lecture is inexhaustible; and when our knowledge of it has become more extended, we must continually say with Seneca: "Our predecessors have done much, but have not finished. Much work yet remains, and much will remain; nor to any one, born after a thousand ages, will be wanting the opportunity of still adding something." Such increase of knowledge must tend to confirm our acknowledgment, with a reverential awe, of that Great Creator whose wonderful works are dimly seen in every form of life, marine and terrestrial, and especially in

> "all that glides
> Beneath the wave, yea, in the wave itself,
> And mighty waste of waters."

XXVI.

THE FORMATION AND ARRANGEMENT OF PROVINCIAL MUSEUMS.

By JOHN HOPKINSON, F.L.S., F.G.S., etc., Hon. Sec.

Read at Watford, 15th March, 1881.

THE establishment of a Museum having been decided upon by the Council of our Society, and the first step towards the formation of one having recently been taken by the purchase of a show-case, which now contains such donations as have already been received, I have thought that it might be well, at the commencement of our undertaking, to give expression to certain ideas on the formation and arrangement of provincial museums which may perhaps be of some practical use.

Museums may be divided into three classes, viz. National, Provincial, and Educational, and although an educational museum may be combined with a national or with a provincial museum, it is impossible successfully to combine a provincial with a national, or, as it may also be termed, an accumulative museum, and yet this is the very thing which is most frequently attempted and which often renders an otherwise valuable collection practically useless.

A national museum is one which, strictly speaking, should aim at illustrating the entire national productions, antiquities, and fine and industrial arts of the nation, but this term, as usually applied to museums, has a much more extensive signification, the national museum of a country legitimately containing objects from all parts of the world. Such is our British Museum, and it is the only really national museum we can have, for, as Dr. Günther has said, "however great, however large, a country or a nation may be, it can have, in reality, only one national museum truly deserving of the name."*

All museums, it may be said, are, or should be, educational, but by this term is here meant only such as are intended to illustrate certain special branches of study, and which are usually additions to the teaching capabilities of educational institutions. As good examples of educational museums in London may be mentioned the Museum of Practical Geology in Jermyn Street, the Museums of the Science and Art Department at South Kensington and Bethnal Green, and the Museum of the College of Surgeons in Lincoln's Inn Fields. The Museum of Economic Botany in Kew Gardens is an excellent example of a strictly educational museum having a special object.

* Presidential Address to the Biological Section of the British Association, Swansea, 1880. 'Rep. Brit. Assoc. for 1880,' p. 593.

We now come to our special subject, Provincial Museums. In their formation the first consideration should be to make them represent, as faithfully as possible, the district in which they are situated. The various productions, natural and artificial, of a definite area, should be brought together in a space no larger than is necessary for their systematic arrangement, proper display, and efficient explanation.

It will, I think, be generally conceded that although almost all the larger towns in the kingdom, and many of the smaller ones, possess one or more museums, there are comparatively few which nearly approach to a possible, or even an easily-attained, state of perfection; and the reason of this will in most cases be found to be that too much has been attempted. What a provincial museum should be, and what, chiefly from this cause, it most often is, I can best express in the words of the late Professor Edward Forbes,* than whom few could be named better qualified to form and express an impartial judgment on this subject. After stating that "In their instructional aspect, considered apart from their educational applications, the value of museums must in a great measure depend on the perfection of their arrangements and the leading ideas regulating the classification of their contents," and also that he believes that "it is to the development of the provincial museums . . . . . we must look in the future for the extension of intellectual pursuits throughout the land," Professor Forbes says:

"When a naturalist goes from one country into another, his first inquiry is for local collections. He is anxious to see authentic and full cabinets of the productions of the region he is visiting. He wishes, moreover, if possible, to study them apart—not mingled up with general or miscellaneous collections,—and distinctly arranged with special reference to the region they illustrate. For all that concerns the whole world or the general affinities of objects, he seeks the greatest national collections, such as the British Museum, the Jardin des Plantes, the Royal Museums at Berlin and Vienna. But that which relates to the particular country he is exploring, he expects to find either in a special department of the national museum, or in some separate establishment, the purpose of which is, in a scientific sense, patriotic and limited. So also with the students of history and antiquities; they are often disappointed, and in the end find what they require here and there, bit by bit, in the cabinets of private individuals. In like manner, when the inquirer goes from one province to another, from one county to another, he first seeks for local collections. In almost every town of any size or consequence he finds a public museum, but how often does he find any part of that museum devoted to the illustration of the productions of the district? The very feature which of all others would give interest and value to the collection, which would render it most useful for teaching purposes, has in

* In a lecture "On the Educational Uses of Museums," delivered before the Metropolitan School of Science (now the Royal School of Mines), in 1853.

most instances been omitted, or so treated as to be altogether useless.

"Unfortunately not a few country museums are little better than raree-shows. They contain an incongruous accumulation of things curious or supposed to be curious, heaped together in disorderly piles, or neatly spread out with ingenious disregard of their relations. The only label attached to nine specimens out of ten is, 'Presented by Mr. or Mrs. So-and-so;' the object of the presentation having been either to cherish a glow of generous self-satisfaction in the bosom of the donor, or to get rid—under the semblance of doing a good action—of rubbish that had once been prized, but latterly had stood in the way. Curiosities from the South Seas, relics worthless in themselves, deriving their interest from association with persons or localities, a few badly-stuffed quadrupeds, rather more birds, a stuffed snake, a skinned alligator, part of an Egyptian mummy, Indian gods, a case or two of shells, the bivalves usually single and the univalves decorticated, a sea-urchin without its spines, a few common corals, the fruit of a double cocoa-nut, some mixed antiquities, partly local, partly Etruscan, partly Roman and Egyptian, and a case of minerals and miscellaneous fossils,—such is the inventory and about the scientific order of their contents. . . ."

"There are, however," he continues, "admirable exceptions to this censure. There are local collections arranged with skill and judgment in several of our county towns, and which at a glance tell us of the neighbourhood and activity of a few guiding and enlightened men of science. It would be invidious to cite examples, and yet the principles, in each case distinct, adopted in the arrangement of those of Ipswich and Belfast ought specially to be noticed. In the former, thanks to the advice and activity of Professor Henslow, the specimens of various kinds, whether antiquarian, natural-history, or industrial, are so arranged as to convey distinct notions of principles, practice, or history. In the Belfast Museum the eminent naturalists and antiquaries who have given celebrity to their town, have made its contents at a glance explanatory of the geology, zoology, botany, and ancient history of the locality and neighbouring province. The museums of Manchester, York, Scarborough, and Newcastle might be cited as highly commendable likewise, thanks to the science and ability of the eminent men connected with them, or who have taken an interest in their formation."

That the views here expressed, with which I entirely agree, are held by other distinguished scientific men besides Edward Forbes, I will now endeavour to show by giving extracts from the writings of Professors Phillips, Bell, and Owen.

In concluding an address delivered at a meeting of the Malvern, Cotteswold, and other Natural History Societies, Professor Phillips (then Deputy Reader in Geology in the University of Oxford) said: "I would, if it were necessary, urge all persons belonging to field-clubs, not selfishly to retain the specimens they gather, but to deposit them where they may be of use to their fellow-explorers.

My experience of the friendly disposition of the officers and members of these clubs, assures me that here it is not necessary. But, I feel justified in proposing a mode by which their liberality may become more effectually and permanently beneficial; I earnestly advocate and petition for the formation of an entirely local museum at Malvern. Such an institution there, would be of the utmost value. It is not so easy to establish as may be imagined. Whoever has the charge of it will have difficulty, except it be made a fundamental law, an invariable statute, to keep the museum to its own narrow but useful purposes. You will be offered curiosities from every land, trifles from every sea. I entreat you to refuse all but what is the growth of your own beautiful Malvernia, or the gift of your own Palæozoic and Mesozoic seas. Resolutely refuse to contend with larger communities, to adopt less definite objects. Have the courage to decline any specimens whatever that do not actually belong to your own district." *

In the year following that in which the Address from which I have taken these remarks was published, Professor Bell, in his Presidential Address to the Linnean Society, thus treated of the subject. "It was the observation of the most accomplished and fascinating writer on local natural history that England has ever seen, that if the natural productions of each district had their local historian, our knowledge of the natural history of the country would become more perfect than by any other means; and every one knows how beautifully and how perfectly the author of that sentiment carried it into practice. It is indeed the only means by which this end can be obtained; and it is therefore with much pleasure that I advert to the numerous local institutions now springing up in various directions . . . . the principal design of which is to allocate in a provincial museum the natural productions of the county or of a more circumscribed district, and frequently associated with a collection of local antiquities. I have thought that it might be useful to point out some circumstances which would conduce to the proper design of such institutions, and at the same time render them the means of greatly extending our acquaintance with indigenous zoology and botany. The primary object then of these institutions should be the collection and preservation of the animals, plants, and palæontological specimens which are found in the district; and to this should be added a full and accurate record of their habitats and of any other interesting circumstances connected with them, whether of soil, of geological position, of meteorological phenomena, the period of the year when obtained, peculiarities in their habits, and in short of any facts which may bear upon their history. If in addition to this first consideration it happens that instruction is to be given, by lectures or other means, in the study of natural history generally, a typical collection may be added, which should be considered as entirely distinct from the local one, and as having

* 'On the Geology of the Malvern Hills,' p. 13.—1855.

a totally different object. . . . . . My friend Professor Phillips, in a recent address to the Malvern Field-Naturalists' Club, alluding to the formation of such a museum, has very strongly, and with great propriety, urged the rejection, by an absolute rule, of all offers of specimens excepting such as are connected with the locality. The consequence of the neglect of this salutary caution is the accumulation of masses of specimens from all parts of the world, many of which might be available if suitably placed, but are a mere useless incumbrance in a local museum. They not only occupy space which might be more beneficially employed, but they take off the attention and waste the time of those who resort to the museum for information, and of those whose duty it is to take care of the contents and keep the records." *

A few years later Professor Owen, referring to the proposed formation of a museum at Wimbledon, in 1862, writes: "I believe that the most useful museum for a suburban locality, such as Wimbledon, contiguous to commons and wooded grounds and preserves, is that which is devoted to the natural objects of such locality. It gives a stimulus to observe and collect: it adds an interest to every object contributed, in the relation which each specimen always bears to its collector, and the circumstances attending its recognition. Well carried out, such a museum is helpful to science in fixing a date to the fauna and flora of the district determined on, and in giving the material means of contrasting it with the condition of both at a later period. . . . ." †

In giving the opinions of four of the most eminent scientific men of our day, who have had, in their official position chiefly, the amplest opportunities of acquiring a knowledge of the causes of success and of failure in the establishment of provincial and other museums, I trust that I have adduced sufficient authority for insisting on the necessity of making a provincial museum an epitome of the productions of a certain definite area—of the district or of the county in which it is situated.

Applying this general rule to our own special case, the museum of the Hertfordshire Natural History Society should represent as faithfully as possible the natural history of the County of Hertford. The formation of such a museum need not, however, preclude the formation of an educational museum under the same roof. If such should be attempted, the advice given by Professor Bell in the remarks quoted from his address to the Linnean Society, should be strictly followed. The educational museum should consist of a typical collection specially adapted for the illustration of lectures, or other means of instruction, and it should be entirely distinct from the local one, having a totally different object.

Upon this point—the desirability of having in the same building a local and a typical educational collection kept entirely distinct—

* 'Proc. Linn. Soc.,' Session 1865-66, pp. xxiii, xxiv.

† From a Letter (dated 19th Jan. 1862) to Mr. Joseph Toynbee, F.R.S., Treasurer of the Wimbledon Museum Committee, in 'Hints on the Formation of Local Museums,' p. 57.—1863.

I will venture to quote at some length from a paper read by Professor Rudler before the Cymmrodorion Society in 1876.*

"Having," he says, "for many years been officially connected with a large museum in London,† I have naturally taken much interest in the formation and arrangement of collections, and have seized every opportunity of studying natural-history museums—metropolitan, provincial, and continental. In this way I have been led to carefully note the characteristics of a large number of public collections, and to compare what appear to me to be their respective merits and demerits."

Advocating, then, the formation of a central museum in Wales, he proceeds: "In forming such a museum, the one great object to be steadily kept in view must be that of collecting, arranging, and exhibiting all the natural productions of the Principality. Every animal and vegetable, whether recent or fossil, every mineral and rock, to be found within the limits of Wales, must be adequately represented, so that the museum shall ultimately form a complete exponent of Welsh natural history. But I would go beyond this. Not only should the indigenous productions be exhibited, as presented in their original condition, but the application of these products to the arts of life should equally be illustrated. In other words, the purely scientific department should be supplemented by a technological collection, exhibiting the uses which we make of the natural resources at our command."

After stating that in such a museum the art and archæology of Wales ought not to be neglected, he continues: "Whilst we should patriotically aspire to render the local collection as perfect as possible, I would not, by any means, have the usefulness of the museum stop here. Comparing any local collection with a general collection, it will of course be found that many important groups of animals, vegetables, and minerals are but imperfectly represented, whilst others are altogether blank. There is, consequently, great danger of very limited and inadequate notions of the great system of nature being formed by the student who confines his attention to local natural history. . . . . To counteract such a tendency, it is eminently desirable to form, under proper conditions, a *general* collection which will give the visitor some notion of, at any rate, the larger groups in which natural bodies are classified. . . . . There should consequently be two departments to our central museum—one *local*, and the other *general*—each with distinct aims, and each appealing to a distinct class of visitors. Differing thus in their objects, it would be well to keep the two departments entirely distinct, as is done, for example, in the Worcester Museum, where a special room is devoted to the illustration of the natural history of the county. Whilst our local collection would certainly give value to the museum in the eyes of genuine students of science, who would be attracted thither by the opportunity of taking a

* 'On Natural History Museums, with Suggestions for the Formation of a Central Museum in Wales.'—1876.

† The Museum of Practical Geology, Jermyn Street.

complete survey of Welsh natural history, it is probable, on the other hand, that the general collection would form the chief source of interest to the casual visitor and less-advanced student. But this general collection must be kept within moderate limits. The investigator, who has occasion to study with thoroughness any particular group of natural objects, will assuredly resort to the great metropolitan collections; and it would be absurd for a provincial museum to endeavour to illustrate with completeness any natural group, unless it happen to be indigenous. All that we should attempt in the general collection is to convey to the visitor, who uses it educationally, some broad, though clearly-defined, notions of the larger groups of natural bodies. This may be done, and indeed best done, by the display of only a limited number of typical specimens, provided that they are selected with judgment, and displayed with intelligence. We have no need of a multitude of objects, tending to bewilder rather than to enlighten. Nor should we covet rare specimens, which always cost much, and often teach little. Neither should we seek pretty and attractive things, such as are to be found in some museums, heaped together in bower-birdish fashion, where they gratify the senses, without nourishing the intellect. Let us by all means have rare and pretty specimens, if they can claim educational value, but not simply for the sake of their rarity or their beauty. What we really want is a moderate number of comparatively common objects, judiciously selected, accurately classified, well displayed, and fully illustrated, where necessary, by preparations and diagrams. Such a collection, though small, would have far higher educational worth, and would command greater respect from scientific authorities, than the large heterogeneous collections of unassorted donations which frequently form the bulk of museums of old-fashioned type."

I have here only quoted Prof. Rudler's general remarks, which are as applicable to the proposed museum at the Watford Public Library as they are to the one the formation of which he was advocating. The greater part of his paper, which should be read in its entirety by all who are interested in the formation and management of museums, is devoted to the expression of his views as to what should be exhibited in the local, the general, and the technological departments of the proposed central museum in Wales, and as to the manner in which the objects should be displayed, arranged, and explained.

Before leaving this subject I will quote briefly from some other addresses, in the Reports of the British Association for the Advancement of Science, which bear out my views.

At the Glasgow meeting of the Association, in 1855, the Rev. Prof. J. S. Henslow furnished a Report, drawn up by the request of the General Committee, on "A Typical Series of Objects in Natural History, adapted to Local Museums," in which he said: "Although our great national establishments in London are adapted for displaying a large proportion of all procurable objects of natural history, it would require larger funds than local museums are likely to command, to adopt the plan which they follow. But it is within the power of every museum, however humble its pretensions, to procure and display such instructive series of objects as may bring the entire range of natural history in a forcible manner before the attention of the public. Wherever a specimen of some species regarded as a sufficient type of a particular group cannot be conveniently procured, then a model, a drawing, or a tracing from some published figure may be introduced as a substitute. . . . . . Very limited museums might advantageously restrict their collections to little more than a general typical series; always excepting those special collections which are to illustrate the natural history of their own neighbourhoods."*

Our honorary member, Sir J. D. Hooker, in his Presidential Address to the British Association at Norwich, in 1868, expressed the same ideas, alluding, in illustration of his views, to a museum Professor Henslow had arranged (the Ipswich Museum). "Confining myself," he said, "to the consideration of provincial and local museums, and their requirements for educational purposes, each should contain a connected series of specimens illustrating the principal and some of the lesser divisions of the Animal and Vegetable Kingdoms, so disposed in well-lighted cases, that an inquiring observer might learn therefrom the principles upon which animals and plants are classified, the relations of their organs to one another and to those of their allies, the functions of those organs, and other matters relating to their habits, uses, and place in the economy of nature. Such an arrangement has not been carried out in any museum known to me, though partially attained in that at Ipswich; it requires some space, many pictorial illustrations, magnified views of the smaller organs and their structure, and copious legible descriptive labels, and it should not contain a single specimen more than is wanted. The other requirements of a provincial museum are, complete collections of the plants and animals of the province, which should be kept entirely apart from the instructural series, and from everything else." †

Professor Rolleston, in his Presidential Address to the Biological Section of the Association, at Liverpool, in 1870, speaking of the great value of "Local Museums, Local Field Clubs, and Local Natural Histories" in giving scope for the development of latent scientific talent, said: "A young man who is possessed of a talent for natural science and physical inquiry generally, may have the knowledge of this predisposition made known to himself and others, for the first time, by his introduction to a well-arranged local museum. In such an institution, either all at once, or gradually, the conviction may spring up within him that the investigation of physical problems is the line of investigation to which he should be content to devote himself . . . ." And he defined a well-arranged museum, for this purpose, to be "one in which the natural objects which

* 'Rep. Brit. Assoc. for 1855,' pp. 110, 111.
† 'Rep. Brit. Assoc. for 1868,' p. lxii.

belong to the locality, and which have already struck upon the eye of such a person as the one contemplated, are clearly explained in a well-arranged catalogue." *

Very similar views were last year expressed by Dr. Günther in his Presidential Address to the Biological Section at the Swansea meeting. After insisting upon the importance of a provincial museum containing an arranged series of well-preserved specimens, and of its curator not admitting into his collection any specimen that is not well mounted and a fair representative of its species, he says: "The direct benefit of a complete collection of the flora and fauna of the district in which the provincial museum is situated, is obvious, and cannot be exaggerated. The pursuit of collecting and studying natural-history objects gives to the persons who are inclined to devote their leisure hours to it a beneficial training for whatever their real calling in life may be: they acquire a sense of order and method; they develop their gift of observation; they are stimulated to healthy exercise. Nothing encourages them more in this pursuit than a well-named and easily-accessible collection in their own native town, upon which they can fall back as a pattern and an aid for their own."

In another part of his address, speaking of the requirements of an educational natural-history museum, he says: "Its principal object is to supply the materials for teaching and studying the elements and general outlines of biology; it supplements, and is the most necessary help for, oral and practical instruction, which always ought to be combined with this kind of museum. The conservation of objects is subservient to their immediate utility and unrestricted accessibility to the student. The collection is best limited to a selection of representatives of the various groups or 'types' arranged in strictly systematic order, and associated with preparations of such parts of their organisation as are most characteristic of the group." †

It is thus seen, in the most recent contribution we have to this subject, how important it is considered that the selection of objects should be restricted to those only which fulfil a definite purpose, either, on the one hand, to illustrate a local flora and fauna, or, on the other, to aid the lecturer in the science he is teaching, or the student in his special branch of research.

Dr. Günther's address deals principally with the arrangement of our new Natural History Museum at South Kensington, which will form one section of the British Museum, and in which the views I have brought before you will find practical expression in the central portion of the building being divided into a room for British Zoology (*a local* zoological collection on a large scale), and an *Index Museum* "devoted to specimens selected to show the type-characters of the principal groups of organised beings" (an *educational* zoological collection).

* 'Rep. Brit. Assoc. for 1870,' Trans. Sections, pp. 93, 94.

† 'Rep. Brit. Assoc. for 1880,' pp. 592, 593.

In entering now upon the consideration of the arrangement of our own proposed museum, it will be evident that if anything which is not local, which has not been found within the limits of our county, is to be admitted, the museum should consist of at least two departments, kept perfectly distinct—a *local* in one room, and an *educational* in another—and I think that our Society should only undertake the responsibility of forming the local collection. The educational collection would more appropriately be formed by the Public Library Committee, as representing the Watford School of Science and Art, and working under the Public Libraries and Museums Act, and therefore able to command funds and acquire specimens which it would be impossible for our Society to do. Such an arrangement would also, more effectually than any other, insure the carrying out of the most important feature in any provincial museum, the entire separation of the local collection from the educational and from everything else.

All objects may primarily be classed as *natural* and *artificial*. Two distinct departments of any local collection are therefore clearly indicated. Natural objects may be classed as *mineral*, *vegetable*, and *animal*; artificial objects as archæological and of recent production. One department of a local collection should therefore be devoted to geology, botany, and zoology, the other to antiquities and modern art.

The department of art and antiquities, as not within the scope of our Society, need not be further considered. I may, however, suggest in passing that the formation of a collection illustrative of the antiquities of Hertfordshire, and of the fine and industrial art-works of its inhabitants—the latter especially designed to show the several processes in the conversion of the raw produce of the county to economic purposes—should be one of the first objects aimed at if our museum is to worthily represent our county, and to contain something of interest for all who may visit it.

The separation of our natural-history collection into a geological, a botanical, and a zoological division requires a little explanation before the sections into which these main divisions may be separated are treated of; for the geological division will not strictly represent the mineral kingdom of nature. In addition to minerals it may contain plants and animals in a fossil state. It has been urged that fossil plants and animals should rightly be arranged with the recent forms; but although there may be some advantage in such an arrangement when the intention is to illustrate the animal and vegetable kingdoms as completely as possible, for which purpose the fossil forms may be intercalated with the recent in one series, for a local collection I think that it is undoubtedly best to keep the fossil and the recent forms entirely distinct.*

* There is much diversity of opinion upon this point. Dr. Sclater says: "I do not hesitate to support the view put forward by Prof. Flower and other naturalists, that the palæontological department of the British Museum, as at present constituted, ought to be abolished, and its contents distributed amongst the zoological and botanical collections." ('Rep. Brit. Assoc. for 1870,' Trans.

The geological division of our museum should therefore contain specimens of the rocks, under which term is included any portion of the earth's crust, hard or soft, and of the fossils of our county. The rocks should be arranged in one series, stratigraphically, and the fossils, whether plants or animals, in another, also stratigraphically. The rock-specimens will scarcely admit of classification, for we can have but very few from each formation. The fossils may be classified in each formation, and the classification adopted should correspond, as nearly as possible, with that of our botanical and zoological divisions.

The geological formations which we now know to be present in Hertfordshire, at the surface or below it, and which should be represented in our museum by their rocks and fossils, are, in ascending order, the Silurian, Devonian, Cretaceous, Eocene, and Post-Pliocene or Pleistocene. The Silurian rocks are represented by the Wenlock Shale in the New River Company's boring near Ware, and the Devonian, or, more correctly, the Old Red Sandstone, was passed into at the boring at Turnford, near Cheshunt. The Cretaceous rocks extend over almost the entire county, though mostly covered by superficial deposits, and are represented by the Gault, the Upper Greensand or Chloritic series, and the various divisions of the Chalk formation. Of the Eocene rocks we have the Woolwich and Reading beds and the lower portion of the London Clay, forming the south-eastern margin of the county, and having numerous outliers on the Chalk. And finally, gravels, sands, and clays of Pleistocene age are spread superficially over the greater part of the older deposits. In the drift-gravels, which form such an important feature in the county, will be found specimens of rocks and fossils of very different geological ages, drifted from distant localities; but these specimens should rightly be placed in the Pleistocene division, which may, for instance, thus contain specimens of Palæozoic rocks from Charnwood Forest, Cumberland, or Wales, and of fossils of Cretaceous and Liassic age. With these, bones of still-existing Mammalia, and flint-implements and other records of man, may be associated. The position of these rocks in, and their relation to, the entire series of sedimentary strata, may best be expressed in a table (Table I, p. 207) in which the members present in Hertfordshire are indicated by distinctive type (*italics*).

The whole of our geological collection, except perhaps any very large specimens, should be exposed in flat or table cases, and maps, sections, or other illustrations may be hung upon the walls.

The botanical division of our museum will necessarily consist of two artificially-distinct portions, for some specimens may be displayed in cases, while the majority, comprising dried specimens

Sections, p. 127.) Dr. Günther, on the other hand, maintains that to incorporate fossil with recent forms "would offer in its practical execution so many and insuperable difficulties that we may well hesitate before we recommend the experiment to be tried in so large a collection as the British Museum." ('Rep. Brit. Assoc. for 1880,' p. 594.) Dr. Gray tried to unite the zoological and palæontological collections in the British Museum, when under his charge, giving up this attempt only after having convinced himself of its impracticability.

attached to sheets of paper, will be contained in our herbarium, which would best be placed in drawers or cupboards underneath the cases. As this separation is merely a matter of convenience, it need not be further referred to here, except to say that exigencies of space only, render it necessary to stow away specimens which are pressed and dried when collected, and will lie flat in the herbarium, the arrangement of which should be precisely the same as that of the collection in the show-cases. It may frequently happen that parts of the same plant may have to be separated, the fruit or seed, for instance, being placed in the show-case, and the rest of the plant in the herbarium.

With regard to the linear arrangement, it appears to me that the most usual system adopted in our British Floras, of commencing with the highest group and ending with the lowest, is not a desirable one. It is surely the most philosophical to begin with the lowest and simplest forms of life, and to proceed onwards to the higher and more complex forms, whether they are to be treated of in a text-book or arranged in a museum.

No better scheme for the classification of the plants of the whole world has, I think, been devised than that proposed by Lindley in his great work 'The Vegetable Kingdom,' though it is not perhaps so suitable for the plants of such a small area as our own county.

All plants may be primarily divided into cryptogamous and phanerogamous. Cryptogamous or flowerless plants are divided by Lindley into the classes (1) Thallogens, comprising algæ, fungi, and lichens; and (2) Acrogens, comprising mosses, lycopods, and ferns. All these may be represented in our museum. Phanerogamous or flowering plants Lindley divides into the five classes (3) Rhizogens, in which class there are no British plants; (4) Endogens, containing grasses, orchids, lilies, etc.; (5) Dictyogens, containing yams and parids; (6) Gymnogens, containing coniferous trees, etc.; and (7) Exogens, in which class are comprised by far the greater number of our forest-trees, shrubs, and herbaceous flowering plants. Exogens are divided into the sub-classes Diclinous, Hypogynous, Perigynous, and Hypogynous Exogens; and these again, as well as the other classes, contain assemblages of the natural orders grouped together in divisions called alliances.

In the accompanying table (Table II, pp. 208-210), while adopting the general plan of Lindley, I have made considerable alterations in his scheme in accordance with the views of recent writers on our British Flora. Lindley's class Dictyogens is here added to Endogens, and his class Gymnogens to Exogens; instead of his arrangement of the sub-classes, that of De Candolle* is followed; the Characeæ are removed from Thallogens and considered as forming the lowest group of Acrogens; and I have altered the sequence and arrangement, and in some instances the extent, of the natural orders and alliances.

* As given in Babington's 'Manual of British Botany,' 7th edit., 1874. The last edition (the third) of Lindley's 'Vegetable Kingdom' was published in 1853.

It need scarcely be said that as perfect a collection as possible of the plants of the county should be formed.

The zoological division of our museum finally claims attention, and here I do not propose to follow exactly any generally-received classification. That of Huxley, in his 'Introduction to the Classification of Animals' (1869), would I think be better adapted for our purpose than the scheme he has more recently proposed in the 'Journal of the Linnean Society.'* This is founded in great measure upon researches into embryological development by Haeckel and other continental biologists, but it may be doubted whether it is really an improvement upon his earlier classification, and it is certainly a less practicable classification for the arrangement of a museum. The same may, I think, be said of Ray Lankester's recently-proposed classification.†

In the earlier classification of Huxley the sub-kingdoms are arranged thus :—

	Vertebrata
Mollusca	Annulosa
Molluscoida	Annuloida
Cœlenterata	Infusoria
	Protozoa ‡

The alterations I would suggest, in accordance with more recent views, relate entirely to the annulose sub-kingdoms, as will be seen in the appended outline sketch (Table III, p. 211), in which the extent of the old sub-kingdoms Annuloida and Annulosa is indicated, and also the recent arrangement of the animal kingdom into the two great divisions Protozoa and Metazoa. The Infusoria are not here considered to form a separate sub-kingdom, being included in the Protozoa; one of the two classes forming the Annuloida—the Echinodermata—ranks as a sub-kingdom; the other—the Scolecida—forms, with the Rotifera and the anarthropode Annulosa, the sub-kingdom Vermes; and the arthropode Annulosa form a separate sub-kingdom, the Arthropoda.

The animal kingdom does not admit of arrangement in a single linear series, nor can the classes of its sub-kingdoms be so arranged preserving their natural affinities. It would not, however, be practicable in a museum to arrange the classes of each sub-kingdom in any but a linear sequence. With the sub-kingdoms the case is different, and it would be an easy matter to preserve to some extent *their* mutual relations, a double row of show-cases

* 'Journ. Linn. Soc.' Zoology, vol. xii, p. 226.—1875.

† 'Quart. Journ. Micros. Science,' 1877, pp. 441-454.

‡ Prof. Huxley, in proposing to make the Infusoria one of the primary groups of the animal kingdom, said that he entertained some doubts regarding the permanency of the group. The difficulty is to frame a definition of the sub-kingdom Protozoa which shall include the Infusoria and Porifera and exclude the whole of the Vermes. It may also be mentioned that the sponges (Porifera or Spongida) are now considered by some of our highest authorities to be Metazoa, and either to form a separate sub-kingdom, or a class of the Cœlenterata below the Hydrozoa.

being all that is necessary for this purpose, or, in a large museum, a double suite of rooms, as may be shown thus:—

Protozoa	Cœlenterata	Molluscoida	Mollusca	Vertebrata
	Echinodermata	Vermes	Arthropoda	

This arrangement is carried out in the table showing the Classes and Orders of the Animal Kingdom (Table IV, pp. 211–214).

I will now only add that with every specimen in our museum there should be a label giving the generic and specific name, the locality where and the date when found, and in the case of fossils, the geological formation; and I will conclude in the words of Edward Forbes:—"I cannot help hoping that the time will come when every British town even of moderate size will be able to boast of possessing public institutions for the education and instruction of its adults as well as its youthful and childish population,—when it shall have a well-organised museum, wherein collections of natural bodies shall be displayed, not with regard to show or curiosity, but according to their illustration of the analogies and affinities of organised and unorganised objects, so that the visitor may at a glance learn something of the laws of nature,—wherein the products of the surrounding district, animate and inanimate, shall be scientifically marshalled and their industrial applications carefully and suggestively illustrated,—wherein the memorials of the history of the neighbouring province and the races that have peopled it shall be reverently assembled and learnedly yet popularly explained; when each town shall have a library the property of the public and freely open to the well-conducted reader of every class; when its public walks and parks (too many as yet existing only in prospect) shall be made instructors in botany and agriculture; when it shall have a gallery of its own, possibly not boasting of the most famous pictures or statues, but nevertheless showing good examples of sound art, examples of the history and purpose of design, and, above all, the best specimens to be procured of works of genius by its own natives who have deservedly risen to fame." *

These remarks were made in 1853, before the act was passed for promoting the establishment of free public libraries and museums in our provincial towns, under which act much progress in this direction has been made; and many public parks then "existing only in prospect" have now been opened. Still much remains to be done towards realising the ideal picture of Edward Forbes, who worked hard himself towards it in London and in Edinburgh. Watford, with its Public Library and its School of Science and Art, is pressing forward on the road which he laid out, and will have advanced still farther on this road when the products of its county, animate and inanimate, and the memorials of its history, are scientifically displayed within the walls of its Museum.

* 'On the Educational Uses of Museums,' p. 18.

TABLE I. *The principal divisions of the British Sedimentary Strata.*

NEOZOIC	POST-TERTIARY	*RECENT*	*Historic*
			Pre-Historic
		PLEISTOCENE	*Post-Glacial*
			Glacial
	CAINOZOIC OR TERTIARY	PLIOCENE	Chillesford beds
			Norwich Crag
			Red Crag
			Ipswich (coralline) Crag
		MIOCENE	Mull leaf-beds, etc.
			Hempstead beds (Oligocene)
		EOCENE	Bembridge beds
			Osborne Series
			Headon Series
			Bagshot Sands
			London Clay
			Oldhaven and Blackheath beds
			Woolwich and Reading beds
			Thanet Sands
	MESOZOIC OR SECONDARY	*CRETACEOUS*	*Chalk*
			Chalk Marl
			Chloritic Series (*U. Greensand*)
			Gault
			Neocomian (L. Greensand)
			Wealden
		JURASSIC	Oolite
			Lias
		TRIASSIC	Rhætic
			Keuper
			Bunter
PALÆOZOIC	DEUTEROZOIC	PERMIAN	Permian
		CARBONIFEROUS	Coal Measures
			Millstone Grit
			Carboniferous Limestone
		DEVONIAN AND *OLD RED SANDSTONE*	
	PROTOZOIC	*SILURIAN*, or UPPER SILURIAN	Ludlow
			Wenlock
			Llandovery
		ORDOVIAN, or LOWER SILURIAN	Bala and Caradoc
			Llandeilo
			Arenig and Skiddaw
		CAMBRIAN	Tremadoc
			Ffestiniog (Lingula flags)
			Menevian
			Harlech and Longmynd
	EOZOIC	ARCHÆAN	Pebidian
			Arvonian
			Dimetian
			Lewisian

TABLE II. *The Classes, Alliances, and Orders of the Vegetable Kingdom represented in Britain, with illustrative Genera.*

THALLOGENS.

ALGALES	DIATOMACEÆ (diatoms)	*Navicula, Pleurosigma.*
	DESMIDIACEÆ (desmids)	*Closterium, Xanthidium.*
	CONFERVACEÆ	*Protococcus, Volvox, Ulva.*
	FUCACEÆ (seaweeds)	*Laminaria, Fucus.*
	CERAMIACEÆ (rosetangles)	*Chondrus, Lomentaria.*
FUNGALES	HELVELLACEÆ (=Ascomycetes)	*Phacidium, Peziza.*
	MUCORACEÆ (=Physomycetes)	*Antennaria, Mucor.*
	BOTRYACEÆ (=Hyphomycetes)	*Penicillium, Oidium.*
	UREDINACEÆ (=Coniomycetes)	*Puccinia, Torula.*
	LYCOPERDACEÆ (=Gastromycetes)	*Geaster, Phallus.*
	AGARICACEÆ (=Hymenomycetes)	*Boletus, Agaricus.*
LICHENALES	GRAPHIDACEÆ (letter-lichens)	*Calicium, Graphis.*
	COLLEMACEÆ (jelly-lichens)	*Collema, Lichina.*
	PARMELIACEÆ (leaf-lichens)	*Cladonia, Parmelia.*

ACROGENS.

CHARACEALES		CHARACEÆ	*Chara, Nitella.*
MUSCALES	Hepaticæ	RICCIACEÆ (crystalworts)	*Riccia, Cyathodium.*
		MARCHANTIACEÆ (liverworts)	*Marchantia, Targonium.*
		JUNGERMANNIACEÆ (scale-mosses)	*Jungermannia.*
		ANTHOCEROTACEÆ	*Anthoceras.*
	Musci	ANDRÆACEÆ (split-mosses)	*Andræa.*
		SPHAGNACEÆ (peat-mosses)	*Sphagnum.*
		BRYACEÆ (urn-mosses)	*Hypnum, Polytrichum.*
FILICALES		LYCOPODIACEÆ (club-mosses)	*Selaginella, Lycopodium.*
		MARSILEACEÆ (pepperworts)	*Pilularia.*
		EQUISETACEÆ (horsetails)	*Equisetum.*
		OPHIOGLOSSACEÆ (adders-tongues)	*Botrychium, Ophioglossum.*
		POLYPODIACEÆ (ferns)	*Osmunda, Asplenium.*

ENDOGENS.

Glumiferæ.

GLUMALES	GRAMINACEÆ (grasses)	*Avena, Poa, Festuca.*
	CYPERACEÆ (sedges)	*Carex, Eriophorum.*
	ERIOCAULACEÆ	*Eriocaulon.*

Floridæ.

ARALES	TYPHACEÆ (bulrushes)	*Typha, Sparganium.*
	LEMNACEÆ (=Pistiaceæ)	*Lemna, Wolffia.*
	ARACEÆ	*Arum, Acorus.*
ALISMALES	NAIADACEÆ	*Zanichellia, Zostera.*
	ALISMACEÆ	*Butomus, Alisma.*
LILIALES	JUNCACEÆ (rushes)	*Luzula, Juncus.*
	MELANTHACEÆ	*Colchicum, Tofieldia.*
	LILIACEÆ	*Allium, Endymion, Tulipa.*
NARCISSALES	AMARYLLIDACEÆ	*Galanthus, Narcissus.*
	IRIDACEÆ	*Iris, Gladiolus, Crocus.*
ORCHIDALES	ORCHIDACEÆ	*Orchis, Ophrys, Neotia.*
HYDRALES	HYDROCHARIDACEÆ	*Eleodea, Stratiotes.*

ENDOGENS (*continued*).

Dictyogenæ.

TRILLIALES	DIOSCOREACEÆ (yams)	*Tamus.*
	TRILLIACEÆ (parids)	*Paris.*

EXOGENS.

	Gymnospermæ.	
CYCADALES	PINACEÆ (conifers)	*Pinus, Juniperus.*
	TAXACEÆ	*Taxus.*
	Monochlamydæ.	
AMENTALES	AMENTACEÆ	*Betula, Salix, Myrica.*
	CORYLACEÆ (= Cupuliferæ)	*Fagus, Quercus.*
URTICALES	ULMACEÆ	*Ulmus.*
	CANNABINACEÆ	*Humulus.*
	URTICACEÆ	*Urtica, Parietaria.*
	CERATOPHYLLACEÆ	*Ceratophyllum.*
EUPHORBIALES	CALLITRICHACEÆ	*Callitriche.*
	EUPHORBIACEÆ	*Euphorbia, Mercurialis.*
	EMPETRACEÆ (crowberries)	*Empetrum.*
ASARALES	ARISTOLOCHIACEÆ (= Asaraceæ)	*Aristolochia, Asarum.*
	SANTALACEÆ	*Thesium.*
	LORANTHACEÆ	*Viscum.*
DAPHNALES	ELEAGNACEÆ	*Hippophaë.*
	THYMELACEÆ	*Daphne.*
CHENOPODIALES	POLYGONACEÆ	*Rumex, Polygonum.*
	CHENOPODIACEÆ	*Atriplex, Beta, Salsola.*
	AMARANTACEÆ	*Amarantus.*
	Corollifloræ.	
PRIMULALES	PLUMBAGINACEÆ	*Statice, Armeria.*
	PRIMULACEÆ	*Glaux, Anagallis.*
BIGNONALES	LENTIBULARIACEÆ (butterworts)	*Pinguicula, Utricularia.*
	SCROPHULARIACEÆ (figworts)	*Linaria, Veronica.*
	OROBANCHACEÆ (broomrapes)	*Lathræa, Orobanche.*
LAMIALES	PLANTAGINACEÆ (ribworts)	*Plantago, Litorella.*
	VERBENACEÆ	*Verbena.*
	LAMIACEÆ (= Labiatæ)	*Mentha, Prunella, Ajuga.*
	BORAGINACEÆ	*Symphytum, Myosotis.*
SOLANALES	SOLANACEÆ (nightshades)	*Solanum, Atropa.*
	CONVOLVULACEÆ (bindweeds)	*Convolvulus, Cuscuta.*
	POLEMONIACEÆ (phloxes)	*Polemonium.*
GENTIANALES	GENTIANACEÆ	*Erythræa, Menyanthes.*
	APOCYNACEÆ	*Vinca.*
	OLEACEÆ (= Jasminaceæ)	*Ligustrum, Fraxinus.*
	AQUIFOLIACEÆ (= Ilicaceæ)	*Ilex.*
ERICALES	ERICACEÆ	*Vaccinium, Calluna.*
CAMPANALES	CAMPANULACEÆ (bellflowers)	*Campanula, Lobelia.*
ASTERALES	ASTERACEÆ (= Compositæ)	*Bellis, Carduus, Crepis.*
	DIPSACACEÆ	*Knautia, Scabiosa.*
	VALERIANACEÆ	*Centranthus, Valeriana.*
CINCHONALES	RUBIACEÆ (= Galiaceæ)	*Asperula, Sherardia.*
	CAPRIFOLIACEÆ	*Lonicera, Sambucus.*

Exogens (*continued*).

Calyciforæ.

UMBELLALES ...	Cornaceæ	*Cornus.*
	Araliaceæ (=Hederaceæ) ...	*Hedera, Adoxa.*
	Apiaceæ (=Umbelliferæ)	*Œnanthe, Anthriscus.*
CUCURBITALES	Cucurbitaceæ	*Bryonia.*
MYRTALES	Lythraceæ	*Peplis, Lythrum.*
	Onagraceæ	*Epilobium, Circæa.*
	Haloragaceæ	*Hippuris, Myriophyllum.*
ROSALES	Droseraceæ	*Drosera.*
	Crassulaceæ	*Sedum, Sempervivum.*
	Grossulariaceæ (=Ribesiaceæ)	*Ribes.*
	Saxifragaceæ	*Saxifraga, Parnassia.*
	Rosaceæ	*Rubus, Pyrus, Prunus.*
	Fabaceæ (=Leguminosæ)	*Ulex, Trifolium, Vicia.*
RHAMNALES	Rhamnaceæ	*Rhamnus.*
	Celastraceæ (spindle-trees) ...	*Euonymus.*

Thalamifloræ.

GERANIALES ...	Linaceæ	*Linum, Radiola.*
	Oxalidaceæ	*Oxalis.*
	Balsaminaceæ	*Impatiens.*
	Geraniaceæ	*Geranium, Erodium.*
SAPINDALES	Aceraceæ (=Sapindaceæ) ...	*Acer.*
	Polygalaceæ	*Polygala.*
MALVALES	Tiliaceæ	*Tilia.*
	Malvaceæ	*Malva, Althæa, Lavatera.*
GUTTIFERALES	Hypericaceæ	*Hypericum.*
	Elatinaceæ	*Elatine.*
SILENALES.........	Tamaricaceæ	*Tamarix.*
	Illicebraceæ (=Paryonychiæ)	*Scleranthus, Herniaria.*
	Portulaceæ (purslanes)	*Montia.*
	Caryophyllaceæ	*Cerastium, Silene.*
	Frankeniaceæ	*Frankenia.*
CISTALES	Violaceæ..........................	*Viola.*
	Cistaceæ (rock-roses)...........	*Helianthemum.*
	Resedaceæ	*Reseda.*
	Brassicaceæ (=Cruciferæ) ...	*Arabis, Sinapis.*
	Fumariaceæ	*Corydalis, Fumaria.*
	Papaveraceæ	*Chelidonium, Glaucium.*
RANALES...........	Nymphæaceæ	*Nymphæa, Nuphar.*
	Berberidaceæ	*Berberis.*
	Ranunculaceæ	*Anemone, Caltha.*

Table III.—*General View of the Animal Kingdom.*

METAZOA
- VERTEBRATA
  - Mammalia
  - Sauropsida
    - Aves
    - Reptilia
  - Ichthyopsida
    - Amphibia
    - Pisces
- MOLLUSCA
  - Odontophora
    - Cephalopoda
    - Pteropoda
    - Heteropoda
    - Gastropoda
  - Lamellibranchiata
- MOLLUSCOIDA
  - Tunicata
  - Brachiopoda
  - Polyzoa
- CŒLENTERATA
  - Actinozoa
  - Ctenophora
  - Hydrozoa

INVERTEBRATA

(Annulosa)
- ARTHROPODA
  - Tracheata
    - Insecta
    - Myriapoda
    - Arachnida
  - Crustacea
- VERMES
  - Chætognatha
  - Annelida
  - Rotifera
  - Scolecida

(Annuloida)
- ECHINODERMATA
  - Holothuroidea
  - Echinoidea
  - Stellerida

- PROTOZOA
  - Porifera
  - Infusoria
  - Gregarinida
  - Rhizopoda

Table IV.—*The Sub-kingdoms, Classes, and Orders of the Animal Kingdom, with illustrative Genera.**

PROTOZOA.

RHIZOPODA ...	Monera	*Protogenes, Myxastrum.*
	Amœbina	*Amœba, Arcella.*
	Heliozoa	*Actinophrys, Clathrulina.*
	Foraminifera	*Globigerina*, [*Nummulites*].
	Radiolaria (= Polycistina)	*Thalassicola, Acanthometra.*
GREGARINIDA	Monocystidea	*Monocystis.*
	Dicystidea	*Gregarina, Pixinia.*
INFUSORIA ...	Flagellata	*Euglena, Noctiluca.*
	Ciliata	*Stentor, Vorticella.*
	Tentaculifera	*Acineta, Ephelota.*
PORIFERA	Myxospongia	*Halisarca.*
	Ceratospongia	*Euospongia, Spongelia.*
	Silicispongia	*Spongilla, Euplectella.*
	Calcispongia	*Grantia, Sycandra.*

* The orders and genera within square brackets are extinct.

CŒLENTERATA.

HYDROZOA...	Hydrophora.	GYMNOCHROA	*Hydra.*
		ATHECATA	*Coryne, Tubularia.*
		THECAPHORA	*Campanularia, Sertularia.*
		[CLADOPHORA	*Ptilograptus, Dendrograptus.*]
		[RHABDOPHORA (graptolites)	*Monograptus, Dicellograptus.*]
		HYDROCORALLA	*Millepora, Stylaster.*
		HAPLOMORPHA	*Ægina, Geryonia.*
	Siphonophora.	CALYCOPHORIDA	*Diphyes, Abyla.*
		PHYSOPHORIDA	*Physalia, Velella.*
	Discophora.	RHIZOSTOMIDA	*Rhizostoma, Cassiopeia.*
		PELAGIADA (=Monostomea)...	*Pelagia, Cyanea, Aurelia.*
		LUCERNARIDA (=Calycozoa)	*Lucernaria, Carduella.*
CTENOPHORA		STENOSTOMATA	*Mnemia, Cestum, Cydippe.*
		EURYSTOMATA	*Beroë, Alcinoë, Neis.*
ACTINOZOA	Zoantharia.	MALACODERMATA (sea-anemones)	*Zoanthus, Actinia.*
		SCLEROBASICA	*Antipathes, Gerardia.*
		SCLERODERMATA (stone-corals)	*Cyathina,* [*Favosites*].
		[RUGOSA	*Stauria, Cyathophyllum.*]
	Alcyonaria.	ALCYONIDA	*Alcyonium, Anthelia.*
		TUBIPORIDA	*Tubipora.*
		PENNATULIDA (sea-pens)	*Pennatula, Virgularia.*
		GORGONIDA	*Corallium, Heliopora.*
		ISIDA	*Mopsea, Melithæa.*

MOLLUSCOIDA.

POLYZOA.........	PEDICELLINEA	*Pedicellina, Loxosoma.*
	CHILOSTOMATA	*Ætea, Flustra, Cellepora.*
	CYCLOSTOMATA	*Tubipora, Defrancia.*
	CTENOSTOMATA	*Alcyonidium, Anguinella.*
	PHYLACTOLÆMATA	*Plumatella, Cristatella.*
	PODOSTOMATA..............	*Rhabdopleura.*
BRACHIOPODA	INARTICULATA	*Lingula, Discina, Crania.*
	ARTICULATA	*Terebratula, Spirifer,* [*Orthis*].
TUNICATA	BIPHORA....................	*Salpa, Doliolum.*
	ASCIDIOIDA.................	*Ascidia, Appendicularia.*

MOLLUSCA.

LAMELLIBRANCHIATA	ASIPHONIATA	*Ostrea, Mytilus, Anodonta.*
	SIPHONIATA	*Cardium, Mya, Teredo.*

(*Odontophora.*)

GASTROPODA	OPISTHOBRANCHIATA......	*Doris, Aplysia, Bulla.*
	PROSOBRANCHIATA.........	*Patella, Cypræa, Littorina.*
	PULMONIFERA	*Planorbis, Helix, Limax.*
	POLYPLACOPHORA	*Chiton.*
HETEROPODA	FIROLIDA	*Firola, Carinaria.*
	ATLANTIDA	*Atlanta,* [*Bellerophon*].
PTEROPODA ...	GYMNOSOMATA	*Clio, Eurybia.*
	THECOSOMATA	*Hyalæa, Limacina,*[*Conularia*].
	SCAPHOPODA	*Dentalium, Entalis.*
CEPHALOPODA	TETRABRANCHIATA	*Nautilus,* [*Ammonites*].
	DIBRANCHIATA	*Sepia, Octopus,* [*Belemnites*].

ECHINODERMATA.

STELLERIDA	[Blastoidea	*Pentatremites*, *Elæacrinus*.]
	[Cystoidea	*Caryocrinus*, *Edriaster*.]
	Crinoidea	*Pentacrinus*, *Comatula*.
	Ophiuroidea (brittle-stars)	*Ophiocoma*, *Ophiura*.
	Asteroidea (star-fishes)	*Uraster*, *Solaster*, *Asterina*.
ECHINOIDEA	Endocyclica	*Cidaris*, *Echinus*.
	Exocyclica	*Spatangus*, *Ananchites*.
	[Tessellata	*Palæchinus*, *Melonites*.]
HOLOTHUROIDEA	Apneumona	*Synapta*, *Echinosoma*.
	Pneumonophora	*Holothuria*, *Rhopalodina*.

VERMES.

SCOLECIDA	Turbellaria	*Planaria*, *Convoluta*.
	Nemertea	*Lineus*, *Nemertes*.
	Trematoda	*Distoma*.
	Cestoda (= Tæniada)	*Tænia*, *Ligula*.
	Nematoda	*Trichina*, *Filaria*, *Gordius*.
	Acanthocephala	*Coleops*, *Echinorhynchus*.
ROTIFERA	Rotifera	*Conochilus*, *Melicerta*.
ANNELIDA	Gephyrea	*Sipunculus*, *Priapulus*.
	Hirudinea (leeches)	*Clepsine*, *Nephelis*.
	Chætopoda	*Nais*, *Arenicola*, *Serpula*.
CHÆTOGNATHA	Chætognatha	*Sagitta*.

ARTHROPODA.

CRUSTACEA	Cirripedia	*Alcippe*, *Lepas*, *Balanus*.
	Copepoda	*Cecrops*, *Lernæa*, *Cyclops*.
	Ostracoda	*Cypris*, *Cythere*, *Cypridina*.
	Cladocera	*Daphnia*, *Lynceus*, *Sida*.
	Phyllopoda	*Apus*, *Estheria*, [*Ogygia*].
	Xyphosura	*Limulus*, [*Pterygotus*].
	Edriophthalma	*Caprella*, *Hyale*, *Oniscus*.
	Podophthalma	*Squilla*, *Astacus*, *Cancer*.

(*Tracheata*.)

ARACHNIDA	Pycnogonida (sea-spiders)	*Achelia*, *Pycnogonum*.
	Pentastomida	*Pentastoma*.
	Tardigrada (water-bears)	*Macrobiotus*.
	Scorpiodea (scorpions)	*Iurus*, *Scorpio*, *Lychas*.
	Cheliferida (chelifers)	*Obisium*, *Chelifer*.
	Acarina (mites & ticks)	*Acarus*, *Myobia*, *Leptus*.
	Araneina (spiders)	*Epeira*, *Tegenaria*, *Lycosa*.
MYRIAPODA	Malacopoda	*Peripatus*.
	Chilopoda (centipedes)	*Geophilus*, *Scolopendra*.
	Chilognatha (millipedes)	*Glomeris*, *Iulus*.
INSECTA	Aptera	*Podura*, *Iapyx*, *Lepisma*.
	Hemiptera	*Aphis*, *Cicada*, *Cimex*.
	Orthoptera	*Blatta*, *Termes*, *Ephemera*.
	Neuroptera	*Phrygania*, *Myrmeleon*.
	Diptera	*Musca*, *Tipula*, *Culex*.
	Lepidoptera	*Noctua*, *Sphinx*, *Colias*.
	Hymenoptera	*Apis*, *Formica*, *Sirex*.
	Coleoptera (beetles)	*Haltica*, *Acis*, *Lampyris*.

VERTEBRATA.

PISCES	Leptocardei	*Amphioxus.*
	Cyclostomi	*Myxine, Petromyzon.*
	Teleostei	*Salmo, Gadus, Perca.*
	Ganoidei	*Acipenser, Lepidosteus.*
	Placoidei (rays & sharks)	*Raia, Scyllium, Lamna.*
	Dipnoi	*Lepidosiren, Ceratodus.*
AMPHIBIA	Ophiomorpha	*Siphonops, Cæcilia.*
	Urodela	*Triton,* [*Telerpeton*].
	Anura (frogs & toads)	*Pipa, Rana, Bufo, Hyla.*
	[Labyrinthodonta	*Labyrinthodon, Herpeton.*]
REPTILIA	Ophidia (serpents)	*Natrix, Pelias.*
	Sauria (= Lacertilia)	*Lacerta, Anguis.*
	Crocodilia	*Crocodilus, Alligator.*
	Chelonia	*Chelone, Testudo.*
	[Ichthyosauria	*Ichthyosaurus.*]
	[Plesiosauria	*Plesiosaurus, Placodus.*]
	[Dicynodontia	*Dicynodon, Oudenodon.*]
	[Pterosauria	*Dimorphodon, Pterodactylus.*]
	[Dinosauria	*Megalosaurus, Iguanodon.*]
AVES	[Saururæ	*Archæopteryx.*]
	Proceres	*Struthio,* [*Dinornis*].
	Natatores	*Cygnus, Anser, Larus.*
	Grallatores	*Crex, Otis, Tringa.*
	Gallinæ	*Tetrao, Perdix, Phasianus.*
	Accipitres	*Falco, Aquila, Asio.*
	Volucres	*Columba, Cypselus, Picus.*
	Oscines	*Corvus, Alauda, Turdus.*
MAMMALIA	Monotremata	*Echidna, Platypus.*
	Marsupialia	*Macropus, Didelphys.*
	Edentata	*Manis, Bradypus.*
	Hyracoidea	*Hyrax.*
	Proboscidea	*Elephas,* [*Mastodon*].
	Ungulata	*Sus, Cervus, Equus.*
	Cetacea	*Balæna, Ziphius, Delphinus.*
	Sirenia	*Manatus,* [*Halitherium*].
	Pinnipedia	*Phoca, Trichechus.*
	Carnivora	*Lutra, Canis, Felis.*
	Rodentia	*Lepus, Mus,* [*Mesotherium*].
	Cheiroptera (bats)	*Vespertilio, Rhinolophus.*
	Insectivora	*Talpa, Sorex, Erinaceus.*
	Quadrumana (apes)	*Lemur, Cebus, Simia.*
	Bimana (man)	*Homo.*

Orders of Doubtful Systematic Position.

Between Rhizopoda and Porifera		Physemaria	*Haliphysema, Gastrophysema.*
,, ,, ,,	Scolecida	Dicyemida	*Dicyema.*
,, Annelida ,,	,,	Myzostomata	*Myzostoma.*
,, ,, ,,	Tunicata	Enteropneusta	*Balanoglossus.*

XXVII.

ON LOCAL MUSEUMS.

By H. George Fordham, F.G.S.

Read at Watford, 15th March, 1881.

I need offer no apology for bringing before a local scientific society the subject of local museums. That these museums might have, and in some cases do have, a most valuable educational influence, will, I think, be readily admitted; and I think it must also be admitted that, as a rule, the influence they do actually exert is very small. In fact, we often find that a local museum consists of a collection or collections of various objects, sometimes well arranged, but generally without a practically efficient arrangement, shut up in some out-of-the-way room and covered more or less with dust. The very existence of a museum in such a condition becomes almost forgotten, even in its immediate neighbourhood. Yet we should very probably find, if we investigated the origin of such a museum, that much enthusiasm had been spent and much labour bestowed in the collection and arrangement of the now dust-hidden specimens.

These unsatisfactory results arise, I believe, primarily from the fact that although the main principle is good, and has been clearly seen to be good by those who have been the originators of these collections, a sufficiently accurate perception has not been obtained of the absolute necessity of keeping one distinct aim in view. It has generally been thought sufficient to get together a number of objects, some interesting in themselves, some perhaps quite useless and valueless, and, having put them in cases, to leave them to attract attention and speak for themselves.

This being so, I will draw your attention to what I consider may be accepted as general principles with regard to museums, and then point out the application of these principles to the subject before us, and I hope I may in this way be able to do something towards arousing a feeling that it is desirable that local museums should be established and maintained upon a proper basis. I take it that there are, broadly, two kinds of museums, which I may term (1) "accumulative" and (2) "educational"; and although all museums may not be distinctly referable to one of these two classes, yet I think it will be found that the majority will naturally fall into one or the other, and that those which do not do so have their value and utility diminished in proportion as they are deficient in definiteness of character.

If we consider, then, the class of museums which I have termed accumulative, we find that the aim is the collection and preservation of natural objects or artificial productions which are rare, valuable, or unique, or of which the species—if I may use the term in such a wide and general sense—is likely to be destroyed. In these museums we find a capacity of absorption only controlled by financial limits and those of space. The work of examining, describing, and cataloguing their various treasures must be confined to those whose abilities and industry are of the very highest order, and of necessity such museums attract to themselves the learned and curious in all the branches of study which are connected with their contents. The collections they contain become naturally of greater and greater value as time goes on; but they become too huge and unwieldy to be attractive to the people or available to any large extent as popular educators.

The accumulative museums are, in fact, store-houses of research; they supply the material sustenance which science requires, and by the digestion of which knowledge is increased.

The British Museum is at once seen to be a typical instance of this class. Here in every department completeness is the ideal which is sought after, and there seems no limit to the mass of specimens which is always increasing from every side.

Differing essentially in almost every characteristic from the accumulative museum, the educational museum fills a place of almost equal value and usefulness. It places conveniently in popular view specimens not in themselves necessarily unique or of great value, but representative of all the vast stores which the accumulative museum preserves. There is a limit, not altogether defined, but still a limit to the accumulation of specimens. It is essentially characteristic of this class of museum that the objects exhibited should be selected and arranged with great discrimination and care, so that they may be truly illustrative and representative of the orders or divisions in nature or art to which they belong. With this in view, it is obvious that in many cases models or copies, which are of no intrinsic value, and may be indefinitely multiplied, are as useful as original specimens or works of art; so that indeed the contents of an educational museum may be of comparatively little value. In the formation of an educational museum it is most important that too great an accumulation should be guarded against, lest by the enormous number and variety of the specimens exhibited these should lose their individual importance.

To such a museum the student does not resort to study particular forms of animal or vegetable life, or the development of ancient language or art, nor has the somewhat miscellaneous collection any charm for the savant who is wrapped up in his own particular investigations; nor is it necessary to maintain a large staff of highly educated directors, curators, or other officials. On the other hand, knowledge is brought in palpable form before the people. The ignorant, or comparatively uninstructed classes, are able to examine the objects which they would never search for, or imagine to exist, if not brought to their notice. Their curiosity is stimulated, their reasoning powers are excited, and they are tempted to inquire further into matters thus demonstrated to be open to them, in common with the learned.

At South Kensington we have a museum answering to this general description. The South Kensington Museum is also, to a considerable extent, a technical museum, containing as it does large special collections illustrative of particular arts and industries; but this does not affect its place in my classification.

Having established, as I hope clearly, a line of demarcation which should be preserved between these two classes of museums, the "accumulative" and the "educational," I will now attempt to show how much the value of a museum is increased by attention to these details, and how necessary it is for its utility that in its whole course of existence one or other of the main principles I have explained should be kept in view.

It is to be observed, and it follows from what I have already stated, that two natural classes of men are attracted by the two classes of museums. The accumulative museum is to the man of science, with his highly-trained mind and store of technical information, the source from which he extracts, with these tools, additions to his knowledge, and through him to the knowledge of the world at large; to such a man an educational museum is a superfluity. On the other hand an educational museum is to the mass of the people a place of easy instruction, a valuable illustrated book of knowledge; but the popular mind justly regards the accumulative museum as a closed book, only to be opened after considerable preparatory study.

It is apparent, therefore, that any mingling of these two separate and clearly-defined ends—the storing of matter for scientific labour, and the direct diffusion of knowledge—will mar the whole, and produce a museum of so mixed a character that it will fail, to a great extent, in subserving any useful purpose. The investigator will not visit it, because he knows that what it may contain interesting to him will probably be mixed up with, and perhaps hidden by, specimens with which he has no concern. The people do not get instruction from it, for in attempting to do so they encounter so much that they do not understand that they would have great difficulty in extracting from the mass what might add to their knowledge. A heterogeneous collection of objects and specimens is therefore to be condemned as likely to be unsuccessful in the production of results of sufficient value to be a recompense for the expenditure of valuable time, energy, and money, and this is as true of local as of central museums.

A local museum should be either accumulative or educational, or it may consist of two perfectly distinct departments having these characteristics. The *raison d'être* for a local museum of the accumulative class is furnished only by the existence in a particular neighbourhood of something which it may be desirable in the interests of science to preserve. It may be that there are quarries producing a peculiar assemblage of fossils, or the country may be rich in rare minerals; botanical rarities may be abundant, or traces of pre-historic man often obtained. Under these or similar circumstances a local accumulative museum fulfils an important function. It naturally obtains specimens which would never find their way to a distant collection. Thus treasures are saved which would be lost were it not for the existence of a convenient place of deposit.

It is probable that such a collection, situated in the district from which it is obtained, would become as complete as possible; for it would itself exercise an influence, and induce a local pride in its completeness, and thus those who are in a position to contribute would do so readily, and feel a satisfaction in helping on the work, a satisfaction and interest which would be much less likely to be developed in the sending of specimens to be buried in a vast, far-distant, central museum. There is, also, a fitness in preserving specimens near their place of discovery, or origin, and a convenience in being able to examine a quarry, for instance, and its products, at the same time, and in this way connecting easily the lithological conditions with the life of the period. We should also hope by this means to promote local study and investigation, which being fostered by superior advantages should produce valuable results. A prominence is given to a distinctive local collection which would not attach itself to the same collection buried amongst other treasures in a large central museum.

It is manifestly absurd, however, to dream of making a local accumulative museum similar to a central museum of the same class in its inclusiveness. A local accumulative museum must gather up the peculiar products of its own immediate neighbourhood; if more than this is attempted, an unsatisfactory result will be inevitable.

A local educational museum might, one would think, be reasonably established in each small centre of population in which one does not already exist, and although at present it is rather utopian to expect any great advantage from these little museums, I am sanguine enough to hope that in the future the advance of knowledge and desire for instruction may make them eagerly taken advantage of, and of great practical value to the people generally.

Museums established with the purpose of instruction in view need not depend on their particular locality for their contents. A representative collection must be got together, and great care must be taken in excluding all superfluous objects. The arrangement of the specimens must be made with knowledge and intelligence; the specimens must be well displayed, must be such as are adapted to being clearly seen and understood when seen, and have such descriptions and particulars attached that their nature and character may be thoroughly and easily comprehended. It is more important in this case that the objects exhibited should be really representative in their different classes or divisions, than that the collection should be complete, or very abundant in specimens. The bony skeleton of knowledge gives a better general notion of the dimensions of the whole than an elaborate display of the minute nerves and intricate organs which constitute the complete body.

As a rule, in a local museum, even when the spread of information has been kept in view, and it may fairly be classed as an educational museum, the circumstances of the particular case have produced a superabundance of some classes of objects, representing particular sciences, or branches of science, to the exclusion of other classes. To obviate this it would be very desirable to set on foot a good system of exchange, by which a greater diffusion of specimens and uniformity of character might be obtained, with very great benefit generally. In forming an educational museum a small library of text-books ought to be an invariable accompaniment of each set of specimens illustrating a branch of science, so that information on all necessary points may be at hand. It would be well if lectures could be arranged on the various sciences, so as to draw attention to, and explain the contents of the museum.

The local scientific society would as a matter of course be the moving power in the formation of a local museum, and would be in a position to arrange for lectures and papers. Indeed it would be a natural work for a local society, and one which would help to bind the members together in working for a common object of undoubted utility.

Private collections and museums should be subject to the same general principles as public museums. It seems almost a pity that an individual should attempt to make a general collection of all sorts of things, as some people do. Although they may feel great interest in a miscellaneous collection, they can never really achieve anything valuable as a whole in this way; while by making such a special collection as they are peculiarly fitted to do, either on account of the products of the locality in which they live, or their own special studies in a department of science, they may confer great benefits on science.

I sometimes think that we who take a more or less strong interest in science do not always make the most of our opportunities for increasing knowledge. Are we always reasonably vigilant lest science should suffer any detriment through our neglect? I think that each one in his own neighbourhood should keep on the look-out for facts and specimens to further his particular branch of science. For instance, a geologist ought to note and examine all excavations in his neighbourhood. If this were generally done much might be learned. As it is, many temporary sections are made, and lost, without any note being made of what they show. Similarly in other branches of science much information is lost for want of persons willing to record simple facts as they come to light.

In reference to Hertfordshire and our work in the county, I will point out what, I think, might be kept in view by this Society.

In the first place, an investigation should be made into the position and condition of the museums at present established in the county. For the information of investigators it would be well to prepare a catalogue of contents, showing in a rough way what particular branches of science are represented in the museums, both public and private, in the county. Such a table of contents would be valuable as showing where to go to examine collections of any particular class of specimens. Having obtained some general information, the Society, through its individual members, or as a corporate body, might stimulate local interest in the arrangement of the collections (where necessary), so that they would become of general utility. At the same time a system of exchange of specimens might be instituted, in order to make all superfluous specimens available, and the curators or authorities of different museums might be brought into correspondence for their mutual benefit. Steps should also be taken to promote the foundation of museums where it seems desirable that they should exist.

By some such work as this I believe much good might be done; it is a work quite suited to a Natural History Society, and may well be undertaken by our members.

XXVIII.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1880.

By Rev. C. W. Harvey, M.A., F.M.S.,

Read at Hertford, 22nd March, 1881.

Having undertaken to prepare in future the annual reports on the Rainfall in Hertfordshire, I shall try as much as possible to follow out the lines laid down by our Honorary Secretary, Mr. Hopkinson, in his reports for the years 1875-79. One advantage I have in commencing at this time is this: We have completed the decade 1870-79, and I have returns for that period from stations well distributed throughout the county, and sufficient in number to enable me to arrive at something approximating to a true mean of the rainfall during this period in the county generally, and in four out of the six main river-basins in particular.

This mean is derived from the following returns:—Colne District—Cassiobury, Gorhambury, Rothamsted, Kensworth, Nash Mills, Berkhampstead, and Cowroast. Lea District—Bayfordbury, Stevenage, and Much Hadham. Ivel District—Hitchin. Cam District—Royston.

The rainfall stations in the county may be said to be substantially the same both in number and distribution as they were in 1879. The only addition to the list of last year being a new station at Throcking, near Buntingford, which practically takes the place of the old station at Aspenden, where observations were discontinued in 1879. The districts pointed out by Mr. Hopkinson in his report for 1878 as needing observers, remain, I am sorry to say, still unrepresented; these are the river-basins of the Thame and Brent as far as they are connected with our county; the Chess district in the basin of the Colne; and the Stort district in the basin of the Lea.

Distribution of Rainfall throughout the Year.—Of the three tables accompanying this report, Table II. gives the actual monthly and annual fall at each of our 27 stations, and the mean monthly and yearly fall in the county; showing moreover its relation to the mean of 1870-79. These figures show that the three months, January, May, and August, were very much below the mean; while the three months, July, September, and October, were very much in excess of the mean. The total rainfall of January, May, and August averaged only 1·85 in. or 6 per cent. of the total fall; while that of July, September, and October averaged as much as 15·40 ins., or 50 per cent. of the total fall. At Bushey Station, Watford, on October 21st, the gauge showed 5·07 inches; this amount was due to the snow drifting over a wall about 30 feet from the gauge. Therefore in deducing the mean fall for *October* and for the whole year, I have omitted in these two instances the Bushey Station values altogether.

Table I.—Hertfordshire Rainfall Stations.

River District.			Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.
							in.	ft. in.	ft.
Thames.	Colne.	Lower Colne	Watford—Bushey Station	Robert Savill	51 38 0 N	0 20 0 W	5	0 6	220
			,, Watford House	Alfred T. Brett, M.D.	51 38 50 N	0 22 50 W	8	1 3	240
			,, Wansford House	John Hopkinson	51 39 25 N	0 23 35 W	5	1 0	224 ↑
			,, Oaklands	Edward Harrison	51 39 45 N	0 23 40 W	5	5 6	273 T
			Rickmansworth—Moor Park	Lord Ebury	51 40 5 N	0 24 20 W	5	2 0	340
		Ver	St. Albans—Gorhambury	The Earl of Verulam	51 37 30 N	0 26 20 W	6	2 6	370
			Harpenden—Rothamsted	Drs. Lawes and Gilbert	51 45 20 N	0 23 0 W	5	0 9	420 T
			,, ,, (2nd gauge)	,, ,,	51 48 10 N	0 21 30 W	*	0 9	420
			Dunstable—Kensworth	Miss Grace Jones	51 48 10 N	0 21 30 W	5	1 0	600 ?
		Gade	Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 51 30 N	0 30 0 W	12	3 9	237 T
			Berkhampstead	William Squire	51 44 0 N	0 26 40 W	8	1 6	370 B
			Great Gaddesden	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426
			Tring—Cowroast	Hubert Thomas, C.E.	51 45 40 N	0 33 30 W	10	4 2	345 L
	Lea.	Lower Lea	East Barnet—Southgate	H. F. Church	51 47 0 N	0 36 30 W	6	0 6	240 T
		Upper Lea	Hertford—Bayfordbury	W. Clinton Baker	51 37 40 N	0 8 0 W	8	0 4	250
			Ware	James Muir, C.E.	51 48 0 N	0 14 0 W	12	3 0	114 T
			Hatfield—Brocket Hall	Hon. H. F. Cowper, M.P.	51 46 30 N	0 5 30 W	8	1 0	?
		Mimram	Welwyn	Rev. C. L. Wingfield	51 48 20 N	0 2 0 W	5	0 4	?
			Datchworth	Rev. J. Wardale	51 49 50 N	0 12 30 W	6	1 0	357 T
		Beano	Stevenage	Rev. J. O. Seager	51 51 20 N	0 9 50 W	8	2 0	319 L
			,, Knebworth	Rev. F. G. Jenyns	51 52 30 N	0 12 30 W	5	1 0	391 ↑
		Rib	Buntingford—Throcking	Rev. C. W. Harvey	51 55 5 N	0 11 40 W	5	1 0	484 T
			Royston—Therfield	Rev. J. G. Hale	52 1 0 N	0 3 0 W	5	4 3	500 ?
		Ash	Ware—Much Hadham	Rev. H. S. Mott	51 51 20 N	0 4 40 E	5	1 0	222 B
Ouse.	Cam. Ivel.	Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238 ↑
			,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422 T
		Rhee	Royston	Hale Wortham	52 1 25 N	0 6 40 W	8	0 6	269 ↑
			,, Odsey Grange	H. George Fordham	52 2 30 N	0 1 0 W	5	1 0	264 ↑

* Area $\frac{1}{1000}$ of an acre.

TABLE II.—SHOWING THE RAINFALL AT VARIOUS STATIONS IN HERTFORDSHIRE IN 1880.

		STATIONS.	JAN.	FEB.	MAR.	APRIL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
COLNE.	Lower Colne.	Watford—Bushey Station	·65	2·49	1·17	2·72	·54	3·02	5·03	·54	5·46	8·39?	2·38	3·33	35·72?	....
		,, Watford House	·36	2·88	1·23	2·62	·51	3·20	4·82	·46	5·35	5·51	2·49	3·68	33·12	150
		,, Wansford House	·37	3·39	1·22	2·47	·46	3·06	4·52	·50	5·30	5·83	2·55	3·69	33·36	161
		,, Oaklands	·35	3·22	1·26	2·55	·45	2·93	4·28	·49	5·31	6·09	2·39	3·71	33·03	160
		Rickmansworth—Moor Park	·42	3·44	1·31	2·74	·58	4·81	5·63	·50	6·04	7·14	3·33	4·33	40·27	166
	Ver.	St. Albans—Gorhambury	·40	2·23	·96	1·35	·47	1·50	3·29	·63	4·34	4·94	2·33	2·63	25·07	161
		Harpenden—Rothamsted	·55	2·87	1·09	2·13	·71	1·94	5·22	1·02	5·68	5·87	2·86	3·45	33·44	181
		,, ,, (2nd gauge)	·55	2·90	1·12	2·16	·74	1·96	5·26	1·06	5·85	5·93	2·91	3·47	33·97	181
		Dunstable—Kensworth	·59	3·40	·87	1·88	1·11	2·22	6·30	·58	6·43	5·47	2·42	2·51	33·78	157
	Bulborne and Gade.	Hemel Hempsted—Nash Mills	·34	2·52	1·10	1·69	·50	2·44	4·52	1·09	6·16	6·84	3·32	3·53	34·05	153
		Berkhampstead	·42	3·25	1·16	1·81	·65	2·84	6·29	·63	6·13	6·34	3·15	3·45	36·12	158
		Great Gaddesden	·45	2·79	1·06	1·79	·57	2·17	6·95	·67	6·01	5·77	2·84	3·31	34·38	....
		Tring—Cowroast	·55	3·32	1·07	2·11	·81	2·47	5·93	·88	5·42	6·10	2·85	3·48	34·99	143
LEA.	L. Lea.	East Barnet—Southgate	·23	2·31	1·04	2·99	·39	2·58	5·45	1·14	3·76	5·60	2·15	3·48	31·12	186
	Upper Lee.	Hertford—Bayfordbury	·29	2·25	·91	2·29	·49	2·54	6·37	·68	2·53	4·46	2·17	2·91	27·89	149
		Ware	·25	1·97	·85	1·96	·60	2·29	7·13	1·19	3·27	4·71	2·16	2·69	29·07	....
		Hatfield—Brocket Hall	·72	2·63	·53	2·46	·59	2·10	4·96	·41	5·87	5·20	2·67	2·03	30·17	159
	Mimram.	Welwyn Rectory	·29	2·33	·89	1·82	·92	1·95	4·83	·91	4·57	5·00	2·65	2·90	29·06	175
		Datchworth	·26	2·12	·70	1·80	·52	1·74	4·19	·81	3·96	4·76	2·22	2·63	25·71	151
	Beane.	Stevenage	·28	2·39	·78	1·91	·72	2·78	5·05	·83	4·63	5·36	2·47	2·60	29·80	195
		,, Knebworth	·45	2·49	·34	2·76	·56	2·07	5·30	·95	4·41	5·68	2·49	2·88	30·38	153
	Rib.	Buntingford—Throcking	·26	2·45	·87	1·74	·68	2·23	5·23	1·09	3·09	4·81	2·30	2·66	27·41	156
		Royston—Therfield	·24	2·31	·92	2·01	·81	2·95	5·36	1·23	3·02	4·73	2·01	2·59	28·18	140
	Ash	Ware—Much Hadham	·29	2·03	·87	2·34	·51	2·57	5·25	·87	3·58	5·38	2·43	2·73	28·85	176
CAM. IVEL.	Hiz.	Hitchin	·26	2·08	·86	1·50	·88	2·45	4·88	1·00	5·06	5·10	2·36	2·45	28·88	171
		,, High Down	·43	2·63	·76	2·06	·77	2·40	5·50	·80	5·18	4·89	2·24	2·39	30·05	145
	Rhee.	Royston	·21	1·98	1·05	1·71	·64	3·48	4·54	1·14	3·28	4·87	2·17	2·31	27·39	140
		,, Odsey	·24	1·70	·70	1·49	·84	2·47	3·99	1·25	3·37	4·55	2·18	2·19	24·97	160
		Mean fall	·40	2·60	·95	2·10	·65	2·55	5·20	·85	4·75	5·45	2·50	3·00	31·00	161
		Difference from Mean of 1870-79	—2·17	+·78	—·71	+·05	—1·47	+·21	+2·56	—1·75	+2·12	+2·89	—·25	+·82	+2·99	—10

TABLE III.—SHOWING THE MEAN MONTHLY FALL IN THE RIVER DISTRICTS.

River District.	January.	Difference from Mean.	February.	Difference from Mean.	March.	Difference from Mean.	April.	Difference from Mean.	May.	Difference from Mean.	June.	Difference from Mean.
Colne	·46	—2·34	2·99	+·92	1·12	—·63	2·15	—·03	·62	—1·60	2·66	+·26
Lea	·33	—2·07	2·32	+·58	·68	—·94	2·21	+·29	·61	—1·42	2·35	=
Ivel	·34	—1·88	2·35	+·76	·81	—·67	1·78	—·17	·82	—1·16	2·42	+·29
Cam	·22	—1·74	1·84	+·25	·87	—·55	1·59	—·09	·74	—1·16	2·97	+·84

River District.	July.	Difference from Mean.	August.	Difference from Mean.	September.	Difference from Mean.	October.	Difference from Mean.	November.	Difference from Mean.	December.	Difference from Mean.
Colne	5·23	+2·45	·69	—2·08	5·65	+2·94	6·00	+3·16	2·75	—·14	3·44	+1·15
Lea	5·19	+2·70	·89	—1·52	3·94	+1·34	5·09	+2·84	2·35	—·30	2·74	+ ·66
Ivel	5·19	+2·49	·90	—1·37	5·12	+2·65	4·99	+2·82	2·30	—·30	2·42	+ ·37
Cam	4·27	+2·16	1·19	—1·13	3·32	+ ·96	4·70	+2·80	2·17	—·11	2·24	+ ·34

Mean annual fall in 1880 in Colne District 33·94 ins., being 4·35 ins. above mean of 1870–79.
,, ,, Lea ,, 28·94 ,, 2·37 ,, ,,
,, ,, Ivel ,, 29·46 ,, 3·80 ,, ,,
,, ,, Cam ,, 26·14 ,, 2·55 ,, ,,

Distribution of Rainfall throughout the County.—Table III. gives the mean monthly and annual fall in each of those four main river-basins in which we have observers, showing the relation these values bear to the mean of 1870-79. In each of these main districts the fall was *above* the mean, the difference being greatest in the Colne district, and least in the Lea district. We may perhaps, in a great measure, attribute this relative difference to the large amount of rain gauged at Moor Park on the one hand, and the comparatively small amount gauged at Datchworth on the other; this latter being the only instance in which the fall was below the mean of its district for the year.

The four main river-districts being divided into eleven minor districts, I here give the mean fall in each of these districts.

Colne	Lower Colne	34·94
	Ver	31·56
	Gade	34·88
Lea	Lower Lea	31·12
	Upper Lea	29·04
	Mimram	27·38
	Beane	30·06
	Rib	27·79
	Ash	28·85
Ivel	Hiz	29·46
Cam	Rhee	26·18

We thus as usual can trace the greatest fall to the S.W. borders of the county and the smallest fall to the N.E. borders.

We have next to consider the greatest falls of rain in 24 hours. And first of all we may take the absolute maximum fall in each month with the station recording it.

Jan. 16th	Kensworth	·42	July 14th	Berkhampstead	2·20
Feb. 17th	Cowroast	1·02	Aug. 6th	Nash Mills	·46
Mar. 31st	Berkhampstead	·64	Sept. 14th	Nash Mills	2·17
Apl. 15th	Knebworth	·69	Oct. 6th	Moor Park	1·58
May 27th	Kensworth	·42	Nov. 15th	Gt. Gaddesden	·78
June 25th	Moor Park	1·04	Dec. 22nd	Brocket Hall	1·03

The fall at Southgate on Aug. 6th was identical with that at Nash Mills.

To the above table I may append an analysis of the wettest day in each month, which is as follows:—

January—13th at one *station*: 15th at 2; 16th at 19; 17th at 3.

February—10th at 1; 16th at 19; 17th at 1; 18th at 2; 19th at 1; 20th at 1.

March—3rd at 3; 30th at 1; 31st at 21.

April—1st at 1; 8th at 1; 14th at 20; 15th at 3.

May—27th at 3; 28th at 1; 29th at 1; 30th at 1; 31st at 19.

June—14th at 3; 15th at 4; 18th at 1; 23rd at 2; 24th at 6; 25th at 7; 30th at 2.

July—3rd at 1; 11th at 2; 14th at 8; 15th at 3; 21st at 1; 25th at 1; 26th at 8; 28th at 1.

August—1st at 1; 2nd at 3; 6th at 7; 7th at 10; 8th at 1; 14th at 1; 29th at 1.

September—11th at 9; 12th at 2; 13th at 1; 14th at 9; 15th at 3; 16th at 1.

October—5th at 1; 6th at 20; 7th at 3; 26th at 1.

November—14th at 1; 15th at 20; 16th at 2; 18th at 1; 25th at 1.

December—19th at 1; 22nd at 14; 23rd at 1; 27th at 1; 29th at 7; 30th at 1.

From this analysis we may conclude that generally speaking the wettest day in each month was as follows:—

January	16th	July	14th and 26th
February	16th	August	6th and 7th
March	31st	September	11th and 14th
April	14th	October	6th
May	31st	November	15th
June	24th and 25th	December	22nd

On the days of maximum fall in each month the following falls of an inch or more are recorded at other stations.

July 14th—Great Gaddesden, 1·99; Throcking, 1·00; Hadham, 1·78.

September 14th—Watford House, 1·85; Wansford House, 1·89; Oaklands, 1·77; Moor Park, 2·12; Gorhambury, 1·35; Rothamsted, 1·85; Kensworth, 1·93; Berkhampstead, 1·95; Stevenage, 1·60.

October 6th.—Watford House, 1·14; Wansford House, 1·23; Oaklands, 1·38; Rothamsted, 1·24; Kensworth, 1·08; Nash Mills, 1·27; Berkhampstead, 1·14; Great Gaddesden, 1·16; Brocket Hall, 1·05; Knebworth, 1·28; Stevenage, 1·42; Throcking, 1·16; Therfield, 1·57; Odsey, 1·25; Royston, 1·36.

Besides these, however, other falls of an inch and upwards are recorded, although they did not occur upon the day of maximum fall. They are as follows:—

July 15th (*14th*?)—Kensworth, 1·90; Cowroast, 1·60; Hitchin (High Down), 2·00. *July 21st*—Southgate, 1·01. *July 26th*—Moor Park, 1·04; Bayfordbury, 1·27. *September 11th*—Oaklands, 1·46; Welwyn, 1·54; Datchworth, 1·42; Knebworth, 1·52; Throcking, 1·22; Therfield, 1·37; Hadham, 1·68; Hitchin, 1·86; Odsey, 1·44; Royston, 1·62. *September 12th* (*11th*?)—Cowroast, 1·42; Hitchin (High Down), 1·90. *September 13th*—Southgate, 1·49. *September 15th*—Oaklands, 1·08. *September 16th*—Brocket Hall, 1·78.

The following shows the mean number of wet days in each month, and also the relation that number bears to the mean of 1870-79:—

Jan. wet days	6,	being	10 below mean.		July wet days	23,	being	10 above mean.	
Feb.	18,	,,	3 above	,,	Aug. ,,	7,	,,	7 below	,,
Mar. ,,	5,	,,	9 below	,,	Sept. ,,	12,	,,	1 below	,,
Apl. ,,	17,	,,	4 above	,,	Oct. ,,	18,	,,	3 above	,,
May ,,	6,	,,	7 below	,,	Nov. ,,	13,	,,	3 below	,,
June ,,	19,	,,	5 above	,,	Dec. ,,	17,	,,	2 above	,,

The most noticeable feature in the year's rainfall is perhaps that which has been already pointed out—the unequal distribution of the rainfall, by which 50 per cent. fell in one group of three months, while as little as 6 per cent. fell in another group of three months. It is also very rarely that we have snow as early in the Autumn as we had this year, namely, on or about October 19th. Mr. Symons in the 'Times' of October 21st gave the details of the earliest date of snow between 1806-31 and 1858-80. These details he summarized in the 'Meteorological Magazine' for November, supplying nearly all the missing years from the 'Cobham Journals.'

From this it appears that there are nine instances in which snow has fallen in October, viz. 1819, 1825, 1829, 1836, 1838, 1842, 1848, 1859, and 1880. The earliest instance being that of October 7th, 1829, and the only really important instance being that of October 29th, 1836, when snow fell to the depth of 2 inches, remaining on the ground for five days.

The present year makes the sixth in succession in which the rainfall has been above the mean. The mean yearly fall for 1870-79 was about 28·01; the last six years have exceeded this mean by the following amounts:—

1875	+ 2·75	.....	1877	+ 3·14	.....	1879	+ 4·20
1876	+ 2·76	.....	1878	+ 1·79	.....	1880	+ 3·00

Looking back at the amounts gauged in past years, it seems as if the rainfall was rather on the increase, as will be seen by the following values of the mean fall for each ten years since the year 1840 at our two oldest stations.

	Nash Mills	Hitchin
1840-49	25·86	
1850-59	26·43	24·69
1860-69	26·34	23·92
1870-79	28·66	25·67

Each set of figures tells the same tale; although there was a slight falling off in the mean between 1860-69, there was an increase of something like 2 inches in the mean of the last ten years, or an increase of about 3 inches in the forty years 1840-79.

Of the heavy falls the most universal were those of Sept. 11th and 14th, and October 6th. Falls of 1 inch or more occurred in 5 months—June, July, September, October, and December; falls of 2 inches and more occurring in two months—July and September.

XXIX.

THE FROST OF JANUARY, 1881, AS EXPERIENCED IN HERTFORDSHIRE.

By the Rev. C. W. Harvey, M.A., F.M.S.

Read at Hertford, 22nd March, 1881.

Thinking such an exceptional frost as that which we experienced in January ought not to go altogether unrecorded in our 'Transactions,' I have collected statistics from observers in various parts of our county, which I propose in the present paper to lay before the Society. The stations from which, by the courtesy of observers, I have received returns, well represent the county, the extreme east being alone unrepresented.

For the sake of comparison we may divide our county latitudinally into three districts. (1) That which lies south of Lat. 51° 45′, in which are situated stations I-IV; namely Moor Park, near Rickmansworth; Southgate, near East Barnet; Wansford House, Watford; and Nash Mills, near Hemel Hempsted. This district I shall call the *Southern* district.

(2) That part which lies between Lat. 51° 45′ and Lat. 51° 55′, in which are situated stations V–VIII; namely Berkhampstead; Bayfordbury, near Hertford; Rothamsted, near Harpenden; and Knebworth, near Stevenage. This I shall call the *Central* district.

(3) That part which lies north of Lat. 51° 55′, in which are situated stations IX-XII; namely Stevenage; Hitchin; Throcking, near Buntingford; and Royston. Besides returns from these twelve representative stations, I have returns from three others,—Oaklands, Watford; Gorhambury, near St. Albans; and Datchworth, near Welwyn; which I have treated as supplementary stations. My reason for doing this was because the locality of Watford in which Oaklands is situated is sufficiently represented by Moor Park and Wansford House; and because the Gorhambury and Datchworth returns are incomplete.

In the accompanying table I have given all the information I could collect, as regards the stations at which the observations were taken, and the instruments used.

In a second table I have given the daily readings of the maximum and minimum thermometers at each of these stations.

In a third table I give the mean max. and min. readings for each day in each of the three districts, which will show how the cold was distributed in the county.

Finding a diversity of practice amongst observers as to the entry of max. and min. temperature, some entering both to the previous day, others, on the other hand, entering both to the day of observation, I have adapted all returns to the rule of the Meteorological Society, which is, when observations are taken in the morning, *to enter the max. to previous day, the min. to day of observation.* It must therefore be borne in mind in examining the table that the min. for 13th is the min. for the night following the 12th day, which probably occurred *early on the 13th,* and so with the rest.

No. of Station.	Stations.	Authorities.	Particulars of Station.			Particulars of Instruments.					
			Lat. N.	Long. W.	Above Sea-level.	Above Ground.	Maker.	Stand.	Verified. Min.	Verified. Max.	Time of Reading.
			° ′ ″	° ′ ″	ft.	ft. in.					
I.	Rickmansworth—Moor Park	J. C. Mundell	51 37 30	0 27 0	340	2 6		O	v	v	7·30 A.M.
II.	East Barnet—Southgate	G. A. Church	51 37 40	0 8 0	240	3 0	N	W	n	n	9· 0 A.M.
III.	Watford—Wansford House	John Hopkinson	51 39 45	0 23 40	223	4 0	H	S	v	v	9· 0 A.M.
*	Watford—Oaklands	E. Harrison	51 40 0	0 24 20	273	3 0		O	n	n	8· 0 A.M.
*	St. Albans—Gorhambury	J. Thompson	51 45 20	0 23 0	370		N ‡	O	n	...	9·30 A.M.
IV.	Hemel Hempsted—Nash Mills	Dickinson and Co.	51 44 0	0 26 40	237	4 6	P	O	n	n	9· 0 A.M.
V.	Berkhampstead	W. Squire	51 45 40	0 33 0	370	4 0	N	G	v	v	9· 0 A.M.
VI.	Hertford—Bayfordbury	W. Clinton Baker	51 46 30	0 6 30	250	4 0	N	O	n	n	9· 0 A.M.
VII.	Harpenden—Rothamsted	T. Wilson	51 48 10	0 21 30	376	5 0		O	v	v	9· 0 P.M.
*	Welwyn—Datchworth	Rev. J. Wardale	51 51 20	0 9 30	357	5 0		W	n	...	
VIII.	Stevenage—Knebworth	Rev. F. G. Jenyns	51 52 30	0 12 30	390	5 0	N	O	n	n	9·30 A.M.
IX.	Stevenage	Rev. J. O. Seager	51 55 0	0 11 40	319	4 0	S	O	v	n	†
X.	Hitchin	W. Lucas	51 57 0	0 12 16	238	4 6		W	n	n	9· 0 A.M.
XI.	Buntingford—Throcking	Rev. C. W. Harvey	51 57 0	0 3 7	484	4 0	N	S	v	v	9· 0 A.M.
XII.	Royston	H. Wortham	52 2 30	0 1 0	269	5 0		G	n	v	10·0 A.M.

Maker.—H, signifies Hicks; N, Negretti and Zambra; P, Pastorelli; S, Steward. Stand.—G, signifies Glaisher; S, Stevenson; O, observer's own pattern; W, instruments exposed on wall; v, verified; n, not verified. * Supplementary stations. † Min. taken morn.; max. even.
‡ An iron garden thermometer.

The severe frost may be said to have commenced generally on Jan. 13th, and to have lasted until the 26th, on which day the thaw set in. The minima on the 27th were in some cases very low, but my own experience leads to the conclusion that these minima represent the actual temperature of the previous morning when the instruments were last set.

The total range of temperature during the fortnight was from 39° at Oaklands, Watford, and 38° at Bayfordbury, on the 23rd, to 4° at Nash Mills and Bayfordbury on the 21st; a thermometer at the lodge of the latter place, fixed a few inches from the ground, registering —3°. The total range of temperature was consequently 35°. The lowest day temperature was 20°·5 at Stevenage on the 16th, while the highest night temperature was 26° at Bayfordbury on the 13th; thus the day range was 18°·5, the night range being 22°. The highest mean temperature was that for the 23rd, namely 27°·4, the lowest being 18°·5 on the 21st. On the 23rd the day temperature was at its highest, the mean being 34°·2; while on the 21st the night temperature reached its lowest point, the mean being only 8°·5.

From this it appears that on the whole the Northern district experienced the greatest cold, the mean temperature for each district being, S. 22°·2; C. 22°·9; N. 21°·6. The night temperature was slightly lower in S. than in N., the C. district showing the highest mean; the values being, S. 15°·2; C. 16°·1; N. 15°·5; while the day temperature was considerably lower in the north, the values being, S. 29°·1; C. 29°·7; N. 27°·8.*

Having said thus much of the frost generally, I will now proceed to speak more particularly of each separate day.

THURSDAY, 13th.—Mean temp. 26°·1. Night temp. lowest in S., day temp. in N. *Minima* ranged from 26° at Bayfordbury to 15° at Southgate; the mean being 20°·5. *Maxima* ranged from 33° at Southgate, Berkhampstead, and Bayfordbury, to 29°·9 at Throcking; the mean being, 31°·7.

FRIDAY, 14th.—Mean temp. 20°·4. Night temp. lowest in C. and N districts, day temp. in S. *Minima* ranged from 20° at Gorhambury and 18° at Moor Park, Rickmansworth, to 10°·5 at Oaklands, Watford; the mean being 15°·1. *Maxima* ranged from 32°·4 at Royston to 22°·1 at Throcking; the mean being 25°·7.

SATURDAY, 15th.—Mean temp. 19°·3. Night temp. lowest in S., in 5 instances minima were registered below 10°; day temp. lowest in N. *Minima* ranged from 18° at Gorhambury to 7° at Oaklands, Watford; the mean being 11°·5. *Maxima* ranged from 31° at Bayfordbury to 23°·2 at Royston, the mean being 27°·1.

SUNDAY, 16th.—Mean temp. 20°·6. Night temp. lowest in S., minima in three instances registered below 10°; day temp. lowest in N. *Minima* ranged from 18° at Knebworth to 8°·7 at Wansford House, Watford; the mean being 14°·2. *Maxima* ranged from 31° at Bayfordbury, to 20°·5 at Stevenage; the mean being 27°.

* Of all the stations Nash Mills shows the lowest means both of max. and min. temperature.

Monday, 17th.—Mean temp. 19°·2. Night temp. lowest in S., minima in 6 instances being registered below 10°; day temp. lowest in N. *Minima* ranged from 15° at Knebworth to 5° at Nash Mills; the mean being as low as 10°·2. *Maxima* ranged from 31°·5 at Wansford House, Watford, to 21° at Stevenage; the mean being 28°·2.

Tuesday, 18th, will long be memorable for the very severe gale and snowstorm. On account of the strong easterly wind which caused the snow to drift, seriously impeding traffic by road and rail, it was impossible to gauge the fall; but probably we shall not be far wrong in estimating the fall, as far as our own county is concerned, at from 6 to 8 inches, representing from ·60 to ·80 of rain-water, instead of from ·50 to ·66, which is the ordinary yield of that depth of snow; probably this difference in the yield was owing in a great measure to the extreme fineness of the snow. Mean temp. 23°·9. Night temp. lowest in S., minima in three instances being registered below 10°; day temperature lowest in N. *Minima* ranged from 28° at Moor Park, Rickmansworth, to 6° at Nash Mills, Hemel Hempsted, the mean being 18°·4. *Maxima* ranged from 31°·5 at Rothamsted to 27° at Berkhampstead and Hitchin; the mean being 29°·5.

Wednesday, 19th.—Mean temp. 25°·4. Night temp., though higher generally, lowest in N.; day temp. slightly lowest in N. *Minima* ranged from 25° at Bayfordbury and Datchworth to 22° at Hitchin; the mean being 23°·7. *Maxima* ranged from 30°·1 at Royston to 25° at Hitchin; the mean being 27°·2.

Thursday, 20th.—Mean temp. 21°. Night temp. lowest in C. and N. districts, minima being in three instances registered below 10°; day temp. lowest in N. *Minima* ranged from 17°·3 at Wansford House, Watford, to 8° at Berkhampstead, the mean being 13°·3. *Maxima* ranged from 33° at Bayfordbury to 25° at Hitchin, the mean being 28°·8.

Friday, 21st.—Some very low minima were registered on this day in all parts of the county. Mean temp., being the lowest in the whole period, was 18°·5. Night temp., which was low in all districts, was lowest in C. district, minima below 10° being registered in eight instances; day temp. lowest in N. *Minima* ranged from 16° at Knebworth to 5° at Berkhampstead, Rothamsted, and Hitchin, and 4° at Nash Mills (Hemel Hempsted) and Bayfordbury; the mean being as low as 8°·5, the lowest mean in the period. *Maxima* ranged from 33° at Oaklands, Watford, to 24° at Stevenage, the mean being 28°·5.

Saturday, 22nd.—Mean temp. 20°·1. Night temp. lowest in C. and N. districts, minima in five instances being registered below 10°; day temp. also lowest in C. and N. districts. *Minima* ranged from 13°·5 at Moor Park to 7°·7 at Royston, and 7° at Gorhambury; the mean being 10°·1. *Maxima* ranged from 32°·5 at Stevenage to 25°·8 at Royston; the mean being 30°·1.

Sunday, 23rd.—Temperature both night and day very much higher, the mean, 27°·4, being the highest in the period. Night temp. lowest in S.; day temp. in N. *Minima* ranged from 28°·7 at Rothamsted to 11°·8 at Wansford House, Watford; the mean being 20°·7, the highest in the period. *Maxima* ranged from 39° at Oaklands, Watford, and 38° at Bayfordbury, to 30°·7 at Throcking; the mean being 34°·2, also the highest in the period.

MONDAY, 24th. — Temperature again declined. Mean 23°·4. Night temperature much lowest in N.; day temp. much lowest in S. *Minima* ranged from 22° at Southgate and Bayfordbury to 11°·2 at Throcking, and 5° at Gorhambury, this latter being relatively very low; the mean was 18°·8. *Maxima* ranged from 36°·2 at Royston to 24° at Nash Mills (Hemel Hempsted), Knebworth, and Oaklands, Watford; the mean being 28°·0.

TUESDAY, 25th. — Mean temp. 22°·6. Night and day temp. lowest in N. *Minima* ranged from 21° at Bayfordbury and Knebworth to 11°·7 at Throcking; the mean being 19°. *Maxima* ranged from 28°·5 at Moor Park, Rickmansworth, to 23°·7 at Throcking; the mean being 26°·2.

WEDNESDAY, 26th.—During the day the frost began to break up. Mean temp. 23°·7. Night and day temp. both lowest in N. *Minima* ranged from 17° at Berkhampstead to 11°·5 at Throcking, the mean being 14°·5. *Maxima* ranged from 37° at Berkhampstead, and 36° at Knebworth to 28° at Royston, and Oaklands, Watford; the mean being 33°·0.

At the commencement of this period the barometer was somewhat below its mean height for the month, there was however a tendency to rise; by the 14th it had attained its mean height, which it maintained with little variation until the 17th, when a rapid depression of the mercury occurred; during the 19th and 20th a very rapid rise took place, pressure being high until the 24th, when a fresh depression appeared. The wind, with the exception of the gale of the 17th and 18th, was slight in force, having a northerly tendency. The weather was on the whole bright, no snow of any consequence falling except on 18th and 19th. At about 3 p.m. on 17th a very distinct halo round the sun was observed.

Such is a record of the frost of January, 1881, a frost which will I fancy long live in our memories as affording us some slight idea of what the intense cold of the far North must be.

The Frost of January, 1881.

No.	Station. Name.	Daily Minimum Temperature. 13	14	15	16	17	18	19	20	21	22	23	24	25	26
I.	Moor Park	20·0	18·0	14·5	14·5	12·0	28·0	24·0	14·5	12·0	13·5	22·0	21·0	20·0	16·5
II.	Southgate	**15·0**	16·0	9·0	11·0	10·0	18·0	24·0	13·0	13·0	12·0	25·0	22·0	18·0	15·0
III.	Wansford House	20·9	15·1	8·6	**8·7**	7·3	9·5	24·5	17·3	6·4	10·7	**11·8**	20·4	20·2	11·6
IV.	Nash Mills	20·0	13·5	9·0	14·0	**5·0**	**6·0**	24·0	14·0	**4·0**	10·0	15·5	20·0	19·5	16·0
V.	Berkhampstead...	20·0	14·0	9·0	15·0	6·0	25·0	24·0	**8·0**	5·0	10·0	18·0	19·0	20·0	17·0
VI.	Bayfordbury	26·0	13·0	11·0	15·0	8·0	11·0	25 0	15·0	**4·0**	8·0	20·0	22·0	21·0	15·0
VII.	Rothamsted	21·0	13·4	10·0	15·2	7·0	?	?	9·7	5·0	8·2	28·7	18·2	18·7	15·2
VIII.	Knebworth.........	23·0	18·0	17·0	18·0	15·0	26·0	24·0	16·0	16·0	12·0	21·0	19·0	21·0	15·0
IX.	Stevenage	22·0	17·5	12·0	16·0	12·0	25·5	?	11·0	10·0	10·0	29·0	18·0	20·0	14·0
X.	Hitchin	20·0	14·0	12·0	14·0	13·0	17·0	**22·0**	13·0	5·0	8·0	20·0	20·0	20·0	15·0
XI.	Throcking	19·1	15·8	13·4	14·3	12·6	15·3	23·2	14·3	14·3	10·7	19·0	11·2	**11·7**	**11·5**
XII.	Royston	19·7	12·5	13·0	14·7	14·0	20·6	22·8	?	7 9	7·7	20·4	14·9	18·0	12·7
	Mean	20·5	15·1	11·5	14·2	10·2	18·4	23·7	13·3	8·5	10·1	20·7	18·8	19·0	14·5
*	Oaklands...........	17·0	**10·5**	**7·0**	9·0	6·5	24·0	23·0	15·0	7·0	10·0	25·5	20·0	19·0	14·0
*	Gorhambury	22·0	20·0	18·0	9·0	11·0	8·0	**22·0**	9·0	20·0	**7·0**	14·0	**5·0**	13·0	15·0
*	Datchworth	?	17·0	14·0	14·0	14·0	25·0	25·0	14·0	13·0	10·5	28·0	20·0	20·0	15·0

No.	Station. Name.	Daily Maximum Temperature. 13	14	15	16	17	18	19	20	21	22	23	24	25	26	Mean. Minimum.	Maximum.	Mean.
I.	Moor Park	32·0	27·5	27·0	27·5	27·5	29·0	29·0	29·5	30·0	31·0	35·5	28·0	28·5	32·0	17·9	29·5	23·7
II.	Southgate	33·0	26·0	27·0	26·0	28·0	29·0	28·0	29·0	28·0	30·0	35·0	28·0	29·0	30·0	15·8	29·0	22·4
III.	Wansford House	31·7	24·0	27·6	29·5	31·5	30·6	26·6	29·7	27·9	31·9	34·0	25·8	26·9	35·4	13·8	29·5	21·6
IV.	Nash Mills	31·5	23·5	26·0	27·0	29·0	30·5	26·0	28·0	27·0	32·0	34·0	**24·0**	24·5	33·0	**12·0**	**24·1**	**18·0**
V.	Berkhampstead...	33·0	28·0	27·0	28·0	29·0	**27·0**	28·0	30·0	30·0	26·0	35·0	29·0	27·0	37·0	15·0	29·5	22·2
VI.	Bayfordbury	33·0	26·0	31·0	31·0	31·0	31·0	28·0	33·0	31·0	32·0	38·0	26·0	28·0	35·0	15·3	31·0	23·1
VII.	Rothamsted	31·5	25·7	29·5	29·5	29·7	31·5	26·5	28 9	26·1	30·5	34·0	30·5	26·4	30·7	14·2	29 3	21·7
VIII.	Knebworth.........	32·0	24·0	29·0	28·0	30·0	30·0	26·0	28·0	28·0	30·0	34·0	**24·0**	25·0	36·0	18·6	29·0	23·8
IX.	Stevenage	31·0	22·5	25·5	**20·5**	**21·0**	30·0	27·5	29·0	**24·0**	32·5	33·0	24·5	25·5	32·0	16·7	27·0	21·8
X.	Hitchin	31·0	27·0	24·0	22·0	27·0	**27·0**	**25·0**	**25·0**	25·0	29·0	34·0	34·0	26·0	33·0	15·2	27·8	21·5
XI.	Throcking	**29·9**	**22·1**	27·9	27·8	28·7	27·9	25·5	27·0	25·1	30·3	**30·7**	25·0	**23·7**	33·6	14·7	27·5	21·1
XII.	Royston	30·7	32·4	**23·2**	27·0	26·1	30·3	30·1	28·0	27·8	**25·8**	33·4	36·2	24·5	**28·0**	15·3	28·8	22·0
	Mean	31·7	25·7	27·1	27·0	28·2	29·5	27·2	28·8	28·5	30·1	34·2	28·0	26·2	33·0	15·5	28·7	22·0
*	Oaklands...........	32·0	26·0	30·0	29·0	30·0	29·0	30·0	30·0	33·0	30·0	39·0	**24·0**	28·0	**28·0**	14·8	29·1	21·9
*	Gorhambury	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
*	Datchworth	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

District.	Mean Minimum Temperature. 13	14	15	16	17	18	19	20	21	22	23	24	25	26
Southern...	19·0	15·6	10·3	12·0	8·5	15·4	24·1	14·7	8·8	11·5	18·6	20·8	19·4	14·8
Central ...	22·5	14·6	11·7	15·8	9·0	20·7	24·3	12·2	7·5	9·5	21·9	19·5	20·2	15·5
Northern..	20·2	14·9	12·6	14·7	12·9	19·6	22·7	12·8	9·3	9·1	22·1	16·0	17·4	13·3

District.	Mean Maximum Temperature. 13	14	15	16	17	18	19	20	21	22	23	24	25	26	Mean. Min.	Max.	Mean.
Southern...	32·0	25·2	26·9	27·5	29·0	29·8	27·4	29·0	28·2	31·2	34·6	26·4	27·2	32·6	15·2	29·1	22·1
Central ...	32·4	25·9	29·1	29·1	29·9	29·9	27·1	30·0	28·8	29·6	35·2	27·4	26·6	34·7	16·1	29·7	22·9
Northern..	30·4	26·0	25·1	24·3	25·7	28·8	27·0	27·2	25·5	29·4	32·8	29·9	24·9	31·6	15·5	27·8	21·6

[*To face p.* 232.

XXX.

METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING, HERTS, DURING THE YEAR 1880.

By the Rev. C. W. Harvey, M.A., F.M.S.

Read at Hertford, 22nd March, 1881.

The position of Throcking is about Lat. 51° 57′ N.; Long. 0° 3′ W., and the district is drained by the River Rib. My observatory is 484 feet above mean sea-level, and it contains the following instruments, all by Negretti and Zambra:—a Fitzroy storm-barometer; a dry- and wet-bulb, a maximum, and a minimum thermometer, the thermometers being inclosed in a Stevenson's screen, with the bulbs about 4 feet from the ground; a solar-radiation and terrestrial-radiation thermometer, the former fixed 4 feet, the latter 6 inches, from the ground, both being well exposed. All the above thermometers were verified at Kew Observatory in December, 1879, and all observations have been corrected for index errors, and the barometer-values have been reduced to 32° and sea-level. A rain-gauge of the Snowdon pattern, having a diameter of 5 inches, and with its receiving rim one foot above the surface of the ground, completes my set of instruments. My times for observing are 9 a.m. and 9 p.m., the self-registering thermometers being read and the gauge emptied *only* at 9 a.m., and the maximum readings and the amount of rain being entered to the *previous* day. The *mean* temperature is the mean of the max., the min., the 9 a.m., and the 9 p.m. readings of the thermometers. In the accompanying tables (pp. 234, 235) I give the result of my observations; all the values being derived from the 9 a.m. observations only, excepting the mean temperature.

General Remarks.—There is little about the weather of 1880 that is in any real sense abnormal. As regards temperature, although below the mean throughout the year, owing no doubt to the great absence of sunshine, we have had no such excess of cold as that of Dec. 1879 or Jan. 1881; and certainly, as will be seen presently there has been no excess of heat; again as regards rainfall we have had no such heavy fall as that of Aug. 2nd and 3rd, 1879. Temperature was below the mean during the whole year, the deficiency being most observable in Jan. and Oct., least so in Feb. and Mar. Still there are some particulars which I think call for notice. We have experienced three deep barometer depressions, one in February, one in October, and one in November; whilst in January and December the mercury attained a very high point. In February the lowest point noticed was at 8 a.m. on the 17th, when the mercury stood at 28·84 ins. at sea-level. Between Oct. 25th and 30th there was a depression amounting to 1·36 in. and a recovery amounting to 1·30 in., the max. and min. pressure being, 25th 30·19 ins.; 28th 28·83 ins.; 30th 30·13 ins. On Nov. 18th pressure was 28·83 ins.; 19th 29 80 ins.; and by the 21st the mercury had reached 30·46 ins. Thus the recovery was 1·63 in. between the 18th and 21st.

Results of Meteorological Observations taken at Throcking Rectory, Herts, in 1880.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°		°		°	°	in.	%
January	30·34	30·7	28·3	36·8	32·0	8·5	14·5	28th	53·4	31st	38·9	2·1	·156	92
February	29·77	39·1	35·3	46·9	40·2	11·6	26·9	5th	54·4	1st	27·5	1·4	·227	95
March	30·10	41·7	34·2	52·3	41·9	18·1	19·9	20th	61·7	26th	41·8	3·8	·228	87
April	29·83	45·7	38·9	54·1	45·0	15·2	32·4	27th	66·2	19th	33·8	4·1	·264	84
May	30·09	51·2	41·8	59·7	49·8	17·9	34·4	3rd	79·6	26th	45·2	6·2	·299	80
June	29·90	55·9	48·2	63·7	55·1	15·5	35·5	5th	75·3	29th	39·8	4·5	·380	85
July	29·86	59·6	52·6	67·1	58·0	14·5	46·6	5th	71·7	23rd	25·1	4·5	·435	85
August	29·98	59·8	54·3	67·8	59·9	13·5	47·6	3rd	76·8	10th	29·1	2·8	·465	90
September	29·96	58·2	52·0	66·3	58·0	14·3	42·5	19th	84·2	4th	41·7	4·1	·419	86
October	29·87	44·4	39·5	51·3	44·5	11·8	28·3	21st	61·3	5th	33·0	2·4	·267	90
November	29·94	39·6	34·5	46·5	40·1	12·0	21·6	22nd	55·4	13th	33·8	2·3	·225	93
December	29·89	39·4	35·3	44·9	39·6	9·6	27·2	26th	53·9	10th	26·7	2·0	·226	94
Year	29·96	47·1	41·2	54·8	47·1	13·6	14·5	Jan. 28	84·2	Sept 4	69·7	3·3	·299	88

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING RECTORY, HERTS, IN 1880—*(continued.)*

Months.	Rainfall.					Cloud.			Wind.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only		Clear Sky.	Over-cast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January.....	·26	·14	16th	5	4	7·4	5	19	2	5	1	2	4	6	5	2	6	0
February	2·45	·52	16th	16	0	7·8	2	19	3	1	0	0	1	10	7	8	2	0
March	·87	·49	31st	6	1	6·7	4	12	3	1	9	7	3	1	4	4	2	0
April	1·74	·44	14th	16	0	7·8	2	12	3	3	8	2	0	6	6	2	3	0
May	·68	·23	31st	7	0	7·1	3	12	3	6	10	2	0	2	4	2	5	0
June	2·23	·30	15th	17	0	8·4	0	15	2	6	6	0	1	2	5	7	3	0
July	5·23	1·00	14th	22	0	7·7	0	11	2	2	1	1	3	5	11	4	4	0
August	1·09	·32	2nd	7	0	8·4	0	18	2	8	12	0	0	1	3	1	6	0
September	3·09	1·22	11th	10	0	6·6	3	13	1	0	3	2	3	1	8	5	8	0
October	4·81	1·16	6th	17	1	7·0	6	15	2	6	7	4	0	3	2	6	3	0
November	2·30	·60	15th	13	0	5·9	5	13	3	3	4	0	0	5	10	3	5	0
December	2·66	·39	22nd	21	3	7·7	3	18	3	0	1	0	0	5	9	10	6	0
Year.........	27·41	1·22	Sept. 1	157	8	7·4	33	177	2·4	41	62	20	15	47	74	54	53	0

The instances of high pressure occurred on January 7th (30·66 ins.) and December 7th (30·63 ins.).

With regard to extremes of temperature, the following are the four highest and four lowest observations :—

Highest Maxima.	°	Lowest Minima.	°
(*a*) September 4th	84·2	(*a*) January 28th	14·5
(*b*) ,, 3rd	82·2	(*b*) ,, 29th	18·2
(*c*) May 26th	79·6	(*c*) ,, 20th	19·4
(*d*) September 2nd	77·9	(*d*) March 20th	19·9

Thus the thermometer attained its third highest point as early in the year as May ; while it sank to its fourth coldest point as late as March.

I now give the values of the warmest and coldest periods of 14 days, the values representing the mean temperature for the respective days.

Warmest period.	°	Coldest period.	°
August 28th	63·8	January 16th	33·4
,, 29th	60·9	,, 17th	31·5
,, 30th	61·6	,, 18th	30·0
,, 31st	63·8	,, 19th	23·6
September 1st	64·2	,, 20th	23·8
,, 2nd	67·6	,, 21st	29·1
,, 3rd	68·0	,, 22nd	30·7
,, 4th	70·4	,, 23rd	31·7
,, 5th	66·5	,, 24th	30·6
,, 6th	60·2	,, 25th	28·6
,, 7th	58·5	,, 26th	27·2
,, 8th	57·4	,, 27th	28·5
,, 9th	58·8	,, 28th	19·1
,, 10th	62·7	,, 29th	24·5
Mean	63·0	Mean	28·0

The last trace of frost was as late as June 5th, when the thermometer on the grass registered 30°·8 ; the first trace again being Oct. 3rd, when the same instrument registered 30°·5.

The temperature on the 1st and 2nd of January was remarkably high, the period falling as it did between two cold periods. I give the max., min., and mean readings.

	Max.	Min.	Mean.
January 1st	52°·4	49°·4	50°·4
,, 2nd	48·8	46·9	45·2

A cold period occurred between November 18th and 23rd, of which I give the max., min., and min. on grass.

	Max.	Min.	Min. on Grass.
November 18th	43°·9	25°·1	20°·9
,, 19th	38·9	23·9	22·3
,, 20th	38·3	28·9	25·8
,, 21st	36·0	25·9	23·4
,, 22nd	33·9	21·6	18·1
,, 23rd	47·2	23·3	18·9

The rainfall, which was below the mean of the district for 1870-79 during the first six months, was in excess during the last six. The following represents the difference from the mean in each month.

		ins.			ins.
January	—	2·14	July	+	2·74
February	+	·71	August	—	1·32
March	—	·75	September	+	·49
April	—	·18	October	+	2·56
May	—	1·35	November	+	·35
June	—	·12	December	+	·58

Dry periods.—January 1st to 15th, and 17th to February 4th, no actual fall, with the exception of ·02 in. of snow on the 22nd. March 4th to 31st, no fall, with the exception of ·02 in. on the 4th and ·01 in. on the 7th; April 22nd to May 10th no fall, with the exception of ·04 in. on the 24th of April, ·05 in on the 26th, and ·03 in. on the 4th of May; May 11th to 27th no fall, with the exception of ·03 in. on the 26th; August 14th to 29th no fall, with the exception of ·02 in. on the 19th, and ·01 in. on the 25th; August 30th to September 10th no fall, except ·01 in. on the 6th of September; September 20th to October 2nd no fall.

Wet periods.—In July rain fell on all but nine days. On the 14th ·89 in. of rain fell in 2½ hours. The chief falls were

	in.		in.
July 1st	·70	July 24th	·54
,, 3rd	·39	,, 26th	·30
,, 11th	·40	,, 28th	·53
,, 14th	1·00	,, 29th	·28

Between September 11th and 20th 3·08 ins. of rain fell. Of the above amount 2·42 ins. fell between the 11th and 14th.

	in.		in.
September 11th	1·22	September 13th	·03
,, 12th	·35	,, 14th	·82

In October 2·03 ins. fell between the 4th and 6th; and 1·69 in. between the 26th and 28th.

	in.		in.
October 4th	·59	October 26th	·85
,, 5th	·28	,, 27th	·36
,, 6th	1·16	,, 28th	·48

Rain fell every day from December 13th to 30th except on 17th and 25th; snow fell on the 19th and 26th.

There is nothing more I think which calls for special remark. I will therefore briefly epitomise the weather of each month, using the following abbreviations:—**F**, fog; **H**, hail; **L**, lightning; **R**, rain; **S**, snow; **T**, thunder; **T S**, thunderstorm.

January.—Cold with little **R** and much **F**. **S** 10th, 14th, 15th, 22nd; **R** 8th, 15th, 16th, 22nd; **F** 4th to 10th, 16th, 28th, and 29th. **F** of 28th heavily charged with soot, the rime from the trees blackening the ground; probably a London fog on the travel.

February.—Wet with a good deal of **F**. **R** 5th to 9th, 11th, 14th to 16th, 18th to 21st, 23rd, 25th, and 29th; **F** 3rd to 7th, 12th, and 23rd; **T** and **L** 8th.

March.—Dry with strong winds. **R** 1st, 2nd, 3rd, 4th, 5th, 7th, and 31st; **F** 9th to 12th, and 14th; **S** 22nd (a few flakes); **H** 4th (slight).

April.—Showery and unsettled. **R** 1st to 3rd, 4th to 6th, 8th, 9th, 11th, 13th to 15th, 19th, 20th, 22nd, 24th, 26th; **T** 4th, 6th, 7th, 22nd.

May.—Dry and fairly warm. **R** 4th, 10th, 22nd, 26th to 28th, 31st; **T** and **L** 26th; **T** 28th; **F** 3rd.

June.—Wet and cool. **R** 1st, 3rd to 9th, 14th, 15th, 19th, 20th, 22nd to 25th, 30th; **T S** 14th and 24th; **T** 25th.

July.—Very wet, with much thunder. **R** every day except 4th, 5th, 16th, 18th, 19th, 22nd, 23rd, 24th; **T S** (heavy) 14th; **T** 1st, 3rd, 10th, 13th, 15th, 17th, 21st, 26th, and 29th.

August.—Dry and bright. **R** 2nd, 6th, 7th, 14th, 19th, 25th, and 29th; **T** 2nd, 6th, 29th; **L** 26th, 27th, 29th.

September.—Warm. **R** 6th and 11th to 20th; **T** 14th and 18th; **H** 19th; **F** 28th to 30th.

October.—Very wet. **R** 2nd, 4th to 9th, 11th, 12th, 16th, 18th to 20th, 22nd, 26th to 28th; **T** 2nd and 7th; **L** 7th and 23rd; **F** 16th, 27th, and 28th; **S** 19th.

November.—Remarkably clear of **F**, and with strong winds. **R** 7th, 10th to 16th, 18th, 23rd to 26th; **F** 5th; **S** 18th and 19th. Aurora Borealis visible 3rd.

December.—Very mild with **R** after 13th. **R** 1st to 4th, 13th to 24th, 26th to 30th; **S** 17th, 19th, 20th, and 26th; **F** 27th.

XXXI.

NOTES ON BIRDS OBSERVED DURING THE YEAR 1880 AND THE FIRST THREE MONTHS OF 1881.

By John E. Littleboy.

Read at Watford, 19th April, 1881.

It is again my duty to offer to the Society a few "Notes on Birds" observed within the county of Hertford. The period of observation includes the year 1880 and the first three months of 1881. I am pleased to be able to announce that I have received information of eight species new to our register, and, in accordance with my previous custom, I will proceed to notice them *seriatim*.

1. The Raven (*Corvus Corax*).—On the 25th of February, 1881, a raven was observed on the outskirts of Mimms Wood. It was seen and recognised by several gentlemen when hunting in that neighbourhood, and is reported by Miss Selby, of Aldenham, who saw it very distinctly. It need hardly be said that the raven is a rare bird in the Midland Counties, but, to use the words of Morris, "he is a citizen of the world," and there is no reason why he should not occasionally visit Hertfordshire. Whether the specimen in question had escaped from confinement, or whether, as is very possible, it was a young bird, driven southward by frost and snow, cannot, of course, be definitely determined. Certain it is that the bird was seen at Mimms Wood, and I am glad to be able to place it on our register. I am informed by Mr. D. Hill, of Pinner, that, only a few years ago, a raven visited a rookery near that town. It attacked and succeeded in dispersing the rooks. It was eventually caught in a rat-trap when feeding from a sheep-trough in an open field. The raven is a circumpolar bird,* is a resident species throughout Europe, but is not found in Africa. It is rapidly becoming extinct in England, although still breeding in Scotland.

2. The Rough-legged Buzzard (*Buteo Lagopus*).—Observed by Mr. Thomas Fowell Buxton, of Easneye, near Ware. Mr. Buxton writes as follows: "Last Tuesday I was shooting snipe with one of my sons on the Rye meads. A large hawk, which I had no doubt was a rough-legged buzzard, rose from the ground within ten yards of my son. We afterwards found near the spot the remains of a thrush (or redwing) and of a golden plover, both of which had been eaten by a hawk, I suppose by the one we saw." Mr. John H. Gurney, jun., a gentleman whose name is a household word among ornithologists, has most kindly supplied me with a short notice respecting this important addition to our register of raptorial birds. "The rough-legged buzzard may be described as a regular autumnal migrant to Great Britain, occurring in some years, as in the autumn of 1880, in great numbers on the east coast, particularly in Norfolk. Unlike the common buzzard, which, in

* Seebohm, 'Siberia in Europe,' p. 53.

the days of our great uncultivated tracts of forest land, when game-preserving was hardly thought of, was a numerous resident, this species is only supposed to have remained to breed in one or two very rare instances. Its food consists of rabbits and other small mammals. It doubtless preys largely on lemmings in Scandinavia, which is its true home. Nearly all the specimens which are killed in this country are immature; examples which have in any degree assumed the adult plumage being very rare. From the common buzzard and the honey-buzzard, with which alone it could be confounded, it may always be distinguished by its legs being feathered down to the toes."

3. The Osprey (*Pandion Haliaëtus*).—An osprey was shot in Hatfield Park during September, 1880. I am indebted to Mr. George Platten, head gamekeeper, for the following particulars. A large hawk had been noticed in the park for several days, but special attention was at length directed to it by a striking exhibition of its peculiar fishing propensity. It was observed to plunge with great force into the broad-water, a portion of the River Lea that flows by Hatfield Park; to dive for a distance of 50 or 60 yards, and, after swimming for a moment or two on the surface like a duck, to rise into the air with a large fish, estimated to weigh at least a pound, in its talons. Such an occurrence left no doubt as to its species. It proved to be a remarkably fine female bird and in splendid plumage. It was stuffed and mounted before I had the opportunity of seeing it, but I am informed that its expanse of wing measured five feet six inches, and its length from head to tail is almost exactly two feet. The osprey, or sea-hawk, is extremely rare in the inland counties. Yarrell reports it as only having been taken in Oxfordshire, Hertfordshire, and Shropshire.* It breeds freely in Scandinavia and Northern Russia, where it frequents rocks and cliffs on the sea-coasts and the neighbourhood of lakes and rivers. It breeds also to a limited extent in Scotland, nests having been frequently reported from the vicinity of Loch Awe and other Highland lakes. It feeds almost exclusively on fish, the great strength and sharpness of its claws enabling it to seize its prey with unfailing certainty. Its method of capturing its food is well illustrated by the incident in Hatfield Park. It is said † that the osprey never condescends to pick from either land or water a fish that it has once dropped; when searching for its food, it hovers over the water or glides slowly along with motionless wing and but rarely alights upon the ground.

4. The Bittern (*Botaurus stellaris*).—Mr. Henry Manser, of Hoddesdon, reports that a bittern in fine plumage was shot near Hoddesdon, on the 24th of January, 1881. It measured 26 inches in height to top of head, and 15 inches to shoulders. Fifty years ago the bittern, the most beautiful of our waders, was in many parts of England comparatively common, and was held in some estimation

* 'History of British Birds,' vol. i, p. 24.

† 'Encyclopædia Britannica,' 8th Ed., vol. xvi, p. 743.

as an article of diet. It appears to have become scarcer and scarcer as population has become more dense and the art of practical agriculture has advanced. The reclamation of waste lands and the drainage of fens and marshes have deprived it of its congenial haunts, and it is now but rarely met with in the home counties. The bittern is a voracious feeder; it devours with apparent indifference birds, fishes, or reptiles; and Yarrell* records several instances in which a water-rat has been taken whole from its stomach.

5. THE GREENSHANK (*Totanus Glottis*).—A beautiful specimen of the greenshank was obtained in the early part of 1880, near the Colne, by Mr. A. Dyson, and is preserved in his collection. The greenshank is a winter visitant to the British Isles. It nests in Scandinavia and Northern Europe, and is generally met with during a short period in autumn or early spring as it migrates backwards and forwards from and to its northern home. It is very similar in general appearance to the green sandpiper, specimens of which were reported as having been shot in 1879 near the river Beane, but is considerably larger.

6. THE HERRING-GULL (*Larus argentatus*).—In February, 1881, a young herring-gull was shot at Oaklands, near St. Albans. The herring-gull is among the largest of the gulls, is a resident species, and is abundant on the sea-coasts of the British Isles. It feeds, as its name implies, on herrings and other surface-swimming fish. It is easily tamed, and when pinioned is readily kept within the precincts of a garden.

7. THE WIDGEON (*Mareca Penelope*).—Two widgeon were shot on the Colne, near Garston, by Mr. Roffe, early in 1880, and in January, 1881, a flock of ten or eleven, one of which was shot, was observed by Mr. Holland, near Otterspool. The widgeon is a winter migrant, arriving during the month of October and generally leaving in March. It nests very rarely in Britain, but, like many of the ducks and waders, breeds freely within the Arctic circle. "It must be considered," writes Mr. Seebohm,† "a palæarctic duck, though its range extends eastward beyond Behring's Straits to the coast of Alaska."

8. THE SCAUP-DUCK (*Fuligula Marila*).—The Society is indebted to Mr. Alfred F. Buxton, Easneye, near Ware, for information that adds an additional duck to our register of Hertfordshire birds. On the 22nd of January, 1881, a female scaup was shot by Mr. T. F. Buxton, on the Ashe. "It rose from the river and was quite alone." Like the preceding species, the scaup-duck visits the British Isles only in the winter. It is a circumpolar bird, but winters throughout temperate Europe and North Africa. During its southern migration it is abundant in Holland and also on the coast of Norfolk.

The birds now mentioned increase the number of species at present on our register to 126.

* 'British Birds,' vol. ii, p. 478.
† 'Siberia in Europe,' p. 107.

I will next extract from my register a few notes supplied to me from various quarters. In the Rev. C. M. Perkins, who has recently removed from St. Albans, the Society has lost an excellent correspondent; but I have to acknowledge, with thanks, very acceptable contributions from the following members, viz.: Dr. A. T. Brett, Watford; Mr. R. W. Brett, Lee Side, Hertford; Mr. Thomas F. Buxton, and Mr. Alfred F. Buxton, Easneye, near Ware; the Rev. T. D. Croft, Kimpton Vicarage, near Welwyn; Mr. R. B. Croft, Fanhams Hall, Ware; Lord Ebury, Moor Park, Rickmansworth; the Rev. J. A. Ewing, Westmill Rectory, Buntingford; Mr. H. George Fordham, Odsey Grange; Mr. Henry C. Heard, Hailey Hall; Mr. Henry Manser, Hoddesdon; Miss Selby, Aldenham; Mr. W. H. Solly, Serge Hill, Bedmont; Mr. Abel H. Smith, Woodhall Park, Hertford; Mr. George Turner, Hertford; Miss Warner, Hoddesdon; and several others. In order to economise space I have tabulated the various reports that record the arrival and departure of summer migrants.

Species.	Locality.	Date.	Observer.
Nightingale (*Daulias Luscinia*)	Colne Kings, Watford	Apl. 12	J. Hopkinson.
	Hailey Hall, Hertford	,, 16	H. C. Heard.
	Mardale House, Watford	,, 16	W. M. Fawcett.
	Near King's Langley	,, 16	T. W. Toovey.
	Near Hoddesdon	,, 17	Miss Warner.
	Hunton Bridge	,, 17	J. E. L.
	Woodhall Park, Sacombe	,, 18	Abel H. Smith.
	Bengeo, Hertford	,, 19	Geo. Turner.
	Odsey Grange, Royston	,, 19	H. G. Fordham.
	Near Ware	,, 19	R. B. Croft.
Redstart (*Ruticilla phœnicurus*)	Near Hitchin	May 6	W. Hill, jun.
Wheatear (*Saxicola Œnanthe*)	The Hoo, Great Gaddesden	Apl. 20	H. Procter.
Chiff-Chaff (*Phylloscopus collybita*)	Frogmore House, Watford	Mar. 13	Mrs. J. Hill.
	Near Broxbourne	,, 16	R. B. Croft.
	Hitchin	,, 27	A. Ransom.
	Hertford	Apl. 1	R. W. Brett.
	Ware (general)	,, 3	R. B. Croft.
	King's Langley	,, 12	Edward Lake.
	Hunton Bridge	,, 15	J. E. L.
Willow-Wren (*Phylloscopus trochilus*)	Near King's Langley	,, 12	T. W. Toovey.
	Near Hertford	,, 22	R. W. Brett.
	Odsey Grange, Royston	May 15	H. G. Fordham.
Whitethroat (*Sylvia rufa*)	Near Rickmansworth	Apl. 19	H. Procter.
	Near King's Langley	,, 20	T. W. Toovey.
	Hunton Bridge	May 2	J. E. L.
Blackcap (*Sylvia Atricapilla*)	Near Hoddesdon	Apl. 18	R. B. Croft.
	Hunton Bridge	May 5	J. E. L.
Sedge-Warbler (*Calamodus schœnobænus*)	Near King's Langley	Apl. 18	T. W. Toovey.
Grasshopper-Warbler (*Locustella nævia*)	Near King's Langley	Apl. 19	Edward Lake.

SPECIES.	LOCALITY.	DATE.	OBSERVER.
RED-BACKED SHRIKE	Near Ashwell	July 17	H. G. Fordham.
(*Lanius Collurio*)	,, ,, (a pair)	Aug. 8	,,
SPOTTED FLYCATCHER......	Odsey Grange, Royston	May 30	H. G. Fordham.
(*Muscicapa grisola*)	,, (nest with young)	June 28	,,
PIED WAGTAIL...............	Hunton Bridge.........	Mar. 10	Mrs. Littleboy.
(*Motacilla lugubris*)	Frogmore House, Watford	,, 13	Mrs. J. Hill.
	Odsey Grange, Royston (nest with five eggs)	June 28	H. G. Fordham.
TREE-PIPIT	Near King's Langley	Apl. 12	T. W. Toovey.
(*Anthus trivialis*)			
SWALLOW	Near Hertford	Apl. 8	R. W. Brett.
(*Hirundo rustica*)	Wiggenhall, Watford	,, 12	J. King.
	Woodhall Park, Sacombe	,, 15	Abel H. Smith.
	Near King's Langley	,, 15	T. W. Toovey.
	Near St. Albans	,, 15	G. Willshin.
	Near Ware	,, 16	R. B. Croft.
	Hailey Hall, Hertford	,, 17	H. C. Heard.
	Odsey Grange, Royston	,, 20	H. G. Fordham.
(Last observed)	West Street, Hertford	Nov. 1	W. M. Wood.
	Odsey Grange, Royston	,, 1	H. G. Fordham.
	Hunton Bridge...	,, 7	F. Littleboy.
	Near Rickmansworth Church	,, 27	Lord Ebury.
MARTIN	River Lea, Hertford...	Apl. 16	R. W. Brett.
(*Chelidon urbica*)	Hunton Bridge.........	,, 22	F. Littleboy.
	Odsey Grange, Royston	,, 28	H. G. Fordham.
	Near Tewin	May 6	R. B. Croft.
(Last observed)	Near Ashwell	Oct. 25	H. G. Fordham.
	Hunton Bridge.........	Nov. 12	F. Littleboy
SAND-MARTIN	Near Rickmansworth	Apl. 16	H. Procter.
(*Cotyle riparia*)	River Lea, Hertford...	,, 18	R. W. Brett.
	Near Ware	,, 20	R. B. Croft.
	Woodhall Park, Sacombe	,, 20	Abel H. Smith.
	Odsey Grange, Royston	May 12	H. G. Fordham.
	Hoddesdon	Mar. 31	R. B. Croft.
	King's Langley	Apl. 11	T. W. Toovey.
WRYNECK	Odsey Grange, Royston	,, 17	H. G. Fordham.
(*Yunx torquilla*)	Wiggenhall, Watford	,, 12	J. King.
	Near Gt. Gaddesden...	,, 15	H. Procter.
CUCKOO	Moor Park, Rickmansworth	,, 19	Lord Ebury.
(*Cuculus canorus*)	Near Ware	,, 19	R. B. Croft.
	Hailey Hall, Hertford	,, 21	H. C. Heard.
	Hunton Bridge.........	,, 22	Miss W. Cooper.
	Near St. Albans	,, 22	Geo. Willshin.
	Between Hertford and Watton	,, 23	R. W. Brett.
	Odsey Grange, Royston	,, 23	H. G. Fordham.
	Serge Hill, Bedmond	,, 23	W. H. Solly.
	River Lea, Hertford...	May 8	R. W. Brett.
	Near Ware	,, 13	R. B. Croft.
SWIFT	Odsey Grange, Royston	,, 13	H. G. Fordham.
(*Cypselus Apus*)	St. Albans	,, 13	Geo. Willshin.
	Near Watford	,, 14	J. E. L.

It remains for me to refer in somewhat fuller terms to a few of the tabulated species.

Swallows, martins, and swifts arrived in our country rather later than usual and only in small numbers, but as the season advanced swifts became unusually abundant. Swallows and martins remained later than I have previously recorded them. Swallows are reported by Mr. W. M. Wood as abundant in Hertford to the end of October. Numbers were seen in different localities during the early part of November, and Lord Ebury reports that as late as November 27th many swallows were observed at Rickmansworth, principally about the tower of the old church.

I have again to report two instances of young cuckoos being fed by wagtails. I have received the following from Dr. A. T. Brett. "At Moor Farm, close to the ruins of the old Moor House, Rickmansworth, a wagtail built its nest in some furze that served as a protection to an old shed. On the 1st of September a farm-boy told his mistress that 'there was such a large queer bird in the wagtails' nest, and it had got such a big mouth.' On examining the young prodigy, Mrs. Bean found it to be a cuckoo, and she states that it made a noise like a gosling. It continued about the garden and orchard until November, and was assiduously waited on and fed by its foster-mother." On Sunday afternoon, the 18th of July, a young cuckoo crossed the lawn at Hunton Bridge and perched upon some wire-fencing beside the river, only about 25 yards from our parlour window. We had previously noticed a pair of pied wagtails industriously hawking over the stream in search of insect-food, and directly the young cuckoo appeared upon the scene, one after the other flew towards it and carefully placed whatever it had been able to catch within its wide open mouth. The cuckoo had nearly attained its full size, and the contrast between the small active wagtails, incessantly on the wing, and their great indolent nursling, perched with open mouth upon the fence, was singularly striking. We watched them for about twenty minutes, during which time the process of feeding was constantly persisted in.

I now proceed onward in regular course.

The Thrushes (*Turdus viscivorus*, *T. musicus*, *T. iliacus*, and *T. pilaris*.)—Thrushes, although not so plentiful as formerly, have been more abundant in the year 1880 than they were in 1879. They commenced to sing early in February, and are reported from various parts of the county from the second to the tenth of that month. There is abundant truth in the words of a Scotch poet:—

> "When snowdrops die, and the green primrose-leaves
> Announce the coming flower; the merle's note,
> Mellifluous, rich, deep-toned, fills all the vale
> And charms the ravished ear."

They continued to sing through November and are last reported as heard near Odsey Grange on the 15th of December. Redwings arrived early in November, but were by no means abundant. In

January and February, 1880, fieldfares were extremely scarce. They arrived in considerable numbers towards the end of October, and are reported as plentiful throughout November and December.

THE GOLD-CREST (*Regulus cristatus*).—This charming little bird has been abundant in the neighbourhood of Hunton Bridge during the whole of the year.

THE GOLDFINCH (*Carduelis elegans*).—A large flock of goldfinches was observed by Mr. George Underwood at Little Gaddesden, in January, 1881. It is satisfactory to find that these beautiful birds are yet occasionally met with in considerable numbers. They become but too frequently the victims of the bird-catcher.

THE SISKIN (*Carduelis Spinus*).—A flight of about a dozen siskins was noticed on the 5th of Nov., close to the Hunton Bridge farm.

THE HAWFINCH (*Coccothraustes vulgaris*) breeds regularly in the garden at Cecil Lodge, Abbot's Langley, and is reported as follows: —January 21st, 1880, in the garden at Hunton Bridge; February 14th, at the mansion, Moor Park; March 7th and 9th, at Serge Hill, and at the same place a pair apparently preparing to build was observed on April 21st and 23rd. On the 21st of January, 1881, when the ground was thickly covered with snow, several were shot, in very fine plumage, in Hatfield Park. On the 22nd of January one was again seen in the garden at Hunton Bridge.

THE BRAMBLING (*Fringilla montifringilla*).—Bramblings were abundant during January and part of February, 1881, throughout the western portion of the county. Several were observed by Mr. Wyman, near Hemel Hempstead, on the 27th of January. At the commencement of February they are reported by Miss Selby as abundant near Aldenham; one specimen having been kindly forwarded to me for identification. Bramblings are also reported as numerous about the same time at Hazelwood near Hunton Bridge, Redbourn, and Little Gaddesden. The brambling is one of the most uncertain and irregular of our winter visitants. Occasionally, as in the present year, it is met with in abundance in the Midland Counties; on the other hand, it is frequently absent for several years in succession. It has been appropriately described as a "gipsy migrant, perpetually trying to migrate northward with every appearance of milder weather, and perpetually driven southward with each recurring frost." It seems pretty certain that we are indebted to the very severe weather that prevailed early in the year for its visit to our county. Like most of our winter visitors, the brambling is met with abundantly throughout Scandinavia, Northern Russia, and Siberia. It breeds within the Arctic circle.

THE JAY (*Garrulus glandarius*).—The jay is reported by Dr. Brett to be so abundant in Oxhey Woods that quantities of its blue feathers are annually sent to Scotland for the manufacture of artificial flies for salmon-fishing.

THE ROOK (*Corvus frugilegus*).—Mr. R. B. Croft reports that rooks began to build near Ware about the 26th of February. Young birds were hatched on the 7th of April, and appeared strong on the wing by the 4th of May. Dr. Brett informs me that seventy-five young rooks were picked up dead, about the end of May, at the Wiggenhall Rookery, and he suggests that their death was caused by starvation, consequent on dry weather. It is possible that this may be a correct explanation of the occurrence, but I cannot find that similar mortality has prevailed at any of the other rookeries in the neighbourhood, and it is difficult to understand why drought should have been more destructive at Wiggenhall than elsewhere, especially when the situation of Wiggenhall, close to the river, is remembered. Mr. H. George Fordham reports that at Odsey Grange rooks commenced pairing about the 1st of February; they commenced to build on March 4th, and young birds were heard calling on the 10th of April. Rooks are notoriously pugnacious. At Odsey Grange a rook was seen to attack a small hawk when on the wing; and the Rev. J. A. Ewing writes from Westmill Rectory, 24th November, 1880, as follows: "Last Friday, as I was riding not far from home, I saw before me a white bird on the road, which on rising up proved to be a sea-gull. It was immediately attacked by some rooks, whose number must have increased to a hundred at least as it and they passed out of sight; it was strange that with its power of flight it should not have at once distanced them."

Lord Ebury has been kind enough to send me the following remarkable anecdote respecting rooks. I quote from his lordship's letter of the 18th of November. "My coachman witnessed a curious sight this afternoon. He was returning from Cassiobury on horseback and passing across the Moor, when the railway servant at the level crossing (Watford and Rickmansworth Railway) called his attention to a quantity of rooks, which, he said, had been '*mobbing a fox*' for some half-hour or so. He went to the place indicated, and found the unfortunate Reynard with these birds cawing vociferously and fluttering round him. On the coachman giving a loud halloa, his tormentors flew up and he made the best of his way to Long Valley Wood, where it is to be hoped he made his escape, but he was pursued by his antagonists till he disappeared among the bushes. I suppose the tradition has been handed down among the crows of one of their female ancestors, described by La Fontaine, being persuaded by an artful fox to drop a nice piece of cheese she held in her beak, upon the pretence of his desire to hear her *beautiful voice*. This is the revenge." In a subsequent letter Lord Ebury humorously writes as follows: "Since I last wrote it has been suggested that Reynard was wide awake all the time, and that he was merely cozening the birds in order to get one of them into his clutches, or perhaps he was acting as chairman or patron of one of their annual concerts. The railway man who watched this strange fraternization tells me that the fox actually laid himself down in order to pursuade his guests to give his friendship a trial." It has been suggested that the fox was wounded, but I am assured that such was not the case. The fact that he ran off to a wood directly the rooks were disturbed seems to contradict this hypothesis.

THE CARRION-CROW (*Corvus Corone*).—A carrion-crow is reported by Mr. D. Hill to have been seen near Pinner, and on the 8th of April a second was observed near St. Stephen's.

THE HOODED CROW (*Corvus Cornix*).—These crows have been again abundant in the neighbourhood of Odsey and Ashwell. They are reported by Mr. H. G. Fordham as seen on the 12th, 13th, and 14th of October; and also on the 9th of December, on which occasion six birds were observed. They have also been plentiful in the neighbourhood of Little Gaddesden and Studham. I am informed that hooded crows may always be observed at Ashridge on days subsequent to a shooting party. It is easy to understand the character of the attraction.

It appears to be more than doubtful whether the carrion and hooded crows are perfectly distinct species. It is certain that they interbreed freely. The fact is admitted by Yarrell,* and I may state in further confirmation of it, that I was recently shown a drawer full of the skins of crows shot by Mr. Henry Seebohm in Siberia. They were arranged in a series, and shaded off, by almost imperceptible degrees, from the jet black of the carrion to the well-known grey shoulders and body of the Royston bird.

THE SKYLARK (*Alauda arvensis*).—Reported by Mr. R. B. Croft as singing near Ware on January 2nd and 3rd, 1880, and by Mr. H. G. Fordham, as heard near Odsey, on January 3rd. On the 13th of January, 1881, a flock of skylarks numbering many thousands settled on a large field near Bennett's End, Hemel Hempstead. They crouched close to the ground, seemed tired, and were extremely tame. When frightened they rose on the wing for only a few seconds and again settled. Portions of the field appeared almost alive with them. I am informed that flights of similar extent were observed on the same day in the neighbourhoods of both Luton and Hitchin. It is probable that the very severe weather that occurred in the beginning of January had driven them in countless thousands southward, either from the north of Scotland or very probably from Norway or Sweden.

THE GREATER SPOTTED WOODPECKER (*Picus major*).—Reported by Mr. Platten as frequent in Hatfield Park.

THE GREEN WOODPECKER (*Gecinus viridis*).—Reported by Mr. Stannard, as observed at Hazelwood, near Hunton Bridge.

THE NIGHTJAR (*Caprimulgus europæus*).—On the 1st of September a nightjar was observed crouching on the ground in a meadow near Langley Road, Watford; and on the 18th of September one was shot by Mr. H. G. Fordham near Odsey.

THE KINGFISHER (*Alcedo Ispida*).—On February 20th, 1880, kingfishers were observed pairing at Hunton Bridge; and they have been tolerably abundant during the year. Mr. Abel H. Smith reports that a nest with eggs was found precisely in the same spot as mentioned last year.

THE STOCK-DOVE (*Columba Œnas*).—Mr. Abel H. Smith reports

* 'British Birds,' vol. ii, p. 86.

that stock-doves have been abundant at Woodhall Park, that they rear two broods during the year, and build in hollow trees. They commenced to lay eggs about the beginning of April, and half-fledged young birds were found in August. I have before reported that stock-doves are plentiful in Cassiobury Park.

The Rev. J. A. Ewing, of Westmill Rectory, Buntingford, informs me that stock-doves breed in a large gravel-pit at Westmill, the holes in which they nest being found at an elevation of 30 or 40 feet. Mr. Ewing has also been good enough to forward the following anecdote: "Some years ago the game-keeper at Coles Park put a ferret into a rabbits' burrow there, and strange to say, out came a fox, a rabbit, and a pair of stock-doves."

The Long-eared Owl (*Asio Otus*).—A fine specimen of the long-eared owl was shot last January near Hatfield.

The Short-eared Owl (*Asio accipitrinus*).—During January, 1881, short-eared owls were tolerably abundant in Hatfield Park, and several were shot. These birds generally frequent open fallows and heaths. Mr. H. G. Fordham reports that on November 6th he put up a pair several times from grassy fallows near Royston. "They rose from the grass within gun-shot, and flew but a short distance, circling round and settling, to be again put up. They were seen about the same fields on a subsequent occasion."

The Buzzard (*Buteo vulgaris*).—Mr. George Platten reports that a buzzard was shot in Hatfield Park in the year 1879, and I am informed by Mr. D. Hill, of Pinner, that one was captured in February, 1881, near Harpenden, by Mr. H. Cox.

The Hobby (*Falco Subbuteo*).—We are indebted to Mr. George Platten for information respecting the occurrence of the hobby, a bird that is at present very scarce in Hertfordshire. It seems that a hobby was shot during 1879 in Hatfield Park.

The Pheasant (*Phasianus Colchicus*).—Under this head it is my duty to record a singular circumstance reported by Mr. A. H. Longman's gamekeeper to have occurred at Shendish, near Hemel Hempstead. A pheasant having made her nest close to a public lane, the eggs were removed as they were laid, and when thirteen had been obtained, were placed under a domestic fowl for incubation. In due time eleven young pheasants were hatched, and it was soon noticed that every one of them was devoid of front toes. They were all, as nearly as possible, alike in their deformity, the tarsi terminating abruptly, with only the small back toe remaining. It is difficult to account for so singular a freak of nature. I inquired of the gamekeeper whether he thought it possible that either of the parent birds could have been caught in a trap or had its toes injured. He replied that he saw the hen-pheasant constantly and was quite certain that her toes were perfect; about the cock he could not speak quite so positively, but he believed that there was not a maimed bird on the estate. Nine of the young pheasants died within a few days of being hatched, two lived for several weeks, but could not be reared. I took the liberty of sending the particulars of this case to our distinguished honorary member, Charles Darwin, F.R.S., etc. In reply he writes as follows:—"The loss of a part or the whole of a limb by monstrosity is not very rare and most likely has been inherited. The most remarkable point about your case is, as I believe, the deformity being common to so many young birds; this renders it possible that we must look to the state of the parentage rather than to any treatment of the eggs as the cause of the monstrosity."

The Quail (*Coturnix communis*).—Quails have been unusually plentiful on the eastern side of the county. They are reported, by Mr. Hill, jun., to have been frequently observed in the neighbourhood of Hitchin, and by our excellent correspondent, Mr. H. G. Fordham, as abundant near Ashwell and Royston.

The Heron (*Ardea cinerea*).—I am informed by Mr. George Platten that a heron's nest, in which three young birds were hatched and brought up, was carefully observed in the vicinity of the Broadwater, Hatfield Park. I am not aware that, prior to this, herons have been known to breed within the limits of our county. If such has been the case, I am sure the Society would esteem as a favour any information respecting the locality selected. A pair of herons are again reported by Lord Ebury as frequenting the water at Moor Park, and Mr. H. Manser reports that two have been occasionly seen on the lake at Hoddesdon.

The Green Sandpiper (*Helodromas Ochropus*).—Mr. W. Hill, jun., informs me that the green sandpiper is a regular spring visitant near Ickleford, and that a few years ago one of these little waders paid a visit for a few weeks in the autumn to the public baths at Hitchin. It used to run round the edge of the baths, apparently in search of food.

The Common Snipe (*Gallinago gallinaria*).— Miss Selby reports that a large number of snipe were observed on the 27th of February, 1881, between Hatfield and Colney Heath. Flocks of snipe are not unusual during the periods of autumnal and spring migration, and it is probable that in this instance they were detained in their northern flight by the severity of the weather.

The Peewit or Lapwing (*Venellus cristatus*).—Unusually large flights of peewits have been observed in most parts of the county. They are reported by Lord Ebury as ocurring near Rickmansworth; by Mr. George Platten, near Hatfield; and by Mr. H. G. Fordham, near Odsey Grange.

The Water-Rail (*Rallus aquaticus*).—Reported by Lord Ebury as seen in Moor Park, and by Mr. George Platten as not uncommon in Hatfield Park.

The Crested Grebe (*Podiceps cristatus*).—A specimen of the crested grebe was shot at Headstone, near Pinner, by Mr. D. Hill. It is a rare bird, but has been reported as occurring in the county on two previous occasions since the commencement of our register.

The Tufted Duck (*Fuligula cristata*).—A young drake hardly in full plumage is reported by Mr. Henry Manser as frequenting the lake at Hoddesdon during the winter of 1880–81.

The Pochard (*Fuligula ferina*).—A pair of pochards was shot by

Mr. Roffe on the 28th of January, 1880, at Garston, near Watford, and a pair is reported by Mr. Henry Manser as frequenting the Hoddesdon lake during the past winter.

General Remarks.—I have again to report a continued paucity of small birds. Wet summers and the extreme severity of succeeding winters satisfactorily account for this fact. The occurrence of several raptorial birds, only occasional visitors in our county, may probably be considered the most notable feature of the year. I may mention that two common buzzards, one rough-legged buzzard, a hobby, an osprey, one long-eared owl, and several short-eared owls have been reported. Bullfinches were very abundant last January, their brilliant plumage being conspicuous along almost every hedge-row. It seems to be certain that several birds that do not rank among migrants, are semi-migrant in their habits, and that, in fact, they migrate in flocks from one part of England to another. Bullfinches must, I think, be classed among this number. A considerable immigration to our district appears to have taken place at the commencement of the present year.

May I be allowed a word or two about wagtails. Only three species have yet been identified, the "pied" which is the commonest of all, the "grey," and the "yellow" or "Ray's wagtail." It is more than probable that two others, the "white," and the "grey-headed," ought to be recorded. There is considerable difficulty in distinguishing these from the birds first mentioned. Mr. Harting has defined the distinctions as follows * :—"The particular respects in which the white wagtail differs from its congeners are noticeable chiefly in the summer, or breeding plumage, when the former has a black cap clearly defined against a grey back, while in the latter the black colour of the head merges in the black of the dorsal plumage and no such cap is discernible." The grey-headed "differs chiefly from Ray's wagtail in having a well-defined cap of a grey colour on the head, a white instead of a yellow streak over the eye, and a white chin instead of a yellow one." All the wagtails are said to be migrants, but the grey is certainly a constant resident at Hunton Bridge.

In conclusion I have once more cordially to thank my numerous correspondents for their welcome contributions. I will also take the liberty of stating that I propose to give in the Hertfordshire newspapers a list of birds not as yet reported to our Society, but which in all probability ought to be found within our district; also a second list of sundry birds that have been reported only occasionally, and about which additional information is very desirable. Notes respecting any of these species will be most acceptable.

* 'Summer Migrants,' pp. 110 and 121.

XXXII.

METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, DURING THE YEAR 1880.

By John Hopkinson, F.L.S., F.M.S., etc., Hon. Sec.

Read at Watford, 19th April, 1881.

Longitude of station, 0° 23′ 40″ W.; Latitude, 51° 39′ 45″ N. Ground-level at thermometer-stand and rain-gauge 223 feet, and cistern of barometer 233½ feet, above Ordnance Datum.

Observations having been taken in 1880 in the same manner as in previous years, it will be unnecessary to repeat here the particulars given in previous reports.* The accompanying tables (pp. 252, 253) give the monthly means of the daily observations and of other results deduced from them; and from these tables, and for December, 1879, those in the previous report, the following summary of the principal results for the different seasons is deduced.

Watford.

Seasons, 1879-80.	Mean Pressure.	Mean Temperature.	Mean Daily Range.	Tension of Vapour.	Relative Humidity	Rainfall.
	ins.	°	°	in.	°/₀	ins.
Winter	30·185	34·5	12·2	·177	89	4·56
Spring	30·040	48·0	17·4	·252	76	4·14
Summer	29·954	60·3	15·1	·420	80	8·08
Autumn	29·963	48·7	14·0	·309	87	13·68

For comparison the results of observations at the Greenwich Observatory are computed as in former reports.

Greenwich.

Seasons, 1879-80.	Mean Pressure.	Mean Temperature.	Mean Daily Range.	Tension of Vapour.	Relative Humidity	Rainfall.
	ins.	°	°	ins.	°/₀	ins.
Winter	30·173	35·8	10·5	·185	87	3·2
Spring	30·025	48·0	18·0	·260	78	3·3
Summer	29·931	62·0	18·3	·432	82	7·1
Autumn	29·943	49·5	14·2	·314	87	13·8

The weather of the year 1880, as experienced at Watford, was of a very similar character to that of 1878. The mean temperature of the two years was practically the same, the difference being only one-tenth of a degree, and neither the mean minimum, mean maximum, nor mean daily range differed by more than half a degree.

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 217, and Vol. II, p. 209.

Results of Meteorological Observations taken at Wansford House, Watford, in 1880.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°		°	°	°	°	in.	%
January	30·406	31·1	27·1	37·4	31·9	10·3	11·2	21st	54·4	1st	43·2	2·6	·156	90
February	29·825	40·7	34·5	47·5	40·9	13·0	24·0	2nd	54·5	18th	30·5	3·0	·226	89
March	30·126	43·5	35·7	53·4	44·2	17·7	22·8	29th	62·1	26th	39·3	5·7	·227	80
April	29·892	47·2	39·5	54·2	47·0	14·7	32·2	8th	66·4	19th	34·2	6·6	·253	78
May	30·102	52·9	41·9	61·8	52·2	19·9	30·4	1st	81·7	26th	51·3	10·0	·276	69
June	29·932	58·0	48·9	65·4	57·4	16·5	35·3	5th	74·8	30th	39·5	6·3	·383	80
July	29·914	61·7	54·1	68·7	61·5	14·6	47·6	31st	75·2	23rd	27·6	6·7	·433	79
August	30·017	61·5	55·0	69·3	61·9	14·3	47·5	3rd	78·4	28th	30·9	5·8	·444	82
September	30·001	59·5	52·4	67·9	59·9	15·5	43·2	20th	86·2	4th	43·0	4·7	·430	84
October	29·904	45·5	39·3	52·5	45·8	13·2	26·0	24th	62·9	5th	36·9	3·2	·270	89
November	29·985	41·1	34·5	47·8	41·1	13·3	19·9	22nd	56·5	13th	36·6	3·2	·228	88
December	29·946	41·2	36·3	46·4	41·3	10·1	26·0	22nd	55·3	10th	29·3	2·7	·233	90
Year	30·004	48·7	41·6	56·0	48·8	14·4	11·2	Jan. 21	86·2	Sept. 4	75·0	5·0	·297	83

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, IN 1880—(*continued*).

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of Days of		Mean Amount 0–10.	No. of Days of		Mean Force 0–12	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow.		Clear Sky.	Over-cast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	·37	·19	16th	6	5	7·9	4	21	1·5	4	4	5	3	2	6	1	3	3
February	3·39	·70	20th	19	0	8·0	2	12	2·1	1	1	0	4	6	5	6	4	2
March	1·22	·55	31st	5	0	5·9	7	9	2·3	3	9	7	5	0	3	1	2	1
April	2·46	·47	14th	17	0	7·2	2	11	2·1	1	10	2	3	2	6	1	4	1
May	·46	·24	31st	6	0	6·0	7	10	1·9	4	15	2	1	1	3	3	2	0
June	3·06	·91	14th	20	0	7·7	0	15	1·3	7	4	2	1	1	5	3	4	3
July	4·52	·57	14th	22	0	6·7	3	9	1·4	4	1	2	1	3	12	5	3	0
August	·50	·20	7th	6	0	8·0	3	13	1·2	11	7	0	0	2	3	1	5	2
September	5·30	1·89	14th	10	0	6·4	4	12	1·7	1	3	2	5	2	6	3	5	3
October	5·83	1·23	6th	20	4	6·8	7	14	1·8	6	10	2	0	3	3	2	3	2
November	2·55	·60	15th	14	1	5·6	9	11	1·9	5	4	0	2	4	8	2	4	1
December	3·69	·55	29th	17	2	7·5	3	14	1·1	2	1	1	1	2	10	7	3	4
Year	34·35	1·89	Sept. 14	162	12	7·0	51	151	1·7	49	69	25	26	28	70	35	42	22

The mean thermometric dryness, also, was within half a degree in the two years, and the total rainfall differed by less than one-tenth of an inch. While, however, 1878 commenced with warm and ended with cold weather; in 1880, on the contrary, January was an exceptionally cold month, and December was exceptionally warm, its mean temperature being higher than that of November; and although the total fall of rain in the two years may be said to have been identical, in 1880 it was more unevenly distributed, there having been three months each with less than half an inch of rain and averaging but 0·44in., while in 1878 there was no month with less than an inch, and the three driest months averaged 1·27in.

Compared with 1879 the year 1880 was not nearly so universally wet, gloomy, and cold; the temperature indeed was considerably higher, and although the mean amount of cloud recorded was but slightly less than in 1879, the sky was much more frequently perfectly free from cloud and less often completely overcast. Although also the total rainfall in 1880 was not much less than in 1879, the number of days on which rain fell was considerably less. In each of these years the atmosphere was humid; in each also there was a marked preponderance of both north-easterly and south-easterly winds. While, however, in 1879 the mean pressure of the atmosphere was about the average or rather below it; in 1880, chiefly during the earlier months, it was very high, and this perhaps may be considered the most exceptional feature in the year.

In the winter of 1879-80 (December to February) the mean pressure was unusually high, the mean temperature low, the humidity great, and the rainfall below the average. In the spring (March to May) the mean pressure was again high, the mean temperature rather high, and the humidity and rainfall below the average. In the summer (June to August) the mean pressure and mean temperature were about the average or a little below it, the humidity great (for the summer months), and the rainfall slightly above the average. In the autumn (September to November) the mean pressure was about the average, the mean temperature low, the humidity rather great, and the rainfall the heaviest which is known to have been recorded at Watford.

In the following notes the general character of the weather in each month, and its principal changes are briefly referred to.

January.—The coldest month in the year by nearly 10°, and with the least rainfall, either as rain or snow; only once was there rain without snow (0·02 in. on 7th). The first two days were very warm (mean 50°·1, max. 54°·3, min. 44°·9); the next three colder (mean 38°·0, max. 47°·9, min. 31°·5); then followed a very cold period lasting to 29th, max. never reaching quite 39°, and min. falling below 22° on eight days, and only once (6th) as high as 32°; the last two days were warmer (mean 34°·6, max. 51°·6, min. 20°·1). Max. above 42° on 6 days, above 52° on 1; min. below 32° on 26, below 22° on 8, and below 12° on 1. Pressure, generally high, reached 30·694 ins. on 7th, and 30·677 ins. on 21st. Wind northerly to E. from 10th to 28th.

FEBRUARY.—Mild and wet, the first month since Oct. 1878 with the mean temperature appreciably above the average, and the first wet month since Sept. 1879. The first six days were the coldest (mean 34°·0, max. 51°·7, min. 24°·0). Max. above 52° on 4 days; min. below 32° on 11. Pressure, generally low, sank from 30·251 ins. on 13th to 29·022 ins. on 16th, the only rapid change. From commencement of depression rain fell every day for ten days (14th to 23rd) exceeding half an inch on 16th and 20th. Wind southerly first three weeks and then westerly. Hail fell on 8th, and also on 20th during a thunderstorm.

MARCH.—Mild, dry, and very bright, and with no decided change in temperature. Max. above 52° on 19 days, above 62° on 1; min. below 32° on 7. Pressure also more equable than usual. Rain fell only on 1st, 2nd, 3rd, 7th, and 31st. N. and E. winds prevailed after 7th, and westerly before. The early part of the month was stormy, especially 2nd and 3rd.

APRIL.—Dull, wet, and stormy, and with an equable temperature, except on three days, 17th to 19th, which were much warmer than the rest (mean 54°·1, max. 66°·4, min. 34°·3). Max. above 52° on 19 days, above 62° on 2; min. below 42 on 22°. Pressure, from a min. of 29·277 ins. on 6th, increased to 30·268 ins. on 9th, the only rapid change. Rain fell every day to 9th, and on eight days afterwards. Hail fell on 1st, 6th (during a thunderstorm), 8th, and 20th. The wind was due N.E. every day from 9th to 15th, and from 26th to 30th.

MAY.—Bright and very dry, both as to the amount of rainfall and presence of moisture in the air. On 20th temperature rose decidedly.

19th	mean 47°·6	max. 60°·3	min. 31°·7
17th to 19th	,, 48°·2	,, 60°·3	,, 31°·7
20th	,, 54°·5	,, 64°·4	,, 49°·2
20th to 22nd	,, 57°·8	,, 72°·8	,, 46°·6

Towards the end of the month it became rather cooler. Max. above 62° on 13 days, above 72° on 4; min. below 32° on 3. The max. on 26th (81°·7) is remarkably high for May. No rain fell between 10th and 27th. Wind N.E. every day from 1st to 18th.

JUNE.—Wet, dull, and with a humid atmosphere. Temperature, slightly higher after 12th than before, rose again on 18th. Max. above 72° on 4 days; min. below 42° on 4. Rain fell every day except 10th to 13th, 17th, 20th, 21st, and 27th to 29th. Thunderstorms occurred on the afternoon or evening of four successive days, 23rd, 24th, 25th, and 26th.

JULY.—Very wet, and humid. Temperature rose about the 12th, and fell decidedly on 30th, the mean of that and following day being 4°·1 below that of the month. Max. above 72° on 5 days; min. below 52° on 9. Rain fell every day except 4th, 5th, 10th, 16th, 20th to 23rd, and 27th. Thunder was frequently heard, and thunderstorms occurred on 14th, 17th, and 18th. On the 21st there was a very severe thunderstorm at St. Albans, with heavy rain; at Watford thunder was heard, but no rain fell.

AUGUST.—Warm, dull, and with very little rain. The first two days only were cold, their mean being 4°·3 below that of the month. Max. above 72° on 12 days; min. below 52° on 7. Pressure was unusually high; never as low as $29\frac{1}{2}$ ins. The wind was northerly from the 8th to the end of the month, and due N. from 12th to 20th. On the night of the 7th there was a heavy gale of wind.

SEPTEMBER.—Very wet, but bright, the rain being due more to storms than settled wet weather. The first twelve days were very warm, but a cold period set in on the 13th, lasting to the 25th; the 26th and 27th were warmer (mean 62°·9); and the last three days colder (mean 55°·5), with fogs and heavy dews. Max. above 72° on 6 days, above 82° on 2; min. below 52° on 15. From the 11th to the 15th (five days) 4·79 ins. of rain fell. Hail, with heavy rain, fell at 2·30 p.m. on the 18th.

OCTOBER.—Cold, very wet, and with a humid atmosphere, not, however, very cold until the 15th, when the first frost was recorded, except a ground frost on the 4th. Max. above 62° on 2 days; min. below 32° on 6. Rain fell every day from 4th to 10th (3·23 ins.), rain or snow every day from 18th to 22nd (0·80 in.), and rain every day from 25th to 29th (1·61 in.). A few flakes of snow fell as early as the 4th. On the 19th and 20th there was a very heavy fall, almost unprecedented for October. North-easterly (N. to E.) winds prevailed to 24th, and S. or S.W. afterwards.

NOVEMBER.—Very bright, rather windy, and with very decided alternations of temperature, dividing the month into two cold and two warm periods.

1st to 11th	mean 38°·5	max. 51°·7	min. 26°·4
12th to 16th	,, 48°·2	,, 56°·4	,, 38°·2
17th to 23rd	,, 31°·1	,, 48°·8	,, 19°·9
24th to 30th	,, 44°·9	,, 55°·2	,, 32°·9

Max. above 52° on 6 days; min. below 32° on 12. Pressure decreased to 28·860 ins. on 16th, increasing to 30·472 ins. on 21st.* Rain fell daily from 10th to 16th (1·31 in.) and from 23rd to 27th (0·62 in.). A fine aurora was observed on the evening of the 3rd.

DECEMBER.—Wet, dull, and with a humid atmosphere, and with as decided alternations of temperature as November, but the changes more frequent.

MEAN TEMPERATURE.

1st to 3rd	37°·3	12th to 16th	43°·6	25th to 27th	34°·2
4th to 10th..	47°·1	17th to 22nd	36°·2	28th and 29th..	47°·6
11th	38°·0	23rd and 24th..	46°·2	30th and 31st..	33°·6

Max. above 52° on 4 days; min. below 32° on 7. Pressure on the 7th was as high as 30·650 ins., the highest since January 21st. To the 12th no rain fell (except 0·01 in. on 1st); from the 13th rain or snow fell every day except 7th, 24th, and 25th. S.W. winds generally prevailed.

* At 11 p.m. on 18th the mercury stood at 28·819 ins., and at 11 p.m. on 20th it had risen to 30·431 ins.; 1·612 ins. in 48 hours.

XXXIII.

REPORT ON PHENOLOGICAL OBSERVATIONS IN HERTFORDSHIRE IN 1880.

By John Hopkinson, F.L.S., F.M.S., Hon. Sec.

Read at Watford, 19th April, 1881.

It is with much satisfaction that I have again to record an increase in the number of observers of Phenological Phenomena, and in the number of localities at which observations are made. In 1879 we had eight localities represented by ten observers, only seven of whom, however, recorded the dates of flowering of plants, each representing one locality. In 1880 regular observations have been taken by three additional observers, and two localities, Hoddesdon, and Great Hormead near Buntingford, have been added to our list of phenological stations. Occasional observations have also been made at some other places, and the total number of our observers has now reached twenty-one. From some of these, however, only two or three returns have been received.

Outline-Map of Hertfordshire, showing Phenological Stations and Places at or near to which Observers are required.

Phenological Stations ● Other Places ○

The latitudes and longitudes of the phenological stations shown above, and from which returns are entered in the tables, are as follow :—

	N. Lat.	Long.		N. Lat.	Long.
Watford ...	51° 39′	0° 24′ W.	Hoddesdon ...	51° 46′	0° 1′ W.
Hunton Bridge	51 41	0 26 W.	Hailey Hall ...	51 47	0 1 W.
Berkhampstead	51 45½	0 34 W.	Hertford	51 48	0 5 W.
St. Albans ...	51 45	0 20 W.	High Wych ...	51 48½	0 8 E.
South End ...	51 47	0 24 W.	Fanhams Hall...	51 49	0 1 W.
Redbourn Bury	51 47	0 23 W.	Great Hormead	51 57	0 2 E.
Harpenden ...	51 48½	0 21 W.	Throcking ...	51 52	0 3 W.
Kimpton ...	51 51	0 18 W.	Odsey	51 1½	0 7 W.

Dates of Flowering of Plants observed in 1880.

No.	Species.	Watford.	St. Albans, 1.	St. Albans, 2.	Harpenden.	Hoddesdon.	Hertford.	Ware.	High Wych.	Hormead.	Odsey.
1.	*Anemone nemorosa*	Mar. 21	Mar. 13	Mar. 18	Mar. 21	Mar. 8	Mar. 8	Mar. 13	.....	Mar. 27	.....
2.	*Ranunculus Ficaria*	Mar. 1	Mar. 13	Mar. 1	Mar. 13	.....	Mar. 1	Mar. 11	.....	Mar. 14	.....
3.	*Ranunculus acris*	Apl. 18	.....	.....	Apl. 21	.....	Apl. 9	.....	.....	.....	.....
4.	*Caltha palustris*	Mar. 20	Mar. 20	Mar. 31	Apl. 9	Apl. 1	Apl. 3	Apl. 17	.....	.....	.....
5.	*Papaver Rhœas*	June 3	.....	June 5	June 7	.....	May 29	June 13	.....	June 11	June 7
6.	*Cardamine hirsuta*	.....	.....	.....	Mar. 25	Mar. 15	Mar. 10	.....	.....	.....	.....
7.	*Cardamine pratensis*	Apl. 11	Apl. 2	Apl. 10	Apl. 18	Apl. 7	Apl. 11	Apl. 24	.....	Apl. 22	.....
8.	*Draba verna*	.....	.....	.....	Apl. 20	.....	Apl. 4	.....	.....	Apl. 21	.....
9.	*Viola odorata*	Mar. 10	.....	Apl. 15	Apl. 17	Apl. 15	Apl. 6	Apl. 6	.....	Feb. 22	Apl. 8
10.	*Polygala vulgaris*	May 8	.....	.....	June 14	.....	May 15	.....	.....	.....	Apl. 25
11.	*Lychnis Flos-cuculi*	May 25	.....	May 22	May 26	.....	May 25	May 30	June 6	June 11	.....
12.	*Stellaria Holostea*	Apl. 16	Apl. 19	Apl. 17	Apl. 21	Apl. 16	.....	Apl. 19	.....	Apl. 26	.....
13.	*Malva sylvestris*	May 25	.....	May 22	May 26	.....	May 25	May 30	June 6	June 9	.....
14.	*Hypericum tetrapterum.*	July 7	.....	.....	July 20	.....	July 5	.....	July 8	.....	.....
15.	*Hypericum pulchrum*	June 28	.....	June 29	July 14	.....	.....	.....	.....	.....	.....
16.	*Geranium Robertianum*	Apl. 24	.....	May 1	May 10	Apl. 23	Apl. 27	Apl. 20	.....	Apl. 27	May 17
17.	*Trifolium repens*	May 15	.....	May 24	May 25	.....	May 14	May 24	.....	May 27	.....
18.	*Lotus corniculatus*	May 25	.....	June 4	May 27	.....	May 15	May 23	.....	May 20	.....
19.	*Vicia Cracca*	June 24	.....	.....	.....	.....	June 10	June 17	.....	June 25	.....
20.	*Vicia sepium*	May 2	Apl. 29	May 14	Apl. 27	.....	Apl. 28	May 8	.....	Apl. 28	.....
21.	*Lathyrus pratensis*	.....	.....	June 14	June 17	.....	June 6	.....	.....	May 27	.....
22.	*Prunus spinosa*	Apl. 6	.....	Apl. 15	Apl. 17	Apl. 15	Apl. 6	Apl. 6	.....	.....	Apl. 8
23.	*Spiræa Ulmaria*	June 20	.....	June 26	June 21	.....	June 15	July 5	June 24	June 23	.....
24.	*Potentilla anserina*	May 18	.....	May 14	May 15	.....	May 19	May 7	.....	May 7	Apl. 30
25.	*Potentilla Fragariastrum*	Mar. 15	Mar. 13	Mar. 20	Mar. 25	.....	.....	Apl. 1	.....	Mar. 31	.....
26.	*Rosa canina*	June 9	.....	June 10	June 8	.....	June 6	June 13	.....	June 12	June 5
27.	*Epilobium hirsutum*	June 24	.....	July 2	July 13	.....	July 8	July 8	July 10	July 19	.....
28.	*Epilobium montanum*	June 14	.....	June 23	June 21	.....	June 6	.....	.....	June 23	.....
29.	*Angelica sylvestris*	.....	.....	.....	.....	.....	.....	.....	.....	July 28	.....
30.	*Anthriscus sylvestris*	Apl. 17	.....	Apl. 24	Apl. 8	.....	Apl. 19	Apl 17	.....	Apl. 17	Apl. 20
31.	*Hedera Helix*	Sept. 18	.....	.....	Sept. 20	.....	.....	.....	Sept. 13	Oct. 4	.....
32.	*Galium Aparine*	May 22	.....	May 19	May 25	.....	May 15	May 8	.....	.....	June 6
33.	*Galium verum*	July 3	.....	July 5	June 28	.....	June 25	.....	.....	July 6	July 13

34.	*Dipsacus sylvestris*	.....	.....	.....	.....	.....	.....	July 27	.....	.....	.....
35.	*Scabiosa succisa*	July 18	.....	.....	.....	.....	.....	.....	.....	.....	.....
36.	*Petasites vulgaris*	.....	.....	.....	.....	.....	Mar. 18	.....	.....	.....	.....
37.	*Tussilago Farfara*	Feb. 28	Mar. 3	Mar. 4	Mar. 17	.....	Mar. 1	Feb. 28	.....	Mar. 25	Feb. 29
38.	*Achillea Millefolium*	June 28	.....	July 21	July 5	.....	July 7	.....	June 28	July 6	.....
39.	*Chrysanthemum Leucan.*	May 13	.....	May 28	May 26	.....	May 14	May 29	.....	June 3	.....
40.	*Artemisia vulgaris*	.....	.....	.....	.....	.....	.....	.....	Aug. 7	Aug. 16	.....
41.	*Senecio Jacobæa*	July 3	.....	July 9	July 10	.....	June 25	.....	.....	July 23	July 8
42.	*Centaurea nigra*	June 28	.....	July 10	July 5	.....	July 4	June 25	June 30	June 18	.....
43.	*Carduus lanceolatus*	June 12	.....	.....	.....	.....	June 21	.....	June 24	.....	.....
44.	*Carduus arvensis*	June 24	.....	.....	July 14	.....	June 11	June 13	.....	July 19	.....
45.	*Sonchus arvensis*	.....	.....	.....	July 29	.....	July 6	.....	.....	July 17	.....
46.	*Hieracium Pilosella*	May 16	.....	May 18	May 16	.....	May 12	.....	.....	May 26	.....
47.	*Campanula rotundifolia*	July 10	.....	July 19	July 21	.....	July 8	July 10	.....	July 23	.....
48.	*Gentiana Amarella*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
49.	*Convolvulus sepium*	June 12	.....	July 16	July 20	.....	July 8	July 2	July 10	.....	.....
50.	*Symphytum officinale*	May 3	.....	.....	.....	.....	Apl. 26	May 10	.....	June 9	.....
51.	*Pedicularis sylvatica*	May 3	.....	.....	.....	.....	May 4	.....	.....	.....	.....
52.	*Veronica Chamædrys*	Apl. 19	.....	Apl. 30	May 1	Apl. 23	Apl. 16	Apl. 19	.....	Apl. 29	Apl. 21
53.	*Veronica hederifolia*	.....	.....	Mar. 4	Mar. 27	.....	Feb. 25	.....	.....	Apl. 8	.....
54.	*Mentha aquatica*	.....	.....	.....	.....	.....	.....	.....	Aug. 4	July 28	.....
55.	*Thymus Serpyllum*	.....	.....	June 22	July 13	.....	June 21	.....	.....	.....	June 6
56.	*Prunella vulgaris*	June 15	.....	June 19	.....	.....	June 25	July 5	June 24	July 5	.....
57.	*Nepeta Glechoma*	Mar. 28	Mar. 26	Mar. 25	Mar. 25	Mar. 26	Apl. 8	Mar. 28	.....	Mar. 28	Mar. 28
58.	*Galeopsis Tetrahit*	July 3	.....	.....	July 31	.....	July 1	.....	.....	July 24	.....
59.	*Stachys sylvatica*	June 6	.....	.....	June 7	.....	May 29	.....	June 16	June 9	.....
60.	*Ajuga reptans*	Apl. 25	.....	May 8	May 3	.....	Apl. 24	.....	.....	Apl. 27	.....
61.	*Primula veris*	Apl. 1	Apl. 2	Mar. 26	Mar. 25	Mar. 29	Apl. 1	Mar. 31	.....	Mar. 29	Mar. 26
62.	*Plantago lanceolata*	Apl. 24	.....	Apl. 29	Apl. 23	.....	Apl. 19	Apl. 20	.....	.....	.....
63.	*Mercurialis perennis*	Mar. 3	.....	Mar. 1	Mar. 24	.....	Mar. 8	Mar. 4	.....	Mar. 4	.....
64.	*Ulmus montana*	.....	Mar. 12	.....	Mar. 6	.....	Mar. 4	.....	.....	.....	.....
65.	*Salix caprea*	Mar. 10	Mar. 7	.....	Mar. 14	Mar. 10	Mar. 9	Mar. 11	.....	.....	.....
66.	*Corylus Avellana*	Feb. 22	Mar. 13	Mar. 5	Feb. 20	.....	Feb. 17	Feb. 27	.....	.....	.....
67.	*Orchis maculata*	.....	.....	.....	.....	.....	June 1	June 13	.....	June 3	.....
68.	*Iris Pseudacorus*	June 6	.....	June 17	June 11	.....	May 31	.....	.....	.....	.....
69.	*Narcissus Pseudo-narcis.*	Mar. 10	Mar. 20	Mar. 25	Mar. 19	.....	Mar. 16	Mar. 13	.....	.....	Mar. 13
70.	*Galanthus nivalis*	Feb. 15	Jan. 28	Feb. 3	Feb. 20	.....	Feb. 14	Feb. 17	.....	Feb. 22	Feb. 17
71.	*Endymion nutans*	Apl. 25	Apl. 29	Apl. 20	Apl. 4	.....	Apl. 27	Apl. 24	.....	.....	May 3

Dates of Observations of Insects, Birds, etc., in 1880.

No.	Species.	Watford.	St. Albans, 1.	St. Albans, 2.	Harpenden.	Hoddesdon.	Hertford, 1.	Hertford, 2.	Ware.	Throcking.	Odsey.
72.	*Melolontha vulgaris* ap.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
73.	*Rhizotrogus solstitialis* ap.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
74.	*Apis mellifica* ap.	.....	Jan. 28	.....	.....	.....	Feb. 23	.....	Feb. 3	Jan. 31	Mar. 7
75.	*Pieris Brassicæ* ap.	Apl. 19	.....	.....	Apl. 30	.....	.....	.....	.....	.....	.....
76.	*Pieris Rapæ* ap.	Feb. 26	Apl. 22	Mar. 29	.....	.....	Mar. 25	.....	Apl. 17	.....	.....
77.	*Epinephile Janira* ap.	.....	.....	.....	.....	.....	May 24	.....	.....	.....	.....
78.	*Bibio Marci* ap.	Apl. 25	.....	.....	.....	.....	.....	.....	.....	.....	.....
79.	*Trichocera hiemalis* ap.	Jan. 30	.....	.....	.....	.....	.....	.....	.....	.....	.....
80.	*Strix Aluco* hoots	.....	.....	.....	Mar. 24	.....	.....	.....	.....	.....	.....
81.	*Muscicapa grisola* seen	.....	.....	.....	.....	.....	.....	.....	.....	.....	May 30
82.	*Turdus musicus* sg.	.....	.....	.....	Jan. 17	.....	.....	.....	Feb. 7	Feb. 12	.....
83.	*Turdus pilaris* arrives	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
84.	*Daulias Luscinia* sg.	Apl. 12	Apl. 22	Apl. 19	Apl. 18	Apl. 17	Apl. 17	.....	Apl. 19	.....	Apl. 19
85.	*Saxicola Œnanthe* returns	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
86.	*Phylloscopus Trochilus* sg.	.....	.....	.....	.....	.....	.....	Apl. 22	.....	.....	May 15
87.	*Phylloscopus collybita* sg.	.....	.....	.....	.....	Mar. 16	.....	Apl. 1	Apl. 3	.....	.....
	—— last heard	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
88.	*Alauda arvensis* sg.	.....	Feb. 2	.....	Jan. 17	.....	Feb. 2	.....	Jan. 3	Jan. 31	Jan. 3
89.	*Fringilla cœlebs* sg.	.....	.....	.....	.....	.....	.....	.....	Feb. 7	Jan. 31	.....
90.	*Corvus frugilegus* builds	.....	Mar. 6	Mar. 14	Mar. 5	.....	Feb. 17	.....	Feb. 21	.....	Mar. 4
91.	*Cuculus canorus* heard	Apl. 12	Apl. 22	.....	Apl. 16	Apl. 19	Apl. 26	Apl. 23	Apl. 21	.....	Apl. 23
	—— changes its note	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
92.	*Hirundo rustica* seen	Apl. 18	Apl. 15	Apl. 22	Apl. 15	Apl. 16	Apl. 15	Apl. 18	Apl. 19	.....	Apl. 20
	—— begins to flock	.....	.....	.....	.....	.....	Aug. 6	.....	.....	.....	.....
93.	*Cypselus Apus* seen	.....	May 13	.....	May 15	.....	.....	May 8	May 13	.....	May 13
94.	*Columba Turtur* seen	.....	May 14	.....	.....	.....	.....	.....	.....	.....	May 12
95.	*Perdix cinerea* hatches	.....	.....	.....	.....	.....	.....	.....	June 11	.....	.....
96.	*Scolopax Rusticola* seen	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
97.	*Rana temporaria* spawns	.....	.....	.....	.....	Mar. 10	Mar. 9	.....	Mar. 11	.....	.....

These places very fairly represent the county, being spread over the northern, southern, eastern, western, and central districts; but there are, nevertheless, other localities from which it would be desirable to have returns. In the extreme south-east of Hertfordshire observers are required in the neighbourhood of Barnet, and also near Waltham Cross or Cheshunt; and in the north-west it would be an advantage to have observers at or near Tring, Kensworth, Hitchin, and Stevenage.

The time of flowering of seventy species of plants, a larger number than in any previous year, has been observed in the county. The total number of species selected by the Meteorological Society for observation is seventy-one, one species only, *Gentiana campestris*, having thus escaped observation. For this, in my report for 1878, I suggested that *Gentiana Amarella* should be substituted, for reasons then explained, but no observations of this species have yet been recorded.

Of these 70 species we observed 57 at or near Watford; 16 were observed in the neighbourhood of St. Albans by Mr. George Willshin (South End), and 47 by Mrs. Arnold (Redbourn Bury); 58 were observed at Harpenden by Mr. Willis; 12 at Hoddesdon by Miss A. Warner; 61 at Hertford by Mr. R. T. Andrews; 13 at High Wych, near Sawbridgeworth, by Miss Simpson; 42 near Ware by Mr. R. B. Croft (Fanhams Hall); 48 at Great Hormead, near Buntingford, by the Rev. J. S. ffoster Chamberlain; and 19 at Odsey, by Mr. H. George Fordham. These observations are all recorded in the table on pp. 258, 259.

In the following supplementary table are recorded 7 observations at Watford by (1) Dr. Brett, and 7 by (2) Mrs. Joseph Hill; 3 at Berkhampstead by Mr. A. S. Eve; and 5 at St. Albans by (1) Mr. A. E. Gibbs, and 3 by (2) Miss Rose White.

No.	Species.	Watford, 1.	Watford, 2	Berkhampstead.	St. Albans, 1.	St. Albans, 2.
1	*Anemone nemorosa*	Mar. 22	.....	.....	Mar. 13	Mar. 23
2	*Ranunculus Ficaria*	Mar. 1	Mar. 12	.....	.....	.....
4	*Caltha palustris*	Mar. 20	.....	.....	Mar. 20	.....
12	*Stellaria Holostea*	Apl. 19	.....	Apl. 28	.....	.....
16	*Geranium Robertianum*	.....	May 1	.....	.....	.....
22	*Prunus spinosa*	.....	.....	Apl. 15	.....	.....
25	*Potentilla Fragariastrum*	Mar. 28	Apl. 1	Apl. 7	.....	Mar. 18
37	*Tussilago Farfara*	.....	.....	.....	Mar. 7	.....
52	*Veronica Chamædrys*	.....	May 1	.....	.....	.....
57	*Nepeta Glechoma*	.....	.....	.....	Mar. 26	Mar. 28
61	*Primula veris*	.....	Apl. 1	.....	.....	.....
65	*Salix caprea*	.....	Mar. 12	.....	Mar. 7	.....
61	*Narcissus Pseudo-narcis.*	Mar. 10	Mar. 15	.....	.....	.....
71	*Endymion nutans*	May 1	.....	.....	.....	.....

Of the 26 species of insects and birds, etc., in the list, 20 have been observed during the year, this being, as in the case of the plants, a larger number than in any previous year.

The accompanying table (p. 260) gives the dates of our observations of 7 species at Watford; the observations of 9 at St. Albans by (1) Mr. George Willshin, and 4 by (2) Mrs. Arnold; of 9 at Harpenden by Mr. Willis; of 5 at Hoddesdon by Miss Warner; of 10 at Hertford by (1) Mr. Andrews, and 5 by (2) Mr. R. W. Brett; of 13 at Ware by Mr. Croft; of 4 at Throcking near Buntingford by the Rev. C. W. Harvey; and of 10 at Odsey by Mr. Fordham.*

In the following supplementary table are recorded 3 observations at Watford by (1) Mrs. Joseph Hill, and 4 by (2) the late Mr. Jonathan King; 3 at Hunton Bridge by Mr. J. E. Littleboy; 3 at Kimpton, near Welwyn, by the Rev. T. D. Croft; and 3 at Hertford by Mr. H. C. Heard (Hailey Hall).

No.	Species.	Watford, 1.	Watford, 2.	Hunton Bridge.	Kimpton.	Hertford.
74.	*Apis mellifica* ap.	.....	.....	.....	Feb. 2	.....
76.	*Pieris Rapæ* ap.	Mar. 29	.....	.....	.....	.....
82.	*Turdus musicus* sg.	.....	.....	.....	Feb. 10	.....
84.	*Daulias Luscinia* sg.	.....	Apl. 16	Apl. 17	.....	Apl. 16
87.	*Phylloscopus collybita* sg.	Mar. 12	Mar. 13	Apl. 15	.....	.....
89.	*Fringilla cœlebs* sg.	.....	.....	.....	Feb. 10	.....
91.	*Cuculus canorus* heard	.....	Apl 12	.....	.....	Apl. 21
92.	*Hirundo rustica* seen	Apl. 19	Apl. 16	.....	.....	Apl. 17
93.	*Cypselus Apus* seen	.....	.....	May 14	.....	.....

The following additional notices are from the memoranda communicated to Mr. Littleboy for his "Notes on Birds observed in 1880."

84. *Daulias Luscinia.*—Heard at Watford, April 16—W. M. Fawcett; Woodhall Park, Watton, April 18—A. H. Smith; Bengeo, April 19—G. Turner.

87. *Phylloscopus collybita.*—Heard at Broxbourne, March 16—R. B. Croft; Hitchin, March 27—A. Ransom.

91. *Cuculus canorus.*—Heard at Great Gaddesden, April 15—H. Procter; Moor Park, Rickmansworth, April 19—Lord Ebury.

92. *Hirundo rustica.*—Seen at Sacombe, April 15—A. H. Smith.

We will now consider some of the results of the observations made in 1880. If the earliest notices this year are compared with the means of the earliest of the four previous years, it will be found that, in the case of the plants, out of 38 species of which the time of flowering has been observed in all the five years, 32 came into flower in 1880 earlier than the previous mean date, 3 later, and 3 at about the same time as the previous mean, showing that in 1880 vegetation was decidedly forward.† The extent to which 1880 was, compared with 1876-79, "an early year," may be more clearly demonstrated by comparing the mean date of the earliest records

* All the phenomena to be observed are entered in this table, although observations of all have not been recorded during the year.

† In relation only to 1876-79. If we had a long series of years to compare with, the result might be the reverse.

of the flowering of the whole of these 38 species in this year with the mean date of the earliest records for the four previous years. The result of a careful analysis shows an extent of forwardness in 1880 over the mean of 1876-79 of 8·3 days, or, to state the same thing in a different way, each species of plant observed opened its flowers on the average rather more than a week earlier in 1880 than the previous mean date.

Not one of the insects in the list has been observed in all the five years, and only five of the birds. These are the nightingale, the sky-lark, the rook, the cuckoo, and the swallow, and of every one of these the record was earlier in 1880 than the previous mean date, this year giving a mean for the five species of 8·4 days earlier than the mean of 1876-79. Frog spawn, which has been observed every year, was seen 12 days earlier than the previous mean. Thus the whole of the observations give a similar result, and characterise 1880 as a forward year in comparison with those of which we have any previous record for our county.

It was not so, however, for the whole of the year, for the lateness which eminently characterised 1879 was continued into 1880, and it was not until the middle of March that the mean was attained. Towards the end of March there was a decidedly early tendency, which increased in April and reached its maximum in May; receding then towards June, this month and July were about as forward as April. After July only two species were observed, and as these have not been noticed every year, the comparison cannot be continued further.

It will thus be seen that the severe winter retarded vegetation until the commencement of spring, when warmer weather accelerated it, having the greatest effect towards the end of spring, after which, as in every previous year of which we have records, a more normal tendency prevailed.

The damage to garden shrubs by the winter frosts, the early appearance of insects on the breaking up of the frost, the unusual abundance of wasps, the great scarcity of orchids, and the small number of plants in flower towards the winter months, are noticeable phenological features of the year 1880.

XXXIV.

ON THE PRESENCE OF CILIA ON THE TADPOLE OF THE COMMON FROG.

By R. B. Croft, R.N., F.L.S., F.R.M.S., Hon. Sec.

Read at Watford, 19th April, 1881.

For several years past I have been of opinion that the exterior cuticle of the tadpole of the common frog (*Rana temporaria*) was minutely ciliated. I therefore, early last spring, requested the co-operation of one of our members, Mr. George Turner, in determining whether this was the case or not. The tadpoles Mr. Turner had under observation were more advanced than those which came under my notice; and before any of the ova of my tadpoles were hatched he informed me that he had detected cilia, and had succeeded in mounting sections showing them very clearly. Also that on cutting off the head of a tadpole the tail had been kept in motion for a considerable time by means of the cilia.

On the hatching of the ova which I had collected I placed some of the young tadpoles in cells, and on adding chloroform to the water in which they were confined I was able, with a $\frac{1}{4}$-inch objective, distinctly to see that the whole of the exterior cuticle, including that of the gills, was covered with minute vibratile cilia.

I have reason to believe that this fact has not been previously recorded. At all events it is not mentioned in either Professor Mivart's work on 'The Common Frog,' nor in the article "Common Frog" in Professor Huxley's 'Practical Biology.' We were not able to detect the precise time of the retraction of the cilia, but believe it to have been coincident with the withdrawal of the external gills.

Postscript, *October*, 1881.—Since I communicated the above to the Society, the second volume* of Mr. F. M. Balfour's elaborate 'Treatise on Comparative Embryology' has been published. In writing on the embryology of the tadpole (p. 205) he says: "The outer layer of the epiblast-cells becomes ciliated after the close of the segmentation, but the cilia gradually disappear on the formation of the internal gills. The cilia cause a slow rotatory movement of the embryo in the egg, and probably assist in the respiration after it is hatched. They are especially developed on the external gills."

* The first volume, on the Invertebrata, was published in 1880; the second, on the Vertebrata, in 1881. Mr. Croft expressed his suspicion that the epidermis of the tadpole of the frog was minutely ciliated in a note in 'Science Gossip' for April, 1878 (p. 90).—Ed.

INDEX.

I.

J.

K.

L.

M.

N.

O.

ERRATA.

Page xxviii, line 6 from bottom, *for* "increasng" *read* "increasing."
,, ,, ,, 5 ,, *for* "ficet" *read* "feet."
,, xxxiv, ,, 27 *for* "this position" *read* "this condition."
,, xxxix, ,, 3 *for* "luxurious" *read* "luxuriant."
,, lxiii, ,, 3 from bottom, *for* "interet" *read* "interest."
,, ,, ,, 2 ,, *for* "masy" *read* "may."
,, 134, line 5 of table (*Papaver Rhœas*), *for* "Apl." *read* "June" *throughout.*
,, 243, line 3 from bottom, *transfer* "SWIFT" *to* line 5 from bottom.

APPENDIX.

LIST OF MEMBERS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB.

February, 1882.

PAST PRESIDENTS.

1875-77. JOHN EVANS, D.C.L., LL.D., Treas. R.S., F.S.A., etc.

1877-79. ALFRED T. BRETT, M.D.

1879-81. J. GWYN JEFFREYS, LL.D., F.R.S., F.L.S., etc.

TRUSTEES.

HONORARY MEMBERS.

Elected.

1875 Allman, George James, M.D., LL.D., F.R.S., F.R.S.E., F.L.S., M.R.I.A., Emeritus Professor of Natural History, University of Edinburgh, *Ardmore, Parkstone, Dorset;* and *Athenæum Club, London, S.W.*

1880 Babington, Charles Cardale, M.A., F.R.S., F.S.A., F.L.S., F.G.S., Professor of Botany in the University of Cambridge, 5, *Brookside, Cambridge.*

1882 Cooke, M. C., M.A., LL.D., A.L.S., 146, *Junction Road, London, N.*

1877 Darwin, Charles, M.A., LL.D., F.R.S., F.R.S.E., F.L.S., F.G.S., Hon. M.R.H.S., and R. Med. Chir. Soc., etc., *Down, Beckenham, Kent.*

1879 Etheridge, Robert, F.R.S., F.R.S.E., F.G.S., *British Museum (Natural History), South Kensington, London, S.W.*

1875 Glaisher, James, F.R.S., F.R.A.S., F.R.M.S., F.M.S., Superintendent of the Magnetic and Meteorological Department, Royal Observatory, Greenwich, 1, *Dartmouth Park, Blackheath.*

1879 Harting, James Edmund, F.L.S., F.Z.S., 22, *Regent's Park Road, London, N.W.*

1876 Hayden, Prof. Ferdinand Vandeveer, A.M., M.D., United States Geologist in Charge, *Washington, U.S.A.*

1877 Henslow, Rev. George, M.A., F.L.S., F.G.S., *Drayton House, Ealing.*

1875 Hooker, Sir Joseph Dalton, M.D., R.N., K.C.S.I., C.B., D.C.L., LL.D., F.R.S., F.L.S., F.G.S., Hon. M.R.H.S., and R. Med. Chir. Soc., etc., Director of the Royal Gardens, *Kew.*

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1875 Morris, John, M.A., F.G.S., Emeritus Professor of Geology and Mineralogy, University College, London, 15, *Upper Gloucester Place, Dorset Square, London, N.W.*

1881 Ormerod, Eleanor A., F.M.S., *Dunster Lodge, Spring Grove, Isleworth.*

1880 Sclater, Philip Lutley, M.A., Ph.D., F.R.S., F.L.S., F.G.S., Sec. Z.S., 11, *Hanover Square, London, W.*

1876 Symons, George James, F.R.S., Sec. M.S., 62, *Camden Square, London, N.W.*

— Whitaker, William, B.A. (Lond.), F.G.S., Geological Survey of England, *Museum, Jermyn Street, London, S.W.*

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An asterisk before a name indicates a Life Member.

Elected.

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1877 Brightwen, Mrs. George, *The Grove, Stanmore.*
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— Buxton, Thomas Fowell, *Easneye Park, Ware.*

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— *Carew, Mrs., *Carpenders Park, Watford.*
1876 *Carew, Robert Marcus, *Carpenders Park, Watford.*
1879 *Carlile, James W., *Ponsbourne Park, Hertford.*
1880 Carlile, Mrs., *Ponsbourne Park, Hertford.*
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— Clayton, Oscar, *Grove Cottage, Heathbourne, Bushey Heath.*
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— Loyd, Mrs., *Langleybury, Watford.*
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— *Lucas, William, *The Firs, Hitchin.*
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— Lytton, Right Honourable the Earl of, G.C.B., *Knebworth Park, Stevenage.*

1876 McFarlane, W. McMurray, *Loudwater, Rickmansworth.*
1875 McGill, H. J., *Aldenham.*
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— McKenzie, A. Caius, *Hoddesdon.*
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— Manser, Alfred, *Lampits, Hoddesdon.*
— Manser, Edward, *Lee Side, Hertford.*
— Manser, Henry, *The Lynch, Hoddesdon.*
1877 Marnham, Henry, *Beech Lodge, Watford.*
1876 Marnham, John, *The Hollies, Boxmoor.*
1881 *Marshall, Rev. C. J., M.A., *Danesbury, Bengeo, Hertford.*
1875 *Marshall, Frank E., M.A., *Harrow.*
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1881 Murray, Miss Alice, *Epcombs, Hertford.*
1880 Mylne, Robert W., F.R.S., F.S.A., F.G.S., *Amwell, Ware.*

1875 Noakes, Simpson, *Bushey Heath.*
1876 Nunn, Charles W., *Fore Street, Hertford.*

1880 Odell, Thomas, *Castle Street, Hertford.*
1879 Odell, William, F.R.C.S., *Castle Street, Hertford.*
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— Part, C. T., *Aldenham Lodge, Watford.*
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— Piffard, Mrs., *Hill House, Hemel Hempstead.*
1876 *Pollard, Joseph, *High Down, Hitchin.*
1879 Price, George, *High Street, Ware.*
1881 *Pryor, Marlborough R., M.A., F.Z.S., *Weston Manor, Stevenage.*
1875 Pryor, Robert, *High Elms, Watford.*
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1880 Ransom, Alfred, *Benslow, Hitchin.*
1881 Ransom, Francis, *Fairfield, Hitchin.*
1877 *Ransom, William, *Fairfield, Hitchin.*
1880 Robins, Henry, *Railway Street, Hertford.*
1879 Robinson, Isaac, *The Wash, Hertford.*
1875 Rooper, George, F.Z.S., *Nascott House, Watford;* and 40, *Princes Gardens, London, S.W.*
1881 Rooper, Miss, *Nascott House, Watford.*
1875 Roper, Freeman C. S., F.L.S., F.G.S., F.R.M.S., *Palgrave House, Eastbourne.*
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1875 Rudyard, Alfred T., M.D., *St. Albans Road, Watford.*

1879 *Salisbury, Most Honourable the Marquis of, K.G., F.R.S., *Hatfield House, Hatfield*; and 20, *Arlington Street, London, S.W.*

1877 *Saunders, H. Demain, *Brickendon Grange, Hertford.*
1875 Scholz, Miss, *Beechen Grove, Watford.*
1877 Schön, Mrs., *Wayhill Road, Andover.*
1875 Sedgwick, John, *Elmcote, Watford.*
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— Selby, Miss Nellie, *Butlers Green, Aldenham.*
1879 Sharp, John F. B., *Christ's Hospital, Hertford.*
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1881 Smith, Abel S. H., *Woodhall Park, Watton, Hertford.*
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— *Smith, W. Lepard, *Nascot Villas, Watford.*
— Smith, Joseph G., *Hamper Mills, Watford.*
1880 *Smith, Robert, *Goldings, Hertford.*
1879 Smith, Urban A., C.E., *Castle Street, Hertford.*
1880 *Smith-Bosanquet, Horace J., F.R.G.S., *Broxbourne Bury, Hoddesdon.*
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— Taylor, Frederick, *Fore Street, Hertford.*
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1876 Tidcombe, Mrs. G., *Chalk Hill, Bushey.*
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1879 Wailes, Herbert, *Park Road, Watford.*
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1879 Warner, Frank, *The Cottage, Hoddesdon.*
1881 Warner, Henry, *Wormley, Hoddesdon.*
1879 Warrener, William, M.D., *Castle Street, Hertford.*
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1881 Weall, John, *Rutland Lodge, Watford.*
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1879 Wilds, William H., *St. Andrew's Street, Hertford.*
1880 Wiles, E. S., *London Road, St. Albans.*
1875 Wilson, John, 159, *New Bond Street, London, W.*
— Wilson, Miss Mary, *Nutfield, Watford.*
1880 Wingfield, Rev. Canon, M.A., *The Rectory, Welwyn.*
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EDITED BY JOHN HOPKINSON, F.L.S., F.G.S.

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Amphibia	,, ,,
Pisces	J. E. Littleboy.

ARTHROPODA.

Insecta (injurious)......	Miss E. A. Ormerod, Dunster Lodge, Isleworth.
Coleoptera	Arthur Cottam, Watford.
Arachnida	F. M. Campbell, F.L.S., Hoddesdon.

VERMES.

Rotifera	F. W. Phillips, Hertford.
Scolecida	A. T. Brett, M.D.

PROTOZOA.

Infusoria	F. W. Phillips.

BOTANY.

ACROGENS.

Filicales..............	J. E. Littleboy.

THALLOGENS.

Lichenales	R. B. Croft, R.N., F.L.S., Ware.
Fungales..............	R. T. Andrews, Hertford.
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Infusoria	F. W. Phillips.
Rhizopoda	,,

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Filicales	J. E. Littleboy.
Muscales	A. E. Gibbs, The Hollies, St. Albans.
Thallogens.	
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Curator:

F. W. SILVESTER, F.M.S.,
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