TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

VOL. VIII.

TRANSACTIONS

OF THE

HERTFORDSHIRE

NATURAL HISTORY SOCIETY

AND

FIELD CLUB.

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

VOLUME VIII.

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[To be inserted, in binding, before the Transactions.]

ERRATA.

Page 39, Table IV, col. 5 (Colne), last line but one, *for* 24·60 *read* 24·57; last line, *for* —4·37 *read* —4·40: col. 7 (Ouse), last line, *for* —2·38 *read* —3·53.

,, 61, line 1, *for* Oct. *read* Nov.

,, 137, Table IV, col. 7 (Ouse), last line, *for* +1·62 *read* +0·4; col. 8 (Thames), last line but one, *for* 22·28 *read* 28·28.

LIST OF ILLUSTRATIONS.

PLATES

Plates VI, VII, XV, and XVI are from photographs by the Editor.

OTHER ILLUSTRATIONS.

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

Part 1.	Pages 1–32	....	October, 1894.
,, 2.	,, 33–64	....	November, 1894.
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,, 4.	,, ix–xl	....	May, 1895.
,, 5.	,, 89–128	....	November, 1895.
,, 6.	,, 129–168	....	December, 1895.
,, 7.	,, 169–204	....	February, 1896.
,, 8.	,, xli–lxxii	....	October, 1896.
,, 9.	,, i–viii, and 205–212	....	November, 1896.

Dates of completion of previous volumes:

TRANSACTIONS OF THE WATFORD NATURAL HISTORY SOCIETY.

Vol. I.	(pp. lxiv and 248)	....	August, 1878.
,, II.	(pp. lx and 260)	....	June, 1880.

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Vol. I.	(pp. lxviii and 272)	....	May, 1882.
,, II.	(pp. lxviii and 286)	....	May, 1884.
,, III.	(pp. lxxii and 274)	....	March, 1886.
,, IV.	(pp. lii and 224)	....	June, 1888.
,, V.	(pp. xlviii and 224)	....	May, 1890.
,, VI.	(pp. lxx and 204)	....	July, 1892.
,, VII.	(pp. lii and 244)	....	April, 1894.

PROCEEDINGS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

Ordinary Meeting, 14th November, 1893, at Watford.

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Mr. Harold Kent, Mr. W. H. Norris, Mr. John L. Pank, Mr. F. W. Reeder, and Miss Swindon were elected Members of the Society.

Mr. John William Duvall, The Grange, Ware; Miss Lake, Wellfords, Bricket Road, St. Albans; and Dr. W. Duncan Scott, M.A. (Oxon.), Glendearg, Watford, were proposed for membership.

The following lecture was delivered:—

"The Bronze Age." By Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas. R.S., V.P.S.A., etc. (*Transactions*, Vol. VIII, p. 1.)

The President referred to the recent discovery of pre-historic human skulls which had been trephined, and he enquired whether they belonged to the Bronze Age, and if so, whether the trephining had been done with any small bronze implement known to Sir John.

Dr. Brett enquired whether the word "brass" in the Bible would not be more correctly translated "bronze," as he had heard stated at the recent meeting of the British Association.

Sir John Evans replied that he thought the trephined skulls referred to by the President belonged, as a rule, to the close of the Stone Age, and that the orifices in the skulls were probably made by neat flint implements. The system of taking out portions of the skull to relieve the inconvenience of headache was still practised in Dalmatia, and with considerable effect. With regard to Dr. Brett's question, as brass was a mixture of copper and zinc, and zinc was a metal known only at a comparatively late period, the word translated "brass" in the Bible ought certainly to have been translated "bronze."

Bronze implements and diagrams were exhibited by Sir John Evans in illustration of the lecture.

Ordinary Meeting, 16th November, 1893, at St. Albans.

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Dr. Dudley Buxton, Bushey Cottage, Bushey Heath, was proposed for membership of the Society.

The following lecture was delivered:—

"Aquatic Mammals." By the President.

Having first drawn attention to the distinction between amphibious and aquatic mammals, the President pointed out that the latter might be divided into three great groups—(1) the seals and their allies, true Carnivora, (2) the Cetaceans, and (3) the Sirenians. That the seals are immeasurably the youngest of the three groups was, he said, proved by their structure. The sea-lion or sea-bear, which furnishes the seal-skin fur, was more easily trained than any other animal except the elephant. Its brain was large and complex, and it possessed a high degree of intelligence, having even been taught to count to a certain extent. The walrus came between the sea-lion and the true seal, standing, however, much nearer the former than the latter. Differing widely from these aquatic Carnivora were the Cetacea, in which group are included such animals as the rorqual, sperm-whale, grampus, porpoise, and dolphin, the more interesting points of the structure and habits of each of which were successively passed in review. The whale, he said, was probably the largest animal in existence, having been estimated to weigh 200 tons, which is equal to an army of about 3,000 men. The Atlantic right-whale or Greenland whale yielded the whalebone of commerce, which was such a valuable product, being worth about £3,000 per ton, or about a third of its weight in silver. Having described some of the curious uses to which whalebone is put, and referred to the toothed whales, the President finally passed on to the consideration of the third group of aquatic mammals, the Sirenia, in which are the estuarine or fluviatile dugongs and manatees.

Ordinary Meeting, 19th December, 1893, at Watford.

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Dr. Dudley Buxton, Mr. J. W. Duvall, Miss Lake, and Dr. W. Duncan Scott, M.A., were elected Members of the Society.

Mr. J. Goodwin, Langley Park House, Watford; Mr. Thomas Hope, St. Ronan's, Watford; Mr. Clement Janes, Hunter's Farm, Leavesden, Watford; Mr. Picton Jones, Conishead, Watford; Mrs. Osborne, Widcombe Lodge, Watford; Dr. H. Ashton Rudyard, St. Alban's Road, Watford; Mr. Rupert W. Sedgwick, 44 High Street, Watford; Mr. Thomas Turner, Oakleigh, Watford; and the Rev. Arthur Wilson, M.A , Leavesden Vicarage, Watford, were proposed for membership.

The following lecture was delivered:—

"Woodland Wanderers, or the Mycetozoa." By James Saunders. An extempore lecture, the substance of which, with additions, was afterwards embodied in "Further Notes on the Mycetozoa, with a List of Species from Herts, Beds, and Bucks." (*Transactions*, Vol. VIII, p. 65.)

The lecture was illustrated by photographic slides representing most of the Mycetozoa alluded to, shown by the oxy-hydrogen lantern lent and manipulated by Mr. H. C. Wardale; and a slide with living and moving plasmodium of a *Badhamia*.

Ordinary Meeting, 23rd January, 1894, at Watford.

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Mr. J. Goodwin, Mr. Thomas Hope, Mr. Clement Janes, Mr. Picton Jones, Mrs. Osborne, Dr. H. A. Rudyard, Mr. Rupert W. Sedgwick, Mr. Thomas Turner, and the Rev. Arthur Wilson, M.A., were elected Members of the Society.

Dr. Adams Clarke, Bushey, Watford; Mr. Arthur Dudgeon, Northbank, Watford; Mr. E. G. Oddie, Oxford Lodge, Watford; Mr. S. H. Spencer, jun., 45, Gladstone Road, Watford; and Mr. W. H. Williams, Alexandra Road, Watford, were proposed for membership.

The following lecture was delivered:—

"The Lower Micro-organisms and their Relation to Every-day Life." By D. Harvey Attfield, M.A., M.B., C.M., D.P.H. (Cantab.). (*Transactions*, Vol. VIII, p. 13.)

A discussion ensued in which the President, Dr. Brett, and Dr. Morison took part.

The lecture was illustrated by means of the oxy-hydrogen lantern, and by living micro-organisms shown under the microscope.

Special Meeting, 23rd January, 1894.
(At Watford.)

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

This meeting was convened for the purpose of considering and passing certain alterations of the Rules proposed by the Council. Mr. Hopkinson stated that the principal alterations would have the effect of extending considerably the objects of the Society, and of admitting another class of members, to be called "corresponding members." He then read the Rules with the revisions proposed, explaining the alterations, which were put to the meeting *seriatim* and carried.

The revised Rules are as follows:—

I. The Society shall be called the HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB; its Headquarters shall be at Watford; and its object shall be the investigation of the Meteorology, Geology, Botany, Zoology, Ethnology, Pre-Norman Archæology, and Topography of the County of Hertford, the publication of the results of such investigation, and the dissemination amongst its Members of information on Physics and Biology.

II. The Society shall consist of Ordinary, Honorary, and Corresponding Members, including Ladies; the number of Ordinary Members being unlimited, the number of Honorary Members being limited to twenty, and the number of Corresponding Members to ten.

III. The Management of the Society shall be vested in a Council, consisting of a President, four Vice-Presidents, a Treasurer, two Honorary Secretaries, a Librarian, a Curator, and twelve other Members, to be elected annually, by ballot, at the Anniversary Meeting. The President shall not hold office for a longer term than two years, and in each year the senior Vice-President and the three senior Ordinary Members of the Council shall not be eligible for re-election; but the Council shall have power to fill up, from these or other Members of the Society, any vacancy which may occur during the year.

IV. The Anniversary Meetings of the Society shall be held at Watford in February; and Ordinary Meetings for the delivery of lectures, the reading of papers, and discussions; Bye Meetings for microscopical study or other purposes; and Field Meetings, shall be held at such times and places as the Council may direct.

V. Minutes shall be kept of the Ordinary and Anniversary Meetings of the Society, and of the Meetings of the Council, and the Minutes of each meeting shall be read as the first business of the next ensuing meeting of the same kind. At the Council Meetings, to be held at Watford only, four Members shall form a quorum.

VI. All Members shall have the privilege of attending the Anniversary, Ordinary, Bye, and Field Meetings of the Society, and (unless otherwise determined by the Council) of introducing two Visitors at such meetings, and shall be entitled to receive a copy of all the ordinary publications issued by the Society during their membership, and to the use of the Library in accordance with the library regulations.

VII. Every Candidate for admission as an Ordinary Member shall be proposed by two or more Members, who shall sign a certificate in recommendation of such candidate, one of the proposers from personal knowledge. The certificate shall be read from the Chair at the Ordinary Meeting following its receipt by either of the Secretaries, and the candidate shall be balloted for at the next Ordinary Meeting at Watford, one black ball in six excluding.

VIII. The Annual Subscription for Ordinary Members shall be Ten Shillings, payable immediately after their election, and afterwards becoming due in advance on the 1st of January in each year; but Members elected in the last two months in any year shall be exempt from the payment of subscription for that year. No Member shall be entitled to any of the privileges of the Society whose subscription is twelve months in arrear; and any Member whose subscription is two years in arrear may be excluded from the Society by the Council.

IX. Any Ordinary Member may compound for his or her Annual Subscriptions by a payment of Five Pounds.

X. All Ordinary Members shall pay an Entrance Fee of Ten Shillings, in addition to their first year's subscription or life composition, before they are entitled to any of the privileges of membership; and the election of any Member shall be deemed void whose Entrance Fee is not paid before a second year's subscription becomes due.

XI. The Honorary Members shall be ladies or gentlemen of eminence in Natural Science, or who shall have done some special service to the Society, and whose usual place of residence is not in the County of Hertford.

XII. The Corresponding Members shall be ladies or gentlemen whose association with the Society is considered by the Council to be desirable, and whose usual place of residence is not in the County of Hertford.

XIII. Honorary and Corresponding Members shall be elected only at the Anniversary Meetings by the Members upon the recommendation of the Council, not more than two Honorary Members and one Corresponding Member to be elected in any one year.

XIV. Members wishing to resign at the termination of any year are required to inform one of the Secretaries, in writing, of their intention to do so, on or before the 31st of December in that year.

XV. The Accounts of the Society shall be made up to the 31st of December in each year, and audited by two Auditors appointed at the first ensuing Ordinary Meeting; and the Balance Sheet, together with a Report on the general progress of the Society during the preceding year, shall be submitted to the Anniversary Meeting in February.

XVI. All the funded and other property of the Society shall be vested in three or more Trustees, who shall be Life Members of the Society, appointed by the Council.

XVII. The Society shall discourage the practice of removing rare plants from the localities of which they are characteristic, and of exterminating rare birds, fish, and other animals, and shall use its influence with landowners and others for the protection of the characteristic birds of Hertfordshire; the rarer botanical specimens collected at the Field Meetings shall be chiefly such as can be gathered without disturbing the roots of the plants; and notes on the habits of birds shall be recorded instead of collecting specimens, either of the birds or of their eggs.

XVIII. The Council may authorize the Society or any of its Members to undertake the investigation of any subject of a scientific nature relating to Hertfordshire, and the results of such investigation may be published by the Society.

XIX. No Rule shall be altered except by a majority of votes of the Members present at a Special Meeting at Watford called for that purpose. The Council may at any time, and shall upon a requisition signed by not less than twelve Members, convene a Special Meeting; and a printed notice stating the purpose for which the meeting is convened shall be sent to each Member not less than seven days before such meeting, at which no business shall be considered except that for which it was convened.

XX. A copy of these Rules shall be sent by one of the Secretaries to each Member upon election to membership of the Society.

Ordinary Meeting, 13th February, 1894, at Watford.

Arthur Stradling, Esq., M.R.C S., F.Z.S., President, in the Chair.

Dr. Adams Clarke, Mr. Arthur Dudgeon, Mr. E. G. Oddie, Mr. S. H. Spencer, jun., and Mr. W. H. Williams were elected Members of the Society.

Mr. F. C. Mahon, Wolfville, Watford, was proposed for membership.

The following lecture was delivered:—

"Crystals and Precious Stones." By G. Herbert Wailes, Assoc. M. Inst. C.E.

Mr. Wailes commenced his lecture with a historical account of the uses to which crystals and precious stones have been put from the earliest times, referring especially to the magical and occult properties with which they were supposed to be endowed, and to their use in connection with nearly all religious beliefs. He then passed on to the consideration of their physical properties, stating that crystals are the natural forms which many substances take when passing from a liquid to a solid state; that gems are transparent crystals whose hardness equals or exceeds that of quartz; and that precious stones are substances remarkable for their beauty and rarity, such as turquoise, lapis-lazuli, opal, onyx, pearl, and coral. The diamond, as the most lustrous, the hardest, and the purest of all gems, received a large amount of attention.

After treating of the chemical composition, the crystalline form, and the characteristic properties and appearance of all the better-known, and some of the little-known precious stones, Mr. Wailes devoted the concluding portion of his lecture to the folklore of gems, giving a large amount of information on the superstitions which have been connected with them in almost all times and all countries.

Specimens, models, and diagrams were exhibited in illustration of the lecture.

Mr. T. J. Broad and Mr. G. H. Wailes were elected auditors of the accounts for 1893.

ANNIVERSARY MEETING, 27TH FEBRUARY, 1894.
(AT WATFORD.)

ARTHUR STRADLING, Esq., M.R.C.S., F.Z.S., President, in the Chair.

The Report of the Council for 1893, and the Treasurer's Account of Income and Expenditure, were read and adopted.

Mr. James Saunders, 49 Rothesay Road, Luton, was elected a Corresponding Member of the Society.

The President delivered an Address on "A Wonderful Animal." (*Transactions*, Vol. VIII, p. 85.)

The following gentlemen were duly elected as the Officers and Council for the ensuing year:—

President.—Arthur Stradling, M.R.C.S., F.Z.S.

Vice-Presidents.—Professor John Attfield, M.A., Ph D., F.R.S., F.C.S., F.I.C.; Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., &c.; Upfield Green, F.G.S.; John Morison, M.D., F.G.S.

Treasurer.—John Weall.

Honorary Secretaries.—John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc.; F. M. Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S.

Librarian.—W. R. Carter, B.A.

Curator.—A. E. Gibbs, F.L.S., F.E.S.

Other Members.—Arthur P. Blathwayt; Alfred T. Brett, M.D.; R. B. Croft, R.N.; Augustus Hawks; Daniel Hill; Henry Lewis; William Ransom, F.S.A., F.L.S.; T. Vaughan Roberts; George Rooper, F.Z.S.; Stephen Salter; F. W. Silvester; Henry Warner.

The thanks of the Society were accorded to the Right Hon. the Earl of Clarendon, Mr. John Hopkinson, Mr. William Ransom, and Dr. C. E. Shelly, retiring from the office of Vice-President; to Dr. John Morison, retiring from the office of Honorary Secretary; and to Mr. A. M. Brown, Mr. J. Thornhill, the Rev. E. T. Vaughan, and Mr. Percy Jenner Weir, retiring from the Council.

Report of the Council for the Year 1893.

The Council has much pleasure in reporting that the Society continues to maintain a vigorous and prosperous condition. The number of meetings held during the year has been up to the average, they have been well attended, and great interest has been taken in the papers which have been read.

During the year twenty-four ordinary members have been elected, and one honorary member; twenty-six members have resigned; and the Council regrets to have to record the loss of one member by death—Mr. R. Russell Carew, F.C.S., one of the original members of the Society.

The number of members at the end of the years 1892 and 1893 was as follows:—

	1892.	1893.
Honorary Members	19	20
Life Members	51	51
Annual Subscribers	192	189
	262	260

The following papers or lectures have been read or delivered at Watford during the year:—

Jan. 17, Man and Ape; by Arthur Stradling, M.R.C.S., F.Z.S.

Feb. 21, Anniversary Address—Charles Darwin; by the President, John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc.

March 21, Climatological Observations taken in Hertfordshire in the year 1891; by John Hopkinson.

—— Notes on Birds observed in Hertfordshire during the year 1892; by Henry Lewis.

—— Notes on some Hertfordshire Mammalia; by T. V. Roberts.

April 18, Report on the Rainfall in Hertfordshire in 1892; by John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

—— Climatological Observations taken in Hertfordshire in the year 1892; by John Hopkinson.

—— Meteorological Observations taken at The Grange, St. Albans, during the year 1892; by John Hopkinson.

—— Observations of Temperature and Rainfall taken at Throcking Rectory, Buntingford, 1880–89; by the Rev. C. W. Harvey, M.A.

—— The Climate of Watford, deduced from Meteorological Observations taken during the ten years 1877–86; by John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

—— Report on Phenological Phenomena observed in Hertfordshire during the year 1892; by Edward Mawley, F.R.Met.Soc.

—— A Preliminary Introduction to the Investigation of Microscopic Leaf-Fungi; by John Hopkinson, F.L.S., F.G.S., F.R.M.S.

—— A List of Hertfordshire Hepaticæ; by A. E. Gibbs, F.L.S.

—— Notes on Lepidoptera observed in Hertfordshire; by A. E. Gibbs.

Nov. 14, The Bronze Age; by Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., etc.
Dec. 19, Woodland Wanderers, or the Mycetozoa; by James Saunders.

The following lecture was delivered at St. Albans:—

Nov. 16, Aquatic Mammals; by the President, Arthur Stradling, M.R.C.S., F.Z.S.

The following Field Meetings were held during the year:—

April 29.—Rickmansworth.
May 13.—Brocket Park, Welwyn.
—— 27.—Knebworth.
June 17.—Zouches Farm, Dunstable.
June 22.—Colney Heath and Tittenhanger, St. Albans.
Oct. 7.—Digswell Park and Sherrards Wood, Welwyn.

A visit was also made to the British Museum (Natural History) on the 15th of April, when the President, Mr. Stradling, gave a demonstration on "Wingless Birds and their Eggs."

Five parts of the seventh volume of the present series of the Society's 'Transactions,' containing 168 pages and three plates, have been published during the year, and the volume will be completed in two more parts, one (already printed) containing the proceedings of the last two sessions, and the other the title page, contents, index, etc., to the volume. The previous biennial volume was completed in July, 1892, but your Editor hopes to complete this one by April, or three months earlier in the year. While viewing with satisfaction this more expeditious publication of the 'Transactions,' the Council desires to point out that it entails an increased expenditure for the time, which can only be met by an increase in the number of members, or by more punctual payment of their subscriptions, by which there would be the additional advantage of the work of your Treasurer being considerably lightened.

Owing to the Society's recent removal to the Endowed Schools, the library is at present in a somewhat disordered condition, but the work of arranging the volumes and preparing for the binder the Transactions of Societies received in exchange, and the serial publications purchased, is progressing, and it is hoped will shortly be completed. The catalogue of the library, revised to July, 1885, and the supplementary catalogue, to December, 1889, are out of print. As soon as possible a new catalogue or a list of the books will be prepared.

In order to meet the convenience of members it has been thought desirable that the library should be open for reference or the exchange of books on the first Tuesday of every month from 7 to 8 p.m. as well as after the Society's evening meetings.

The following publications are forwarded to members who desire it, on payment of the postage:—'Meteorological Magazine,' 'Natural Science,' 'Nature Notes,' 'Grevillea,' 'Journal of Botany,' 'Royal Natural History,' 'Entomologist,' 'Entomologist's Record,' 'Journal of Conchology,' 'Zoologist,' and 'Hertfordshire Illustrated Magazine.'

INCOME AND EXPENDITURE FOR THE YEAR ENDING 31*st* *DECEMBER*, 1893.

Dr.	£	*s.*	*d.*	Cr.	£	*s.*	*d.*
To Balance from 1892	48	8	0	By Printing 'Transactions'	53	3	3
,, Entrance Fees	17	0	0	,, Miscellaneous Printing	7	18	6
,, Subscription for 1889		10	0	,, Expenses of Meetings	1	0	6
,, ,, ,, 1890		10	0	,, Rent: Watford Endowed Schools	7	0	0
,, Subscriptions ,, 1891	4	0	0	,, Library expenses	4	3	3
,, ,, ,, 1892	11	10	0	,, New Bookcase and Fittings	8	13	3
,, ,, ,, 1893	49	0	0	,, Expenses of removing	2	0	0
,, ,, ,, 1894	21	10	0	,, Salary of Assistant	5	0	0
,, Dividends on £130 India 3 per cent. Stock.	3	18	0	,, Postages and Stationery	20	12	9
,, Sale of Publications ['Flora of Hertfordshire' 10*s.* 6*d.*; 'Transactions' 7*s.* 9*d.*, less expenses]		18	3	,, Fire Insurance	0	7	6
				,, Sundry small expenses	0	5	4
				,, Balance at Bank	46	19	11
	£157	4	3		£157	4	3

Amount invested in the purchase of £130 India 3 per cent. Stock . . . . £126 15*s.* 6*d.*

Audited and found correct this 24th day of February, 1894, { GEO. HERBERT WAILES, THOS. J. BROAD.

Additions to the Library in 1893.

Presented.

Title.	Donor.
Baxendell, J. Borough of Southport. Meteorological Department. Report and Results of Observations for the year 1892. 4to. Southport, 1893.	*The Author.*
Buchan, A. Handy Book of Meteorology. 8vo. London, 1868.	*Mr. J. Hopkinson.*
Evans, Sir John. Anniversary Address [to the] Society of Chemical Industry, 12th July, 1893. 8vo. [London, 1893.]	*The Author.*
Huxley, Prof. T. H. Six Lectures to Working Men on our knowledge of the Causes and Phenomena of Organic Nature. 8vo. London, 1863.	*Mr. J. Hopkinson.*
Kirby, Rev. W., and W. Spence. Introduction to Entomology. 4 vols. 8vo. London, 1815.	"
Linnean Society. Journal. Botany. Vols. xxiii and xxiv. Zoology. Vol. xxii, Nos. 138 and 139. Vol. xxiv, No. 153. 8vo. London, 1889-92.	*Mr. R. B. Croft.*
Natural Science. Vol. i, Nos. 1, 4-7, 9, and 10. 8vo. London, 1892. Vols. ii and iii. *Ib.* 1893.	*Mr. A. E. Gibbs.*
———. Vol. i, Nos. 1-4. 8vo. London, 1892.	*Mr. J. Hopkinson.*
Ormerod, Eleanor A. Report on Observations of Injurious Insects and Common Farm Pests during the year 1892. 8vo. London, 1893.	*The Authoress.*
Powell, Rev. Baden. The Order of Nature. 8vo. London, 1859.	*Mr. J. Hopkinson.*
Science Gossip. Nos. 337-344. 8vo. London, 1893.	*Mr. A. E. Gibbs.*
Symons, J. G. (*Ed.*). Monthly Meteorological Magazine. Vol. xviii. 8vo. London, 1893.	*The Editor.*
Wallace, A. R. Darwinism. 2nd Ed. 8vo. London, 1889.	*Mr. J. Hopkinson.*
Water Supply of London. Newspaper Cuttings, 1893.	"

Received in Exchange.

American Monthly Microscopical Journal. Vol. xiii. 8vo. Washington, 1892.

American Museum of Natural History. Bulletin. Vol. iv. 8vo. New York, 1892.

———. Report for the year 1892. *Ib.* 1893.

Bath Natural History and Antiquarian Field Club. Proceedings. Vol. vii, No. 4. 8vo. Bath, 1893.

Belfast Naturalists' Field Club. Annual Report and Proceedings. Series 2, Vol. iii, part 6. 8vo. Belfast, 1893.

Birmingham Philosophical Society. Proceedings. Vol. viii, part 1. 8vo. Birmingham [1893].

Brighton and Sussex Natural History Society. Abstracts of Papers and Report . . . 14th June, 1893. 8vo. Brighton, 1893.

Bristol Naturalists' Society. Proceedings. New Series. Vol. vii, part 2. 8vo. Bristol, 1893.

Conchology, Journal of. Vol. vii, Nos. 5-8. 8vo. Leeds, 1893.

Ealing Microscopical and Natural History Society. Report and Proceedings for 1892. 8vo. Ealing [1893].

Edinburgh, Botanical Society of. Transactions and Proceedings. Vol. xix, part 2. 8vo. Edinburgh, 1893.

———. Geological Society. Transactions. Vol. vi, part 5. 8vo. Edinburgh, 1893.

EDINBURGH. ROYAL PHYSICAL SOCIETY. Proceedings. Session 1891–92. 8vo. Edinburgh, 1893.
ESSEX FIELD CLUB. Essex Naturalist. Vol. vi, Nos. 11 and 12, and Index. Vol. vii, Nos. 1–9. 8vo. Chelmsford, 1893.
GLASGOW, GEOLOGICAL SOCIETY OF. Transactions. Vol. ix, part 2. 8vo. Glasgow, 1893.
——— NATURAL HISTORY SOCIETY. Proceedings. New Series, vol. iii, part 3. 8vo. Glasgow, 1892.
———, PHILOSOPHICAL SOCIETY OF. Index to the Proceedings, vols. i–xx. 1841–90. 8vo. Glasgow, 1893.
———, ———. Proceedings. Vols. xxiii and xxiv. 8vo. Glasgow, 1892–93.
LIVERPOOL GEOLOGICAL SOCIETY. Proceedings. Vol. vii, part 1. 8vo. Liverpool, 1893.
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Ordinary Meeting, 20th March, 1894, at Watford.

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Mr. F. C. Mahon was elected a Member of the Society.

Mr. Alfred E. Cox, 78 Queen's Road, Watford; Mr. C. A. Curry, Woodoaks, Rickmansworth; Mr. Daniel A. Wehrschmidt, Cleveland, Bushey, Watford; and Mr. T. P. Grosart Wells, L.R.C.P. (Edin.), St. Peter's Street, St. Albans, were proposed for membership.

A letter was read from Mr. James Saunders, of Luton, thanking the Society for his election as a corresponding Member.

The following paper was read:—

"The Natural History of the Salmon." By George Rooper, F.Z.S. (*Transactions*, Vol. VIII, p. 17.)

A discussion ensued in which the President, Professor Attfield, Dr. Brett, Mr. Hopkinson, and Mr. Vaughan Roberts took part.

ORDINARY MEETING, 17TH APRIL, 1894, AT WATFORD.

ARTHUR STRADLING, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Mr. Alfred E. Cox, Mr. C. A. Curry, Mr. Daniel A. Wehrschmidt, and Mr. T. P. Grosart Wells, L.R.C.P. (Edin.), were elected Members of the Society.

Miss Adams, St. Peter's House, St. Albans, and Mr. Noel Heaton, Sans Souci, Watford, were proposed for membership.

The following papers were read:—

1. "The Wasp Infestation of 1893." By A. E. Gibbs, F.L.S., F.E.S. (*Transactions*, Vol. VIII, p. 22.)

2. "Report on Phenological Phenomena observed in Hertfordshire during the year 1893." By Edward Mawley, F.R.Met.Soc., F.R.H.S. (*Transactions*, Vol. VIII, p. 27.)

3. "Notes on Birds observed in Hertfordshire during the year 1893." By Henry Lewis. (*Transactions*, Vol. VIII, p. 49.)

4. "Notes on Lepidoptera observed in Hertfordshire during the year 1893." By A. E. Gibbs, F.L.S., F.E.S. (*Transactions*, Vol. VIII, p. 74.)

The following papers were taken as read:—

1. "Report on the Rainfall in Hertfordshire in the year 1893." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. VIII, p. 33)

2. "Climatological Observations taken in Hertfordshire in the year 1893." By John Hopkinson. (*Transactions*, Vol. VIII, p. 45.)

3. "Meteorological Observations taken at the Grange, St. Albans, during the year 1893." By John Hopkinson. (*Transactions*, Vol. VIII, p. 57.)

BYE MEETING, 21ST APRIL, 1894.

NATURAL HISTORY MUSEUM, SOUTH KENSINGTON.

This meeting was under the conductorship of the President, Mr. Arthur Stradling, and was well attended, a party of about fifty assembling in the Great Hall of the Museum.

The members were received by Sir William Flower, Director of the Museum and an honorary member of the Society, who invited special attention to a new collection of representative birds' eggs, and to some extraordinary insects just brought over from Madagascar, and exhibited on the actual slips of moss-covered bark on which they were caught. These creatures are supposed to illustrate better than anything else in the animal world the protection from observation afforded by mimicry of their surroundings, for, although each was nearly as large as a florin, it was almost impossible to detect them for some time under the closest scrutiny, and not a few of the visitors seem to have come away without detecting them at all.

After a glance at the Index Collections, which he declared to be the salient feature of the Museum and a whole education in themselves, the President led the way to the room devoted to the stuffed specimens of reptiles such as exist at the present day. The peculiarities which distinguish the crocodile, alligator, and gavial were first pointed out, particular attention being drawn to the fact that these beasts are enabled, owing to the position of their eyes, ears, and nostrils, to lie with the entire bulk of their huge bodies submerged, and yet to breathe, listen for signs of danger, and watch for their prey. The manner in which the nasal passages tunnel the whole length of the enormous upper jaw is also of great advantage to them, allowing them to hold down and drown an animal too powerful to be otherwise disposed of, while breathing without embarrassment themselves, and to remain in that attitude if necessary until the flesh of large prey should become softened. Only the bigger forms of lizards and serpents are suitable for display in the dry state, but the cellars of the Museum contain many thousands preserved in spirit for purposes of scientific study. Fantastic species, such as the frilled and spiny iguanas, are well represented in the room, as well as the monitors, greatest of all the lizard tribe, reaching a length of seven or eight feet, and feeding not only on the eggs of the crocodiles but on the newly-hatched young ones. The President spoke in terms of strong disapproval of the collection of snakes as being wrongly named in many instances, erroneously described on the labels, and badly set up; but explained that most of them were survivals of the old Bloomsbury days of the Museum, and that to replace them with better specimens (as will certainly be done eventually) must be the work of time.

Having inspected the most striking and gigantic fossil reptiles in the gallery allotted to those now extinct, the party proceeded upstairs to the great collection of the stuffed mammals, where Mr. Stradling restricted his remarks for the most part to such as are becoming rare and may be considered on the verge of extermination. Some of the creatures commented upon had been actual pets or importations of his own when alive, and had been contributed, when dead, by him to the Department, either directly or through the Zoological Society. The scarce red wolf of Paraguay (stolen from him and sold to provide funds for a wedding tour) was amongst these.

After a demonstration lasting about two hours, the proceedings terminated with a vote of thanks to the President.

Field Meeting, 28th April, 1894.

AYOT ST. PETER AND AYOT ST. LAWRENCE.

Although Ayot Station has frequently been the trysting-place for a field meeting of the Society, this is the first time that the walk has been in the direction of Ayot St. Lawrence, past the churches—the new and the old—of Ayot St. Peter. At each of the Ayots there is a portion of an old church standing at some distance from the one now used, but while at Ayot St. Peter an elegant building has replaced an ugly one, at Ayot St. Lawrence a beautiful Norman church has been discarded in favour of a hideous Grecian temple.

Ayot St. Peter is also known as Little Ayot; it contains 1097 acres; while Ayot St. Lawrence, or Great Ayot, contains only 737 acres, and its population, like its acreage, is two-thirds that of its "Little" neighbour. Salmon says that in Domesday Book the name was written Eia; Chauncy says Eye. Salmon derives the name from "Ayest, or Desert, a wild, uncultivated place"; Chauncy from Eye or "Ea, which," he says, "signifies a watry place."

The members were met at the station by the Rev. H. Jephson, Rector of Ayot St. Peter, who first conducted them through the picturesque grounds of The Fryth, the residence of Mr. C. W. Wilshere, where the Alpine rock-garden attracted much attention, many rare and beautiful Alpine plants being in bloom. The new church of Ayot St. Peter, which owes its existence mainly to Mr. Jephson's exertions, and the schoolrooms, were then visited, and amongst other interesting objects the register, dating from the year 1686, was examined, wherein was seen an account of the great flood of "1795. Feb^y^. Sunday y^e^ 8^th^." This account is transcribed by Cussans in his 'History of Hertfordshire' (Broadwater Hundred, p. 250).

A visit was then paid to the Rectory, where, quite unexpectedly, the members were invited to partake of tea and other refreshments.

The portion of the old church still standing, now used as a mortuary chapel, was next examined. This is at least the third church built upon the same spot, half a mile from the new church. Ayot St. Peter was a Rectory as early as the twelfth century, but no record exists of the building of the first church. Chauncy, in 1700 ('Hist. Antiq. Herts,' p. 321), speaks of the church as "situated on a dry hill, not far from the River Lea and the Mimeram"; and Clutterbuck, in 1821 ('Hist. Herts,' vol. ii, p. 265), says that this old church was rebuilt, with the rectory-house, "by Ralph Freeman, who was instituted to the rectory in the year 1732." This church, when Clutterbuck wrote, was "a small octagonal building of brick," with a belfry, separate therefrom, "also of brick, forming an entrance into the church-yard on the south." Cussans ('Hist. Herts,' Broadwater, p. 245) speaks of this building as having the aspect of a "lock-up," and says that in 1862 it "gave place to another which even surpassed it in some of its objectionable features." On the 10th of July, 1874, the new church was struck by lightning, and, the woodwork taking fire, the greater part of it was destroyed. The present church was then built, half a mile nearer the village. Mr. Jephson pointed out the still-existing evidences of the fire and showed the former extent of the church; and in taking leave the thanks of the party were accorded to him for his courteous attention and hospitality.

A field-path was then taken to Ayot St. Lawrence to see its ruined church, the most picturesque in Hertfordshire. The tower is nearly perfect, but the rest of the church is in utter ruin, through its demolition rather than falling to decay, for it was unroofed and partly pulled down. The church was built by one Radhere, to whom the manor was granted by Henry the First. "He built the Church with Stone," says Chauncy, "and then began the Hospital near it, which Church was founded . . . 1123, 23 H. I." In the year 1778 Sir Lionel Lyde built in his own park a new church on the plan of a heathen temple, and commenced to pull down the old one, but the Bishop interfered, and he had to desist, leaving the walls roofless and the tower only intact.

After viewing the old ruins and visiting "the abomination," as Cussans remarks, "which is now dignified by the name of the parish church," tea was partaken of at the village inn, and then the walk was continued through Lamer Park to Wheathampstead Station.

In the course of the walk the following plants were observed in flower, and recorded by Mr. Hopkinson, the director of the meeting:—

Anemone nemorosa, *L.*
Myosurus minimus, *L.*
Ficaria verna, *Huds.*
Ranunculus acris, *L.*
,, auricomus, *L.*
,, bulbosus, *L.*
Caltha palustris, *L.*
Fumaria officinalis, *L.*
Cardamine pratensis, *L.*
,, hirsuta, *L.*
Alliaria officinalis, *Andrz.*
Sisymbrium officinale, *Scop.*
,, thallianum, *J. Gay.*
Sinapis arvensis, *L.*
Erophila vulgaris, *DC.*
Capsella bursa-pastoris, *Moench.*
Reseda lutea, *L.*
Viola Riviniana, *Reichb.*
,, canina, *L.*
Polygala vulgaris, *L.*
Melandrium silvestre, *Roehl.*
Cerastium arvense, *L.*
Stellaria holostea, *L.*
Moehringia trinervia, *Clairv.*
Acer pseudo-platanus, *L.*
Geranium Robertianum, *L.*
Oxalis acetosella, *L.*
Ilex aquifolium, *L.*
Ulex europæus, *L.*
Sarothamnus vulgaris, *Wimm.*
Medicago lupulina, *L.*
Trifolium pratense, *L.*
,, repens, *L.*
Vicia sepium, *L.*
,, sativa, *L.*
Ervum hirsutum, *L.*
Prunus cerasus, *L.*
,, spinosa, *L.*
Fragaria vesca, *L.*
Potentilla fragariastrum, *L.*
Poterium sanguisorba, *L.*
,, muricatum, *Spach.*
Pyrus malus, *L.*
,, ,, *var.* acerba.
,, ,, *var.* mitis.
Cratægus oxyacantha, *L.*
Chærophyllum temulum, *L.*
Anthriscus silvestris, *Hoffm.*
Scandix pecten-veneris, *L.*
Sanicula europæa, *L.*
Galium cruciata, *Scop.*
Asperula odorata, *L.*
Senecio vulgaris, *L.*
Leucanthemum vulgare, *Lam.*
Bellis perennis, *L.*
Taraxacum officinale, *Weber.*

Hieracium pilosella, *L.*
Fraxinus excelsior, *L.*
Lithospermum arvense, *L.*
Myosotis palustris, *Relh.*
,, intermedia, *Link.*
Veronica officinalis, *L.*
,, chamædrys, *L.*
,, serpyllifolia, *L.*
,, agrestis, *L.*
,, hederæfolia, *L.*
Ajuga reptans, *L.*
Lamium album, *L.*
Galeobdolon luteum, *Huds.*
Glechoma hederacia, *L.*
Primula vulgaris, *Huds.*
,, officinalis, *Jacq.*
Plantago lanceolata, *L.*
Rumex acetosa, *L.*
Mercurialis perennis, *L.*
Euphorbia amygdaloides, *L.*
Quercus pedunculata, *Ehrh.*
Betula verrucosa, *Ehrh.*
Orchis morio, *L.*
Scilla nutans, *Sm.*
Luzula campestris, *DC.*
Carex riparia, *Curt.*
,, acutiformis, *Ehrh.*
,, paniculata, *L.*

The most interesting plant in the list is the mousetail, *Myosurus minimus*, which was found by Mr. A. E. Gibbs in a field between The Fryth and Ayot St. Peter's Church. It is recorded in Pryor's 'Flora of Hertfordshire' as a "Weed in the garden of The Fryth, near Welwyn." *Crepis taraxacifolia* was observed by Mr. James Saunders *in bud* near Wheathampstead, a new locality for it.

Field Meeting, 19th May, 1894.

BROCKET PARK AND WHEATHAMPSTEAD.

Starting again from Ayot Station, a party of about forty, including members from St. Albans, Watford, Hitchin, Hertford, and other places, under the direction of Mr. Hopkinson, walked through Brocket Park, taking a private path amidst hawthorns in full blossom and through a wood towards the flint bridge, by permission of Lord Mount Stephen, and at his request not wandering into the wood so as to disturb the game. In the park are some fine old trees, and on one hillside an immense quantity of wild hyacinths was seen, giving for an extent of several acres a beautiful rich blue tint.

A field-road was then followed by the side of the River Lea as far as Water End House, over which the members were shown by Lord Cowper's tenant, Mr. James Cole. Some interesting incidents relating to the history of the house, and of the Manor of Sandridge, in which it is situated, were given by Mr. Upton Robins and the director, the connection with it of the beautiful and accomplished Sarah Jennings, Duchess of Marlborough, an ancestor of the present Earl Spencer, Lord of the Manor of Sandridge, being especially dwelt upon, and Mr. Cole showed the room in which it is believed that she was born on the 6th of June, 1660. She was baptized in St. Alban's Abbey. The house was built about the year 1610 by Sir John Jennings, and is a fine example of the architecture of the period.

Crossing the river here by the foot-bridge, the road leading to Coleman Green was taken as far as the turning to Lower Beech Hyde Farm, an ascent nearly all the way. A little beyond the farm-buildings the field-road crosses the Moat, a trench in which there is always water, and it was found that, notwithstanding the recent dry weather, the ground here was moist, even the road being slightly muddy, showing that water is retained in the moat, which is locally known as "The Slud," owing to the retentive nature of the clayey subsoil. The moat is nearly half-a-mile in length, and curves round, but not so that the two ends nearly approach each other, and there is no indication that it ever enclosed any defensive earthwork or buildings.

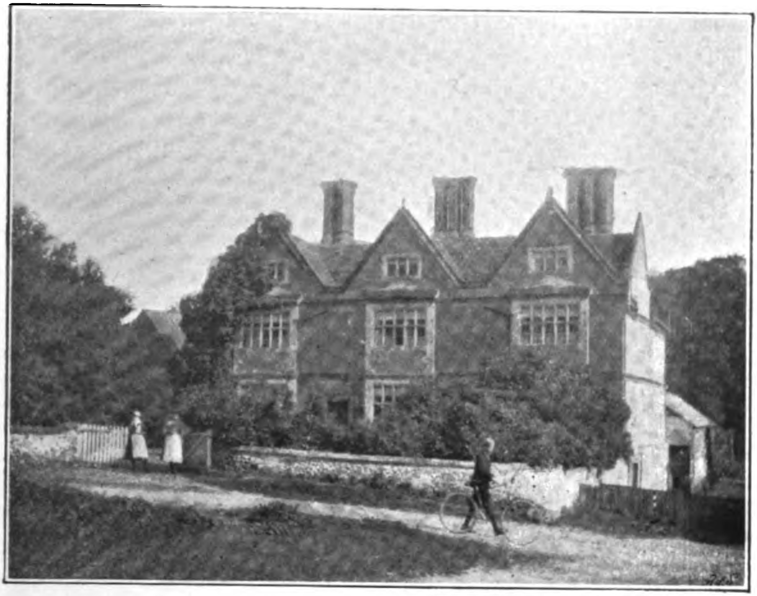
Nearly a quarter of a mile beyond the moat there is a deep and dry trench called "the Devil's Dyke," about half a mile in length. The earth has been thrown up on either side, and the roadway through it, which was traversed, leads almost straight down the hill to Marford. This dyke seems to be very similar to Beech Bottom and the dyke at Maynes, near St. Albans, and, like these earthworks, is generally believed to be of early British origin, but no satisfactory explanation as to its purpose, nor that of the moat near it, has been offered. It is probably either a portion of an ancient British tribal boundary or of an old fosseway, perhaps once continuous with Beech Bottom.

At Marford foot-bridge the Lea was again crossed, and the meadow by its side (*now* cruelly fenced off with barbed wire) was traversed as far as Wheathampstead. Taking the road to the north for a short distance, and then a path across the fields on the left, Delaport was reached at six o'clock, and the members and their friends were most hospitably entertained at tea by Mr. and Mrs. Upton Robins. The walk had been at least five miles in length, the air was keen if not positively cold, and the natural result was a healthy appetite, so that ample justice was done to the repast. At its conclusion a vote of thanks was accorded to the host and hostess for their kindness, on the proposition of Mr. William Ransom, seconded by Mr. Hopkinson.

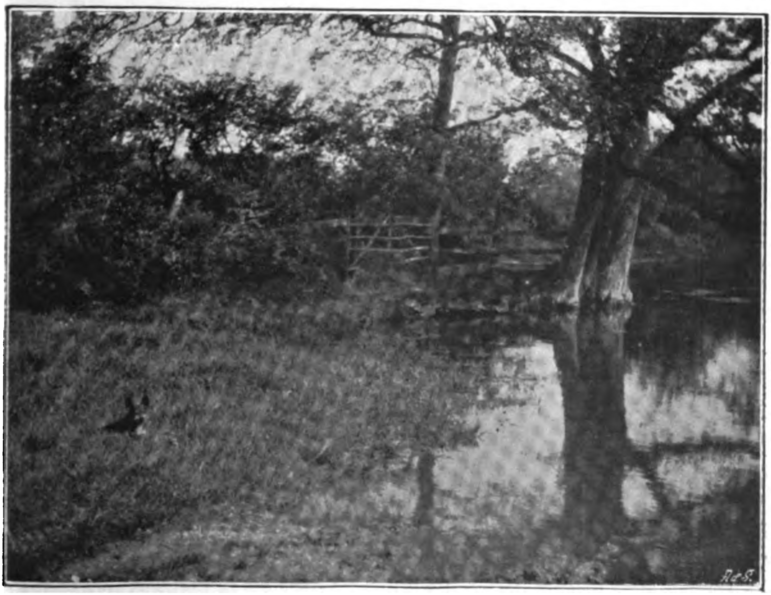
Most of the members then returned to their respective destinations by train from Wheathampstead Station, some drove or rode home, and several accompanied the director on foot to St. Albans, by way of No Man's Land Common, Hill End, and Sandridgebury.

The following ornithological notes are contributed by Mr. Henry Lewis :—

The song-thrush, nightingale, chiffchaff, blue tit, jay, and cuckoo were heard. The robin, whitethroat, willow-wren, swallow, greenfinch, yellow-hammer, and skylark were both heard and seen. The starling was seen, and a broken starling's egg was found on the ground. Nests were seen of the blackcap, chaffinch, and yellow-hammer, containing eggs; of the reed-bunting, containing young birds; and of the blackbird and wren, without either eggs or young birds. "Wren's nests," Mr. Lewis adds, "which are often found of imperfect construction, and containing no eggs, are called in the country 'cock's nests.' They are supposed to be built by the male bird for his own accommodation at night."



WATER END HOUSE, NEAR WHEATHAMPSTEAD.



THE MOAT, NEAR WHEATHAMPSTEAD.

Field Meeting, 26th May, 1894.

LUTON, CADDINGTON, AND DUNSTABLE.

This meeting was held in conjunction with the Geologists' Association of London, and was under the direction of Mr. Worthington G. Smith, F.L.S., of Dunstable. The chief object was to enable Mr. Smith to show to the members of the two societies the beds at Caddington from which he has obtained a large number of Palæolithic flint implements, described in his book, 'Man, the Primeval Savage.'

Arriving at Luton at a few minutes to eleven, the party first inspected the parish church of St. Mary and noticed particularly the use of local materials in its construction, the tower being built of Totternhoe Stone and flints from the Upper Chalk in alternate cubes. In the interior, the Wenlock chapel, the ancient font with its ornate canopy, and the fine oak carvings, attracted attention. The quaint inscriptions on some of the tombs were also noticed.

Soon after leaving Luton on the way to Caddington a storm came on, and the party sheltered for some time in a barn. The walk being continued by Farley Green to Woodside, some brick-fields between that hamlet and Slip End were visited. The pits are in re-laid Tertiary clay about 50 feet thick and 400 feet above sea-level, and, in the whitish beds above this clay, abraded Palæolithic flint implements have been found.

Bedfordshire having been left for Hertfordshire, the county boundary running through Caddington, the brick-fields near Caddington were visited, and Mr. Worthington Smith stated that he had come to the conclusion from long and careful investigation that they were on the site of an ancient lake, on the shores of which huts were built in which dwelt the primitive inhabitants who have left many relics attesting their occupation of the site. Here they made their implements, and left the flint tools they made them with and the flakes they chipped off in making them. Many of those which Mr. Smith has found he has pieced together, building up with them the flints in their original form, thus showing that the fragments were struck off on the spot. Many of the flint flakes, of which some hundreds have been found, have edges nearly as keen as those of knives.

The men who built these huts and made these implements were already, as Mr. Smith says in his book, skilful workmen, and they were therefore not nearly the most ancient of the human race, for "man must have existed thousands of years as a being incapable of designing and making stone weapons and tools of geometrically-correct form." They probably migrated from warmer climes, and, travelling over Europe in a north-westerly direction, reached Britain (which then formed, with Ireland, part of the European continent) as glaciers were here for the last time retreating northwards.

There is evidence near Caddington of the great northern ice-sheet with glaciers at its southern margin, in beds of boulder-clay, the clay itself being the ground-up surface-material of the district where it is now found, and often having much chalk in it, also of local derivation, whence it is called the "chalky boulder-clay." The stones or boulders which it contains, mostly water-worn and frequently ice-scratched, have been brought down by glaciers from higher land in the north, west, and east, often from great distances. In this boulder-clay no relics of man are found, though human relics occur immediately above it; but bones of the great hairy elephant or mammoth, of the reindeer, and of other animals contemporaneous with man, occur in a stratum of sand, gravel, and clay intercalated in it. After its deposition the land probably sank beneath the surface of the icy sea, and was then re-elevated to a greater height than it now stands. The rivers then were broad and ran at great heights, as is known "by the deposits of river-gravel, sand, brick-earth, and fresh-water shells which occur in terraces on the hill-sides bordering the Thames Valley. In these deposits of gravel, sand, and brick-earth, relics of the primeval human savage first appear. In some positions these relics are comparatively abundant, not on the surface, but imbedded amongst the constituent stones of the gravel and sand, or fixed in the brick-earth a hundred or more feet above the present river-level." ('Man, the Primeval Savage,' p. 7.)

Caddington is on the Chalk capped with re-distributed Tertiary beds, brick-earth, and gravel. The brick-yards near the village are from 550 to 600 feet above sea-level, and the water-level in the Chalk—the level of permanent saturation—varies from about 110 to 160 feet beneath the surface of the ground. This probably represents the extent of the depression in the water-level since Man first took up his residence on the shores of the ancient lake or swamp whose bed has been traced by Mr. Smith in pits on both the Hertfordshire and the Bedfordshire side of Caddington. Every important find, however, has been made in pits in our own county, and it was these which were now visited.

The pits are in Drift (brick-earth, etc.) and Tertiary *remanié* beds, and are worked for gravel as well as for clay and sand for brick-making. After examining the section in one of the pits, Mr. Cameron stated that the Tertiary beds, upon which lies the Palæolithic floor with its artificially-raised heaps of flints, were Reading sands and clays probably estuarine in origin, and that the bed immediately above was brick-earth. The section was very obscure, the sides of the pit having fallen in, but Mr. Smith stated that above the brick-earth he had found contorted beds of clay and gravel with Palæolithic implements and flakes, then *remanié* boulder-clay with sub-angular gravel above, again with Palæolithic implements and flakes, the whole being capped by reddish-brown, tenacious drift clay, and surface-soil with Neolithic implements of black lustrous flint, etc.

There are thus three distinct layers in which Palæolithic flint implements occur, the lowest being the Palæolithic floor or old land-surface, with flint tools varying in colour "from whitish-grey to dark grey, grey indigo, or indigo-blackish," nearly all being lustrous; the middle layer having porcellanous, white, or whitish implements, flakes, and cores, identical in age with the implements found on the true "floor"; and the upper layer having generally ochreous implements — yellow, brownish, speckled, creamy, or ochreous-whitish—and all slightly abraded. The tools in this layer differ in their nature from those below, and Mr. Smith believes that they are of different age, showing a second occupation of the spot by primeval man; while the presence of Neolithic tools in the surface-soil shows a third and much more recent occupancy, for there must have been a considerable interval of time between the period when man made implements by merely chipping off flakes of flint and that when he rounded and polished stones of various kinds.

This neighbourhood was again inhabited in Roman and in Saxon times, for in one of the Caddington pits numerous fragments of Roman pottery have been found; in other places near have been discovered cinerary urns, stones used, when heated, for pot-boilers, and numerous other relics attesting the early occupation of the country; and by the side of the road from Caddington to Zouches Farm was seen a large Saxon tumulus not marked on the Ordnance map. Close to Zouches Farm was also seen an old pasture believed to have been a place for making bricks or tiles in Mediæval or perhaps Roman times. It was pointed out that in the construction of the farm-house, notably in the chimney, Roman tiles were used, which it was thought might have been obtained from excavations on the site, or more probably from an older building which the present house has replaced.

Zouches Farm is on the Dunstable Downs, and a little farther on, overlooking Dunstable, but still in Hertfordshire, some hollows in the hill-side were pointed out by Mr. Smith, who stated that they were the remains of early British hut-foundations, of which, till lately, there were twenty-four, but eight of the best had been destroyed. In one of them he had found the greater part of a human skeleton. Deep excavations were, he explained, made by these primitive inhabitants, and were roofed in with skins, etc., these hollows forming more effectual shelter than tents erected on the natural surface of the ground.

From this point, some 600 feet above sea-level, and about the horizon of the Chalk Rock, is an extensive view to the north and west, embracing Dunstable, Maiden Bower (an early British camp), the Five Knolls (ancient tumuli), and Kensworth Hill (800 feet), on the Middle Chalk; Totternhoe, with its beacon-hill and evidences of early British and Roman occupation, on the Lower Chalk; and beyond, a Gault plain bounded by distant hills of Lower Greensand.

The steep hill was descended in a heavy shower, from which a hedge-bank on the boundary between Herts and Beds afforded a scanty shelter. At Dunstable a substantial repast was partaken of near the crossing-point of the two Roman road-ways, Watling Street and Icknield Way, after which a vote of thanks was accorded to Mr. Worthington Smith, on the proposition of the President of the Geologists' Association, Lieut.-General C. A. McMahon.

The residence of Mr. Smith was then visited, and his extensive geological and archæological collection was examined with much interest; and on the way to the Great Northern Station a brief inspection was made of Dunstable Priory Church, with its beautiful west front of Totternhoe Stone and fine Norman arch.

Bye Meeting, 16th June, 1894.

ZOOLOGICAL GARDENS, REGENT'S PARK.

On this occasion there was the largest gathering of the Society which has ever taken place, more than 140 members and their friends presenting themselves for admission at the turnstiles of the Zoological Gardens. The meeting was favoured with almost perfect weather, and the ornamental lawns and flower-beds of the Gardens were at their best. Actual members of the Society were admitted free on signing their names at the gate, while tickets were provided for all whose names did not appear on the list by the President, Mr. Arthur Stradling, by whom the party was conducted.

The pelican's enclosure was first visited, and attention was drawn to the fact that nowhere else in London can white birds be seen so little sullied by the sooty atmosphere as these, a state of purity maintained by the well-filled ponds with which they are provided. These birds, with the seals, sea-lions, and otters, subsisting as they do entirely on fish, are the most expensive creatures in the menagerie to feed—far more so than the lions and tigers, which are among the least costly. The Zoological Society pays nearly £600 a year for fish, including about £2 a week for live fish for the diving-birds. The great open-air cage for the waders was spoken of as probably the finest tenement for any captive animals in the world; enjoying abundant opportunities for even lofty flight within its spacious area, the birds are seen in a condition which approximates to freedom, and nest and breed there as they do in no other zoological establishment.

The series of cages on the opposite side is tenanted for the most part by representatives of the great and worldwide group of the Gallinaceous birds, those akin to our common domestic fowls, the "curassows" or mountain turkeys being especially in evidence just now in the Society's collection. Like so many animals which make their home in the New World, these are arboreal in habit. In this part of the grounds, too, are shown specimens of the interesting Weka-rail of New Zealand, a creature rapidly on the road to extinction, in spite of recent efforts to effect its preservation, its extermination being due, like that of the apteryx, to the ill-advised introduction of the mongoose as an experimental antidote to the rabbit-plague. These beautiful and defenceless birds, nesting on the ground, fall an easy prey to the marauding carnivore, which also devours their eggs. The hornbills with their phenomenal beaks and helmets, and two fine examples of the Brazilian screamer, a bird in which the "air-sacs" extending from the lungs are so developed that it can absolutely inflate its naked legs when enraged, were noticed in passing.

The animals in these Gardens are arranged in groups according to their systematic relationship, so far as is consistent with the well-being of each individual, not thrown together haphazard or simply with regard to picturesque effect in the way that obtains in many Continental menageries. Thus, the Perissodactyla, or "odd-toed" ungulates, are presented in a continuous chain of houses in the shape of the sole survivors of a once enormous race —the rhinoceros, elephant, tapir, and horse (zebras and wild asses).

Having given a short demonstration on the camels and their allies, the llamas and alpacas, showing how the formation of the feet which distinguishes them from all other animals proves their relationship, though they inhabit opposite corners of the earth and each is specialized for its mode of life, the President led the way to the north side of the grounds, where "Jenny," a young chimpanzee, successor to the lamented and famous "Sally," and a large gibbon, were taken out of their cages while their respective likenesses and points of distinction with regard to humanity were described. As both these anthropoid apes were very tame and trustworthy, and submitted with the utmost docility to the examination as well as the caresses of the visitors, the lecture would have been prolonged at this point had it not been for the great heat and inconveniently-overcrowded state of the small house. Both specimens illustrated admirably the various instances of comparison and contrast, such as the entire absence of hair on the terminal joint of the fingers and toes, even when viewed through a strong magnifying glass, a peculiarity which we alone of all animals share with them.

The curious structure of the feather-like fur of the ant-eater, each hair of which is nearly square in section, and its huge development of tongue, next attracted attention; and in the adjoining marsupial house another instance of that singular mimicry, real or apparent, which so many of the pouched animals offer in respect of higher groups, was shown by certain little beasts newly arrived from Australia, almost exactly simulating rabbits in their outward aspect.

The specially-constructed dens which were inhabited for so many years by the giraffes, of which a large number were bred in the establishment, are still retained in their original form, although it is sadly improbable that any other example of this beautiful ungulate will ever reach our shores alive—indeed, a skin and skeleton for the National Museum is now a desideratum; the relentless war which is waged against them in their native haunts for the sake of their hides (worth about £4 apiece for the making of colonial cattle-whips) must unfailingly result in their total extermination before long, although that enlightened chief, Khama, is doing his best to prevent their slaughter within his territory. Their place is now occupied by a pair of Zebu oxen and the large African ostrich presented by the Queen, both of which served as types of their respective sections for the purpose of demonstration, the former furnishing a text for a short lecture on horns, antlers, and similar structures, while the latter was utilized as subject-matter for some remarks upon that modification of the hand and arm which constitutes a wing, an evolution which these archaic birds evince even more obviously than those endowed with the faculty of flight. The ostrich in question is very gentle, and offered no resistance to being posed in its capacity of an object-lesson in the hands of its keeper.

Most of the houses and groups were visited in turn, Mr. Stradling lightening the more scientific part of his discourse with personal anecdotes of the history or peculiarities of disposition of the specimens under observation. The sea-lions and diving-birds were fed and put through their various performances specially for the benefit of the Society, and in the lion and reptile houses the members were admitted "behind the scenes," and shown the arrangement of the dens, sundry baby specimens, and other details not revealed to the general public.

A very young and playful leopard, and a cheetah, just arrived and not yet unpacked, were the centre of attraction at the rear of the lion-house, where the ingenious apparatus by means of which the great cats are transferred from their sleeping compartments to the open-air and other cages was exhibited in its working. The alligators and egg-eating lizards in the reptile-house were indulged with an extra meal, for the benefit of the visitors no less than their own; and some of the serpents were taken from their dens in order that the points of interest attaching to them might be more advantageously indicated.

At half-past five an adjournment was made to the large saloon of the restaurant, where Mrs. Stradling entertained the party at tea, while the strains of the band of the 1st Dragoon Guards contributed pleasingly to the harmony of the occasion. At the conclusion of the meal, Archdeacon Lawrance proposed a hearty vote of thanks to Mr. and Mrs. Stradling, and alluded to the fact that the Hertfordshire Natural History Society had scarcely ever been more prosperous or had a greater increase in its roll of members than at the present time, under the reign of the President who had brought them there that afternoon.

The President responded briefly, saying that he hoped the visit to the Zoo would become an affair of annual recurrence in their summer fixtures.

FIELD MEETING, 23RD JUNE, 1894.

TRING.

The chief object of this meeting was to visit the Zoological Museum established by the Hon. Walter L. Rothschild, F.Z.S., at Tring. Mr. Rothschild's permission having been obtained, the arrangements were made by Mr. A. Macdonald Brown, of Beech Grove, Tring, who acted as director.

The members, numbering about forty, assembled at Tring Station at half-past one, and drove to the Museum, where they were received by Mr. Rothschild's principal Curator, Mr. E. Hartert. Only a few of the more interesting objects of the collection which were pointed out by Mr. Hartert can here be mentioned.

The first case which attracted special attention was one of extinct and nearly extinct birds, such as the Moa (*Dinornis*) of New Zealand—probably the biggest bird that ever lived, and which, in former days, was hunted by the Maoris. The same case contains some enormous bones of the *Æpyornis*, a gigantic bird of nearly equal size from Madagascar, of which no entire skeleton has been obtained; and also specimens of the Kiwi (*Apteryx*) of New Zealand, which is not yet quite extinct but will probably soon become so, falling a prey to rats, cats, and other animals introduced there by man. These are wingless birds. The Labrador duck (*Camptolæmus labradoricus*), seen in another case, is also nearly extinct.

In another case a hybrid between the lion (*Felis leo*) and the tiger (*F. tigris*), born in Austria, attracted attention from the strangeness of such ferocious animals of distinct species breeding together.

There are a few fossils, introduced to elucidate the affinities of the living forms. Amongst them one of the most conspicuous is the giant ground-sloth (*Megatherium americanum*) of the Argentine Republic, in juxtaposition with a stuffed skin and skeleton of the recent two-toed sloth (*Cholœpus didactylus*) from the same region, to illustrate the various differences.

The fishes are stuffed here by a new process. Amongst them are already most of the British species, including an enormous sun-fish, and many foreign rarities, specially noticeable being some species with beaks like those of parrots.

Besides the large collections which are open to the public on four days of the week, there are private collections, which, from the standpoint of the zoologist, are still more valuable. They are for the scientific researches of Mr. Rothschild as well as of his curators and other competent persons, and are not generally accessible to visitors. These collections consist only of Lepidoptera, Coleoptera, and the skins and eggs of birds, and they are being arranged, studied, and added to continually. The results derived from these studies are given in an illustrated magazine ('*Novitates Zoologicæ*') edited and published at the Museum, and to which the Society subscribes. The butterflies and beetles, which are under the special care of the second curator, Dr. K. Jordan, are especially numerous, and amongst the latter a box attracted much attention in which Mr. Rothschild, for his own study, had arranged a number of beetles in a graduated series, each beetle differing but very slightly from its neighbour, while half-a-dozen specimens at least might be picked out which, but for the connecting links, would unhesitatingly be referred to different species.

In the library, an indispensable adjunct to all well-appointed museums, there is a very fine collection of zoological and other natural-history works.

In an enclosure outside the Museum were seen some living examples of the sacred cattle of India, mostly bred here, and also a large collection of living birds.

Tring Park, adjoining—the seat of Lord Rothschild—was next visited, and in it were seen emus (wingless birds) and kangaroos.

The party, accompanied by Mr. Hartert, then drove to "Dundale," a pretty dell excavated in the Middle Chalk by a stream issuing from a spring which is one of the feeders of the Thame. Several birds are breeding here, including the Rhea, an American winged bird allied to the ostrich. A few clutches of eggs, which are occasionally added to, were seen. The *male* bird only sits upon them.

The following account of the Dundale spring, and of other springs in the neighbourhood, is contributed by Mr. A. M. Brown:—

"The spring at Dundale is one of the four sources, in the Lower and Middle Chalk of Tring, of, originally, as many small streams, which, soon uniting north-westward from the escarpment, once flowed out of our county to the valley of the Thame. The water-bearing beds producing them are the Totternhoe Stone, the Rag-bed of the Lower Chalk, some 40 feet higher, and the Melbourn Rock, forming the base of the Middle Chalk, about 80 feet above the Totternhoe Stone.

"The Melbourn Rock, with its underlying marly bands, is probably responsible for 'Dundale' and the springs at 'Frogmore' in the town of Tring, and the Rag-bed for those at Miswell and Bulbourne Head, the latter sending two streams in opposite directions, one running south-east through Berkhamsted, the other north-west by Gubblecote or Bubblecote, forming there the boundary between Herts and Bucks.

"By the construction of the Grand Junction Canal and its reservoirs at the end of the last century, and the erection of the Tring Silk Mill in 1824, all these streams were diverted, and a considerable length of those issuing from Bulbourne Head absorbed. The other three were conducted to the Silk Mill and thence by an embanked 'feeder' to the Reservoirs, whence a corresponding flow has to be delivered to the ancient channels beyond.

"In 1889 Dundale was converted by Lord Rothschild into its present picturesque state by raising the level and increasing the extent of the water, planting numerous trees, and building the pretty lodge and summer-room near the Icknield Way."

The meeting was very pleasantly brought to a close by a visit to Beech Grove, the residence of Mr. Brown, where tea and other refreshments were provided, collections of fossils and of dried plants were examined, and a photograph of the party was taken by Mr. Downer of Watford. Votes of thanks were accorded to Mr. Brown, to the Hon. Walter Rothschild, and to Mr. Hartert; and Tring Station was reached at about six o'clock.

Field Meeting, 30th June, 1894.

STEVENAGE, THE WYMONDLEYS, AND HITCHIN.

The members assembled at noon at Stevenage Station, where they were met by a few members of the Hitchin Natural History Club, and by Mr. William Ransom, F.S.A., who had made all the arrangements for the meeting, providing carriages for the ladies, and also acted as director.

After passing through Fisher's Green the first object of interest inspected was the famous old Spanish chestnut tree at Wymondley Bury, near the church of Little Wymondley. This tree is now fifteen yards in circumference at four feet from the ground, the trunk is hollow and riven quite to the ground in several places, but the foliage is still luxuriant. Some enormous branches which have fallen off have taken root and sent up saplings which grow around the parent stem. The age of the tree is unknown. It is not mentioned in Domesday Book, but it was probably standing at the time of the Norman Conquest. Canon Gee, in his paper on "Famous Trees in Hertfordshire" in the Society's Transactions ('Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 8) says that this is the largest tree that he knows, and seemingly the oldest, in Hertfordshire. "It is now," he adds, "the wreck of a wreck. There is not half of its circumference standing, though a print at High Elms, of the year 1790, shows the tree as much more nearly perfect." The following description of the tree which Mr. Ransom read from Gilpin's 'Forest Scenery,' a work which was written at about this time, would however well apply to it now:—

"After mentioning a chestnut in the garden at Tortworth, in Gloucester[shire], which has been celebrated so much, I cannot forbear mentioning another, which is equally remarkable for not having been celebrated at all, though it is one of the largest trees that perhaps ever existed in England. If it had ever been noticed merely for its bulk, I should have passed it over among other gigantic plants that had nothing else to boast; but as no historian or antiquarian [antiquary], so far as I have heard, hath taken the least notice of it, I thought it right, from this very circumstance, to make up the omission, by giving it at least what little credit these papers could give. This chestnut tree grows at a place called Wimley, near Hitchin Priory in Hertfordshire. In the year 1789, at five feet from the ground its girth was somewhat more than fourteen yards. Its trunk was hollow, and in part open, but its vegetation is still vigorous. On one side its vast arms, shooting up in various forms, some upright and others oblique, were decayed and peeled at the extremities, but issued from luxuriant foliage at their insertion in the trunk. On the other side the foliage was still full and hid all decay."

Mr. Ransom then compared this Spanish chestnut with the "Grizzly Giant" of California, a *Sequoia gigantea*, which he measured when in the Mammoth Grove at Calaveras in 1887, and found to be thirty-one yards in circumference near the ground, only a little more than double that of the "Wymondley Giant." He also lamented that means were not taken to protect this venerable tree from injury. Many less noteworthy trees are carefully fenced round and preserved as national monuments, as this ought to be.

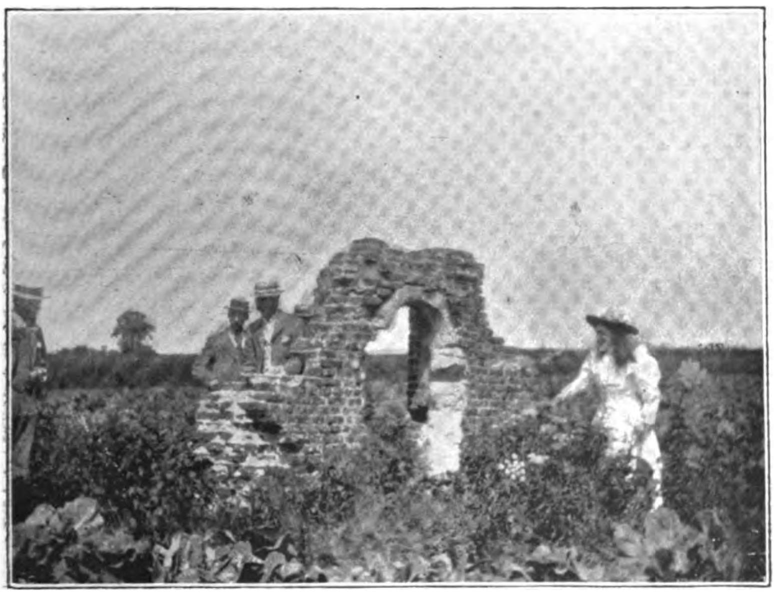
Little Wymondley Church was then visited. It is at least the third church which has been erected on the same site. Cussans ('Hist. Herts,' Broadwater, p. 61) says that "the Vicarage, from the time of its ordination by the Bishop of Lincoln, in 1209, until the Dissolution of Religious Houses by Henry VIII, belonged to the Prior and Convent of Wymondley. It then, by grant of the King, became a donative in the gift of the owner of the Priory."

The old Priory is no longer in existence, but on its site is a comparatively modern house to which the same name has appropriately been given. It is occupied by Mr. Charles Sworder, and by his permission it was now visited, the village of Little Wymondley, to the north-east of which it stands, having been passed through. In the old box-trees enclosure, a square space enclosed by box-trees, lunch was partaken of, Mrs. Sworder kindly providing refreshing beverages, especially acceptable just in the hottest part of a very hot day. While still in the shade of the box-trees, Mr. Ransom gave a brief history of the Priory. It was founded, he said, in the reign of Henry the Third to the honour of St. Lawrence, by Richard de Argentein, for canons of the order of St. Augustine, and according to Chauncy ('Hist. Antiq. Herts,' p. 361) it was "a fair old Building with Cloysters; there was a Chappel in it consecrated since the Dissolution, [it was] almost surrounded with a Mote, scituated upon the Side of a small Hill, incompassed with near 400 Acres of rich meadow, pasture, and arrable Land inclosed to it, with a very fair Orchard and Garden, yielding the best Sort of Fruit. The House is supply'd from a Conduit, with sufficient Water to turn the Spit in the Kitchen upon all Occasions." Mr. Sworder added that his father could remember the time when the spit was thus worked, but this contrivance has been done away with for many years, and there is not now a sufficient flow of water to turn the spit upon any occasion.

At the head of the conduit, two fields' lengths from the house, is a ruined arch, apparently of Early Norman architecture. As this appears to be almost the only existing remnant of any building connected with the old Priory, and is likely soon to be demolished, a photograph was taken of it, and is here reproduced.

After viewing the moat, the remains of an old wall, and the old tithe-barn, built entirely of oak, and one of the largest barns in England, the house was entered, and Mr. Sworder pointed out the arches in the cellar, an old arch at the entrance to one of the

THE WYMONDLEY CHESTNUT.



RUINED ARCH, WYMONDLEY PRIORY.

bedrooms, the old oak panelling, and the enormous stack of chimneys with the passage which he had had cut through the middle of it a few years ago.

On leaving the Priory a vote of thanks was accorded to Mr. and Mrs. Sworder for their kind attention.

Mr. Ransom then led the way to the site of the Roman buildings and cemetery adjoining Great Wymondley Church, and gave some particulars of an old enclosure of about twenty acres which once existed here. It was to be traced, he said, by a bank which encircles it, and it was probably given to a distinguished Roman soldier on which to retire. Some years ago he excavated at one corner of the estate, and found ample evidence of a Roman settlement. Amongst other things he discovered the cemetery and the rubbish-heap, from the former of which he obtained about forty urns, and from the latter from twenty to thirty Roman coins and a variety of culinary and other articles.

Great Wymondley Church was then entered; it now presents but few features of interest, except the rood stairs.

A walk of nearly two miles brought the party to the clay pits near Hitchin Hill, where Mr. William Hill, F.G.S., gave an account of his researches, which led him to the conclusion that a large lake once existed at this spot. Overlying the Chalk, he said, were beds of stony clay, sand, and gravel, deposited during the Glacial period; the gravel was evidently deposited by water running with considerable velocity, and on the top of it was a fresh-water deposit laid down under very still water, and he concluded that it was the bed of a lake. Its extent to the west was probably a quarter of a mile, to the north and east its limit was defined by a boss of chalk distant a third of a mile, and it probably extended a greater distance to the south-west, though there was no evidence of its continuation in that direction. He had found a great number of shells in this lake-bed, all being fresh-water forms and of species still living in lakes and ponds. An examination of the sandy loam under the microscope had disclosed the presence of the seeds or spores of a fresh-water plant (*Chara*), and of the minute valves of four species of water-flea (*Daphnia*). One species was thought to have been extinct, but it had been discovered by Dr. Brady living in lochs in the north of Scotland. This deposit passes down into a black calcareous loam, again with shells, and with teeth of the elephant, which must have been fairly abundant, bones and teeth of the bear, bones of the rhinoceros, and antlers of a large stag, these relics being now in the possession of Mr. W. Ransom. Evidence that pre-historic man must have considered Hitchin to be a very eligible position for a residence existed in the number of worked flints which are found in the clay. The implements—rudely-shaped axes, knives, and scrapers—belong to the Palæolithic or Old Stone Age, and form the earliest record of the existence of man upon the earth.

The meeting was very pleasantly brought to a conclusion with a visit to Fairfield, Hitchin, the residence of Mr. Ransom, who provided tea for the party, which, by the accession of members of the Hitchin Natural History Club, had more than doubled its numbers. Here Mr. T. B. Blow and Mr. Henry Groves showed some rare plants which they had just gathered in the neighbourhood, including *Trifolium ochroleucon*, Huds.; *Œnanthe Lachenalii*, Gmel.; *Bulbocastanum Linnæi*, Schur.; *Orobanche major*, L. (parasitical on *Centauria scabiosa*); *Samolus Valerandi*, L.; *Carex lepidocarpa*, Tausch.; and *Phleum phalaroides*, Koel. The *Œnanthe*, *Samolus*, and *Phleum* are the rarest of these. The localities in which they grow in the neighbourhood of Hitchin will be found in Pryor's 'Flora of Hertfordshire.'

Mr. Ransom has a fine collection of antiquities, which were examined with much interest, especially a case of Phœnician glass at least 2,500 years old; Roman pottery and coins found in the neighbourhood; and a large collection of implements of the Palæolithic, Neolithic, and Bronze Ages.

Before the party separated a vote of thanks was accorded to Mr. Ransom for his hospitality and the trouble he had taken to make the meeting a complete success.

Field Meeting, 13th October, 1894.

ALDBURY AND ASHRIDGE PARK.

The members, who numbered more than at any previous fungus foray of the Society, assembled at Tring Station at half-past ten, and walked through the village of Aldbury and up the slopes of Moneybury Hill to the Bridgewater Monument, commencing the collection of fungi in the village, on an old tree near the pond, and being busily at work all the way. Some then walked to Little Gaddesden for lunch; others who had brought it with them partook of it by the Monument; and while the most enthusiastic fungologists prosecuted their investigations in the immediate neighbourhood, others went farther afield, walking through the Avenue, about two miles in length, to Ashridge House, and returning by a more circuitous route through the Park and over the Common, searching for fungi all the way. With the exception of one member, who had to leave by an earlier train than the rest, for Luton by way of Leighton, all had tea together at the "Greyhound" in Aldbury, and then walked to Tring Station for the 4.51 train for Watford, St. Albans, and other places.

The meeting was under the direction of Mr. Hopkinson, and the fungi which were collected were determined by Mr. George Massee, of Kew; Mr. James Saunders, of Luton, recording the Mycetozoa.

The following is a list of the fungi recorded by Mr. Massee. It comprises 185 species, of which 65 are for the first time recorded for Hertfordshire. To these an asterisk (*) is affixed. The rare species, 4 in number, are indicated by an obelisk (†), and the edible species by a double dagger (‡).

HYMENOMYCETES.

Agaricus (Amanita) phalloides, *Fr.*
,, ,, mappa, *Batsch.*
,, ,, muscarius, *L.*
,, ,, pantherinus, *DC.*
,, ,, rubescens, *Pers.*‡
,, ,, spissus, *Fr.*
,, ,, vaginatus, *Bull.*‡
,, (Lepiota) procerus, *Scop.*‡
,, ,, rachodes, *Vitt.*‡
,, ,, gracilentus, *Kromb.**
,, ,, Badhami, *B. & Br.** ‡
,, ,, hispidus, *Lasch.**
,, ,, clypeolarius, *Bull.*
,, ,, cristatus, *Fr.*
,, ,, carcharius, *Pers.*
,, ,, granulosus, *Batsch.*
,, (Armillarius) melleus, *Vahl.*‡
,, ,, ramentaceus, *Bull.*
,, ,, mucidus, *Fr* ‡
,, (Tricholoma) equestris, *L.*
,, ,, portentosus, *Fr.*
,, ,, flavo-brunneus, *Fr.*
,, ,, albo-brunneus, *Fr.*
,, ,, rutilans, *Schæff.*
,, ,, imbricatus, *Fr.*
,, ,, vaccinus, *Pers.**
,, ,, terreus, *Schæff.*
,, ,, saponaceus, *Fr.*
,, ,, sulphureus, *Bull.*
,, ,, bufonius, *Pers.*
,, ,, albus, *Schæff.*
,, ,, personatus, *Fr.* ‡
,, ,, nudus, *Bull.* ‡
,, ,, grammopodius, *Bull.**
,, ,, melaleucus, *Pers.*‡
,, ,, sordidus, *Fr.**
,, (Clitocybe) nebularis, *Batsch.*‡
,, ,, clavipes, *Fr.*
,, ,, odorus, *Fr.*‡
,, ,, phyllophilus, *Fr.*
,, ,, pithyophilus, *Fr.*
,, ,, candicans, *Fr.*
,, ,, dealbatus, *Sow.*
,, ,, gallinaceus, *Scop.*
,, ,, fumosus, *Pers.**
,, ,, infundibuliformis, *Schæff.*
,, ,, gilvus, *Pers.**
,, ,, inversus, *Scop.**
,, ,, ericetorum, *Bull.**
,, ,, cyathiformis, *Fr.*
,, ,, ditopus, *Fr.*
,, ,, fragrans, *Sow.*‡
,, ,, laccatus, *Scop.*
,, ,, Sadleri, *Berk.** †
,, (Collybia) radicatus, *Rehl.*
,, ,, platyphyllus, *Fr.**
,, ,, maculatus, *A. & S.*
,, ,, butryaceus, *Bull.*
,, ,, hariolorum, *Bull.**

Agaricus (Collybia) confluens, *Pers.*
,, ,, cirrhatus, *Schum.**
,, ,, tuberosus, *Bull.*
,, ,, nitellinus, *Fr.**
,, ,, succineus, *Schæff.**
,, ,, esculentus, *Jacq.** ‡
,, ,, dryophilus, *Bull.*
,, ,, rancidus, *Fr.*
,, ,, ozes, *Fr.** †
,, (Mycena) pelianthinus, *Fr.*
,, ,, elegans, *Pers.**
,, ,, purus, *Pers.*
,, ,, pseudo-purus, *Cke.**
,, ,, lineatus, *Bull.*
,, ,, luteo-albus, *Bolt.*
,, ,, flavo-albus, *Fr.*
,, ,, rugosus, *Fr.*
,, ,, galericulatus, *Scop.*
,, ,, polygrammus, *Bull.*
,, ,, alcalinus, *Fr.*
,, ,, tenuis, *Bolt.*
,, ,, stanneus, *Fr.**
,, ,, filopes, *Bull.*
,, ,, hæmatopus, *Pers.*
,, ,, sanguinolentus, *A. and S.*
,, ,, galopus, *Fr.*
,, ,, epipterygius, *Scop.*
,, ,, discopus, *Lév.**
,, ,, corticola, *Schum.*
,, (Omphalia) pyxidatus, *Bull.*
,, ,, rusticus, *Pers.*
,, ,, muralis, *Sow.**
,, ,, umbelliferus, *L.*
,, (Pleurotus) lignatilis, *Pers.*
,, ,, ostreatus, *Jacq.*
,, ,, limpidus, *Fr.**
,, ,, applicatus, *Batsch.**
,, ,, chioneus, *Pers.**
,, (Volvaria) medius, *Fr.**
,, (Pluteus) cervinus, *Scop.*
,, ,, nanus, *Pers.*
,, (Entoloma) sinuatus, *Fr.*
,, ,, sericellus, *Fr.*
,, ,, sericeus, *Bull.*
,, ,, nidorosus, *Fr.*
,, (Clitopilus) prunulus, *Scop.*‡
,, ,, undatus, *Fr.**
,, (Leptonia) lampropus, *Fr.*
,, ,, euchrous, *Pers.** †
,, ,, chloropolius, *Fr.**
,, (Nolanea) pascuus, *Pers.*
,, (Eccilia) atropunctus, *Pers.*
,, (Claudopus) deplueus, *Batsch.**
,, ,, variabilis, *Pers.**
,, (Pholiota) erebius, *Fr.**
,, ,, togularis, *Bull.**
,, ,, radicosus, *Bull.*
,, ,, squarrosus, *Müll.*
,, ,, spectabilis, *Fr.*
,, (Inocybe) cincinnatus, *Fr.**

Agaricus (Inocybe) pyriodorus, *Pers.*
,, ,, lacerus, *Fr.**
,, ,, fastigiatus, *Schæff.**
,, ,, Clarkii, *B. & Br.**
,, ,, geophyllus, *Sow.*
,, (Hebeloma) fastibilis, *Fr.*
,, ,, nudipes, *Fr.*
,, (Flammula) lentus, *Pers.*
,, ,, spumosus, *Fr.**
,, ,, scambus, *Fr.**
,, (Naucoria) cerodes, *Fr.**
,, (Galera) tener, *Schæff.*
,, ,, hypnorum, *Batsch.*
,, (Psalliota) augustus, *Fr.** ‡
,, ,, arvensis, *Schæff.** ‡
,, ,, pratensis. *Schæff.** ‡
,, (Stropharia) æruginosus, *Curt.*
,, ,, squamosus *Fr.*
,, (Hypholoma) pyrotrichus, *Holmsk.**
,, ,, velutinus, *Pers.*
,, (Panæolus) retirugis, *Batsch.**
,, (Psathyrella) pronus, *Fr.**
Coprinus atramentarius, *Fr.* ‡
,, comatus, *Fr.* ‡
Cortinarius balteatus. *Fr.**
,, largus, *Fr.*
,, ochroleucus. *Schæff.*
,, lepidopus, *Cke.**
,, paleaceus. *Fr.*
Paxillus involutus, *Batsch.*
Hygrophorus aromaticus. *Berk.**
,, pratensis, *Pers.*‡
,, niveus, *Scop.*‡
,, nitratus, *Pers.**
Lactarius utilis, *Weinm.** ‡
,, blennius, *Fr.*
,, deliciosus, *L.** ‡
,, helvus, *Fr.**
,, volemus, *Fr.** ‡
Russula nigricans, *Fr.*
,, rubra, *Fr.*
,, vesca, *Fr.*‡
,, barlæ, *Quélet.** †
Cantharellus cibarius, *Fr.*‡
Marasmius peronatus. *Bolton.*
,, oreades, *Fr.*‡
Boletus scaber. *Fr.*‡
,, laricinus, *Berk.*
Polyporus velutinus, *Fr.**
,, versicolor, *Fr.*
,, sanguinolentus, *A. & S.**
,, vaporarius, *Fr.*
Corticium comedens, *Fr.*
Stereum hirsutum, *Fr.*
Clavaria fragilis, *Holmsk.*‡
,, fusiformis, *Sow.** ‡
,, grisea, *Pers.*

GASTROMYCETES.

Phallus impudicus, *Grev.**
Lycoperdon saccatum, *Vahl.*
,, excipuliforme, *Scop.**

DISCOMYCETES.

Rhytisma maximum, *Fr.**
Phacidium coronatum, *Fr.**
Peziza granulata, *Bull.*
,, luteo-nitens, *B. & Br.**
,, hemispherica, *Wigg.**
Helotium æruginosum, *Fr.*

"In looking over the above list," Mr. Massee remarks, "three points appear to be very pronounced: (1) the large number of species collected; (2) the very large proportion of species with white spores; (3) the large number of perfectly safe, edible species—31—each having its own peculiar flavour and aroma."

A very rare and beautiful species—*Agaricus* (*Leptonia*) *euchrous*, Pers.—was found by Miss Daisy Weall. It has only once before been detected in Britain.

Mr. James Saunders records the finding of the following species:—*Comatricha pulchella*, Bab.; *Trichia contorta*, Ditm., var. *inconspicua*; and *Arcyria incarnata*, Pers.

The weather was fine, the country beautiful, and the foray the most successful one the Society has held.

Mr. Massee desires to point out that, however numerous the species collected in the autumn may be, no fairly complete list of the fungi of the county can be made unless those which are to be met with throughout the year are recorded.

Ordinary Meeting, 27th November, 1894, at Watford.

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Miss Adams, St. Peter's House, St. Albans, and Mr. Noel Heaton, Sans Souci, Watford, were elected Members of the Society.

Mr. Cecil Braithwayt, Overbury, Watford; Mr. W. J. Hardy, F.S.A., Milton Cottage, St. Albans; Mr. William Holloway, Arncot, Watford; Mr. Edmund L. Johnson, Heathdene, Watford; Dr. Arthur King, Belmont, Watford; Mr. W. Ronald Mackay, Shirley House, Watford; Mr. W. Metcalfe, Woodford Road, Watford; Mr. Edwin Spurr, Fernlea, Westland Road, Watford; and Mrs. Wood, Woodside, Leavesden, Watford, were proposed for membership.

The following lecture was delivered:—

"Herbert Spencer: a Sketch of his Life and Work." By William R. Hughes, F.L.S., of Birmingham.

The lecture was illustrated by a large number of photographs shown by means of the oxy-hydrogen lantern.

Ordinary Meeting, 28th December, 1894, at Watford.

Arthur Stradling, Esq., M.R.C.S., F.Z.S., President, in the Chair.

Mr. Cecil Braithwayt, Mr. W. J. Hardy, F.S.A., Mr. William Holloway, Mr. Edmund L. Johnson, Dr. Arthur King, Mr. Ronald Mackay, Mr. William Metcalfe, Mr. Edwin Spurr, and Mrs. Wood, were elected Members of the Society.

Mr. Alan Fairfax Crossman, St. Cuthbert's, Berkhamsted, was proposed for membership.

The following papers were read:—

1. "Report on the Conferences of Delegates to the British Association at Oxford in 1894." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Having acted as your delegate to the Oxford meeting of the British Association, it is my duty to bring before the Society the various subjects which were discussed at the Conferences of Delegates of the Corresponding Societies. The Conferences were held on the 9th and 14th of August, the first Conference being devoted to the subject of Local Museums, and the second to the consideration of the work of the sectional Committees of the Association, or Committees of Research.

Professor R. Meldola, F.R.S., presided at each Conference. All the members of our Society who are on the Corresponding Societies Committee were present at the first Conference. They are Sir John Evans, Mr. G. J. Symons, Mr. W. Topley, Mr. W. Whitaker, and myself. At the second were present Mr. Symons, Mr. Whitaker, and myself.

First Conference.

Local Museums.—The discussion on Local Museums, to which the first Conference was devoted, was opened by Mr. Cuthbert Peek, who dealt with the subject under the following headings:—

1. Methods of registration and cataloguing.
2. The protection of specimens from injury and dust.
3. The circulation of specimens and type-collections for educational purposes.
4. Central referees for nomenclature and classification.
5. The most satisfactory methods of making museums attractive.
6. Museum lectures and demonstrations.
7. The relations between museums and County Councils.

1. *Methods of Registration and Cataloguing.*—Having examined several systems before arranging a small general museum of his own, Mr. Peek came to the conclusion that for small museums the card catalogue was the most convenient, on account of the ease with which changes and additions could be made. Sectional letters distinguished the various classes of objects. Each specimen when received had a number allotted to it under the letter assigned to the section. In order that the number might remain attached to the specimen, he painted the letter and number on the specimen with red or white paint, and gave them when dry a coat of oil varnish. When practicable it was a good thing to paste a photograph showing the locality at which the object was found at the back of the card. Labels were often displaced by the careless cleaner, but if the exact dimensions of a specimen, with a rough outline of it, were entered on the back of the card, identification would always be possible.

2. *The Protection of Specimens from Injury and Dust.*—On this subject it was necessary to remind the delegates that every closed case was practically acted upon by changes in the pressure of the atmosphere (in the same way as the cistern of a mercurial barometer), and that it drew in or gave out air and dust with every change of pressure. Professor Miall, at the Yorkshire College, had a rectangular hole cut in the top of each case and this was covered with damiette. This filters the air passing in. He (Mr. Peek) felt inclined to use a tube filled with cotton-wool for this purpose. It must be remembered that enough air should be admitted at the authorized entrance to prevent supplies from being sucked in through the inevitable joints and cracks elsewhere.

3. *The Circulation of Specimens and Type-Collections for Educational Purposes.*—The importance of educating the eye was now generally recognized, and the London scientific societies are more and more introducing the optical lantern at their evening meetings. The advantage of the circulation of loan collections illustrating the subjects taught in elementary schools was therefore obvious. At Liverpool a system had been elaborated by which loan collections were prepared and circulated among a large number of schools. Experience had shown that the collections should be arranged in

cabinets, each containing some special class of objects, such as food-products, woods, etc. Those wishing to organize a plan for circulations of this kind should consult a paper by Mr. J. Chard in the Report of the Museums Association for 1890.

The educational advantages of a museum were much increased by a liberal use of pictorial illustrations placed as near as possible to the objects illustrated. In the case of minute objects drawings on a larger scale were of the highest value, while models and casts were often of the utmost service. Labels should be clear, and should indicate the most important points in plain language. When specimens could be replaced without difficulty, a certain amount of handling might be permitted. It was most desirable that over-crowding should be avoided, and that the utmost care should be taken in the selection of type-specimens. Much economy of space would result from the adoption of an American invention which he would briefly describe. The side of the cabinet, instead of having one slide for each drawer, has a series of slides, one inch apart, all the way up the side, the bottom of each drawer having a tongue to fit into one of these slides. It was clear from this that the drawers might be made in multiples of an inch and arranged in any order desired.

4. *Central Referees for Nomenclature and Classification.*—One of the greatest difficulties which the average curator of a small museum had to deal with was the nomenclature of the various specimens under his charge. An organization of specialists who would for a small fee allow specimens to be forwarded to them for identification would be of the greatest possible value. Certain abstruse questions might not even then be easy to answer; but if nine-tenths of our museum specimens could be accurately catalogued a great step in the right direction would be taken.

5. *The most satisfactory Method of making Museums attractive.*—To those who know the museums at South Kensington, or some of the equally well-arranged local museums, this heading might seem unnecessary. But many present might be able to call to mind some collection in a country town containing many most valuable local specimens, the very existence of which was unknown to the majority of the inhabitants. This state of things was yearly becoming rarer; but many persons could point out some museum almost as much fossilized as the fossils it contained, with labels either illegible from age or invisible from displacement. Those who casually entered such museums seldom revisited them. It was most desirable that the English as well as the Latin name of a specimen should be given. Much might be done to allow of comparisons between creatures of different families or genera. Thus, at the Natural History Museum, South Kensington, the skeletons of a man and of a horse in the attitude of running had recently been placed the one in front of the other, so that the relations of the two, bone for bone, could be distinctly seen. The surgical, ordinary, and veterinary names of the bones were added throughout.

6. *Museum Lectures and Demonstrations.*—While the great value of case-to-case explanations was invariably admitted, the difficulty attending any attempt to make a museum demonstration useful to any large number of persons was equally obvious. One most experienced demonstrator had stated that the largest number of persons who can receive real benefit from a case-to-case demonstration is about a dozen, and had recommended that the lecture, illustrated by specimens and lantern-slides, should be given in an ordinary lecture-room, and a demonstration afterwards in the museum to the smaller number seeking further information. In any case it was most desirable that the demonstrator should be placed on a temporary stand, so that he might see and be seen by his audience.

7. *The Relations between Museums and County Councils.*—It having always appeared to him that demonstrations in museums should take a very prominent part in technical education, especially in rural districts, he had been surprised that so little assistance had been given in aid of local collections by County Councils. In order to ascertain what had been done in that direction he had sent out a circular to County Council technical education committees, and found that local museums and free libraries had been assisted only in nine cases. The County Council of Cumberland had been the most liberal, having made a grant of £600 per annum during the last three years for the purpose of aiding the Corporation of Carlisle to erect a museum, free library, and art school. A grant had also been made to a free library at Whitehaven for the purchase of text-books for the use of students at technical instruction classes, and a grant of £200 per annum had been given to the Local Board of Millom in aid of the free library and technical school at that town. In Westmoreland a grant of £100 had been made to the Kendal Free Library, and a similar sum had been given for the purchase of books on scientific subjects at other centres in the county. In Northumberland 50 per cent. of the cost of technical books for village and other libraries had (under certain conditions) been defrayed. At Leeds grants had been made to the Free Public Library Committee of the Corporation for the purchase of pictures and books. In Hertfordshire money had been given to free libraries for the purchase of technical books, and in Montgomery grants had been made in two cases. In Surrey no aid had been given to free libraries, but it was proposed to found a museum in connection with buildings for technical education, and a reference library. The London County Council had a proposal to aid a certain museum under consideration; and in Dorsetshire the museums at Poole, Dorchester, and Sherborne had all received aid. From some counties no information had yet been received, but enough had been stated to show that there was no insuperable obstacle to the application of money intended for technical education to the development of museums. A leading object with the Government was the development of local activity, and he felt convinced that any grants made to local museums

and free libraries would tend more than anything else to further that object.

A considerable amount of discussion followed, the principal question considered being the legality of grants being made to museums by County Councils. It was elicited that, although in some cases aid had thus been directly given, it was only strictly legal to make grants in aid of lectures and demonstrations in museums, or for the purchase of technical books, apparatus for lectures, and specimens required to increase the efficiency of the lectures. It will thus be seen how advisable it is in establishing a provincial museum to provide a lecture-room and arrange for lectures to be given. Sir John Evans doubted whether grants to museums would be permitted to pass by the Government auditors, though a grant of technical books might be allowed, and he said that inquiries should be made to the Science and Art Department at South Kensington as to the legality of any proposed grant for the purchase of specimens to illustrate lectures. Mr. H. Coates stated that a large addition was being built to the Perth Museum, and a grant had been obtained from the County Council on condition that specimens suitable for agricultural teaching should be provided. These specimens would be used for lectures and demonstrations. Otherwise, they had been advised they could not obtain the grant.

Some useful hints on the management, etc., of museums were also given in the course of the discussion. Sir John Evans recommended the American system of card-catalogue, a perforated card through which a wire passed, so that the cards could not be disturbed. He spoke of the difficulty of keeping dust out of cabinets, for they exhale air whilst the day is warm, and inhale it, with dust, in the cooler evening. As regards referees for nomenclature and classification, he said that any curator might consult the keepers of the various departments of the British Museum at South Kensington or at Bloomsbury, with a certainty of receiving prompt and valuable assistance. Referring to the obliteration of labels, the Rev. O. P. Cambridge and Dr. Garson recommended for preparations in spirit that labels should be written *in pencil* on good paper and be placed *inside* the glass jars.

The only other question which arose was as to the difficulty of deciding upon what specimens were worthless and should be got rid of, and Sir John Evans thought that the opinion of the secretary or curator of a museum ought to be deemed sufficient.

The following resolution was proposed by Sir Douglas Galton, seconded by Dr. Brett, and carried:—

"That in the opinion of this Conference it is desirable that local natural history societies, and those in charge of local museums, should place themselves in communication with the Technical Instruction Committee of the county or borough in which they are placed, with the view of obtaining pecuniary grants towards extending technical knowledge by means of lectures or by demonstrations in museums."

Second Conference.

The principal subjects brought before the second conference were as follows:—Meteorological Photography, Earth-Tremors, the Pollution of Air in Towns, the Erosion of the Sea Coast, Underground Waters, Erratic Blocks, Geological Photographs, the Teaching of Geography in Schools, and the Ethnographical Survey of Great Britain.

Meteorological Photography.—The work of this Committee has already been brought before our Society by its Secretary, Mr. A. W. Clayden, in a lecture delivered at St. Albans in 1891, to the report of which in our 'Transactions' (Vol. VI, p. 162) reference should be made. At this Conference Mr. Clayden stated that a sufficient number of photographs of clouds had now been received, but he would be grateful for photographs of lightning showing anything abnormal; and also for photographs showing the results of whirlwinds or other exceptional occurrences.

Earth-Tremors.—We are scarcely likely to assist this Committee, the investigation of earth-tremors requiring an instrument costing at least £60. That best suited for the purpose, and adopted by this Committee, is the bifilar pendulum invented by Mr. Horace Darwin, who exhibited one to the Conference and explained its construction and use. It is not affected by certain rapid, complicated movements which take place during an earthquake, or by the slight tremors caused by passing carts or trains. The movements which it will measure are such as would make a factory chimney or a vertical post fixed in the ground lean over on one side. Extremely small movements of this kind can be measured by it and recorded on photographically-prepared paper. An account of the instrument was given in 'Nature' of 12th July, 1894, and also in the 'Report of the British Association' for 1893, p. 291.

Mr. G. J. Symons, Chairman of the Committee, stated that pulsations recorded by one of these instruments in a coal-mine at Newcastle-on-Tyne had been traced to the gradual settlement of the ground in consequence of the removal of the coal, and to the beating of the sea-waves on the coast. On one occasion the pulsations shown were found to have been produced by an earthquake in Greece. The Committee wished to have several of these instruments established in different parts of the British Isles, in order to make sure that not merely local phenomena were being recorded, but the great general phenomena of the earth's crust, such as changes going on in connection with faults in geological strata, and records of the alterations in the earth's crust caused by tidal waves.

Pollution of Air in Towns.—For the last three or four years Dr. G. H. Bailey has been examining the air of towns in order to ascertain the extent of its pollution, and he gave an account of his investigations in Manchester. It was a question, he said, of much practical importance, for it had been found that the death-rate was highest when the air was most polluted. The amount of sulphur-compounds present in the air was a measure of the extent of its pollution. The amount of sunlight in towns was also being investigated, and it had been found that about 50 per cent. of the sunlight was cut off by the smoke of a town, the diminution of light in the centre of a large town amounting to about 75 per cent., and in the suburbs to about 25 per cent., as compared with the amount of light in the open country. The co-operation of members of the Corresponding Societies in more rural districts would be sought when the methods of investigation were more perfect. Prof. Meldola remarked upon the value of lichens as indicating the purity of the air. They were disappearing from the tree-trunks in Epping Forest, it being too near London for them to flourish.

Coast Erosion, which was next dealt with, is not a subject within the province of our Society.

Underground Waters.—The question of the circulation of water in the Chalk of Hertfordshire has frequently been brought before our Society, and the nature of the information required by the Underground Waters Committee will be found in our 'Transactions,' in my paper on "Water and Water-supply" (Vol. VI, p. 136). At this Conference Mr. Whitaker stated that it was intended to give the substance of the eighteen annual reports of the Committee in a single volume, for which he hoped the Corresponding Societies would subscribe. The cost of the book would not exceed 10*s*.

Erratic Blocks.—For information on the work of the Erratic Blocks Committee reference should be made to a paper by Mr. H. George Fordham in our 'Transactions' (Vol. I, p. 163). The work of the Committee is now drawing to a close, but there is still plenty of scope for observers in our county. The work required to be done is to record the position, height above the sea, lithological character, size, and origin of our erratic blocks or boulders, to report other matters of interest connected with them, and to take measures for their preservation.

Geological Photographs.—The work of the Geological Photographs Committee has also been brought before our Society, in a paper by me which is published in our 'Transactions' (Vol. VI, p. 49). I regret that out of 1055 photographs which the Secretary of the Committee has received, there are only a few from our county, all of which have been taken by myself. The collection of photographs will be deposited in the Museum of Practical Geology, Jermyn Street, London, where it will be accessible for inspection. I have duplicates for the Society of the photographs which I have contributed to this collection, and should be glad to receive photographs from others, in duplicate, one copy for this collection and one for our Society.

The teaching of Geography in Schools is not exactly a subject to engage the attention of provincial societies, but it is one in which some members of such societies may help by their influence. Mr. Sowerbutts said that it was disgraceful that geography was so badly taught, or sometimes utterly neglected, in the schools of a country which had territory in every part of the world. He also advocated the institution of *School Museums*, and stated that much progress had been made in some of the primary schools by the institution of museums. A beginning has been made at the headquarters of our Society, the Watford Endowed Schools, and at the St. Albans Grammar School. There are also museums in some other schools in our county, as at Haileybury College.

Ethnographical Survey.—The Chairman of the Committee appointed to organize an Ethnographical Survey of the United Kingdom, Mr. E. W. Brabrook, remarked that the Corresponding Societies had, through their delegates, shown much interest in this question, and that many had given assistance. During the past year the list of villages at which ethnographical observations might suitably be made had been considerably increased; there were now 367, a much larger number than they had expected would be suggested. He then gave an account of how their work was progressing in England, Wales, Scotland, Ireland, and the Isle of Man. He had been told that the instructions with regard to photographing were too minute; but these instructions had been drawn up by Mr. Francis Galton with reference to his system of composite photographs, and any departure from them would make the application of that system comparatively difficult. At the same time they did not wish to lose any photographs which might be useful, even if, in their case, the instructions had not been followed.

With this subject the work of the Conference was brought to a close, and the Chairman expressed the hope that the delegates would bring its proceedings under the notice of their respective Societies. The custom of the Essex Field Club was to ask their delegate to send in a report of what had been done, and to publish it as soon as possible in the 'Essex Naturalist,' and he hoped that other Societies would act in a similar manner.

2. Note on a Tree-Wasp's Nest at Herga, Watford. By Daniel Hill. (*Transactions*, Vol. VIII, p. 203.)

Mr. Hill exhibited the nest, which he has had mounted in a case.

The President exhibited and described a series of photographs showing the feeding of a young *Boa constrictor* (the first ever taken); also a photograph of a large reticulated python at the Zoological Gardens.

ORDINARY MEETING, 29TH JANUARY, 1895, AT WATFORD.

Professor JOHN ATTFIELD, M.A., Ph.D., F.R.S., etc., Vice-President, in the Chair.

Mr. Alan Fairfax Crossman was elected a Member of the Society.

The following papers were read:—

1. "The Advantages of a Supply of Soft Water for the Town of Watford." By Arthur King, M.B., C.M., D.P.H. (*Transactions*, Vol. VIII, p. 116.)

2. "The Relative Advantages of Hard and Soft Water, with Special Reference to the Supply of Watford." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. VIII, p. 101.)

A discussion ensued, of which the following is an abstract:—

The Chairman (Professor ATTFIELD) said that he need scarcely remind the members of the Society that our country was often called Albion because of the whiteness of its cliffs, which served to draw their attention to the facts that limestone, either chalk, or the harder varieties of limestone, constitutes the greater part of our island, and that falling rain, always dissolving a certain amount of chalk, they got hard water; hence that every town on chalk or limestone was immensely interested in the possible artificial softening of its water. Watford, being directly on the Chalk, was not the least interested. Its water had a very considerable degree of hardness, and therefore Watford could well discuss the question as to whether its natural supply of hard water should be softened or not. To begin with, they must go to experts to know something about the softening of the water, and to know something about the cause of the hardness. Secondly, they must know whether the hardness could be reduced. Thirdly, how? And fourthly, at what cost? Dr. King and Mr. Hopkinson had given what in his humble opinion was a very good *résumé* of all these data, and for their carefulness and the time they had occupied in doing that, and the judgment they had evinced in the doing of it, he thought, and he was sure they all would think, that they deserved their thanks. As to the questions which the inhabitants of Watford would look to scientific men to give them information upon, in order that they might discuss them from their economical and financial point of view, the first had been answered. It was possible for the water to be softened, and the chemistry of the matter generally was not a question for discussion at that meeting; it had all been settled long ago, and was now being practically carried out in such towns as Canterbury and Southampton, and in some seven or eight other prominent towns, to say nothing of the work which was done in the Colne Valley Waterworks close by. A question which had been put to him within the last three or four days was, "What do we all mean by hard and soft water?" That had been partly answered that night as to the cause of the hardness and softness. Professor Attfield then alluded to the difference felt between hard and soft water in washing the hands, and said that another question which had been put to him as a chemist for the hundredth time was a question relating to the difference between lime and chalk. He was afraid that unless the inquirers had the rudiments of chemistry within them nothing would make the thing perfectly clear. Having explained the mingling together of carbonic acid and lime in the formation of chalk, he pointed out that there was only one practical way of softening the water, as had been shown by the authors of the papers. He supposed the town would look to its engineer to explain whether it would be better to get out the deposit by mere subsidence or by means of filters. Different methods were adopted in different towns, and he thought the question was one of local conditions, local circumstances, and rate of wages. With regard to disadvantages in the softening of water, he would only remark that in softening water they were getting within measurable distance of a water that would dissolve lead, and might possibly, *though not probably*, be jumping out of the frying-pan into the fire, or, to coin a more appropriate figure, might tumble from a cliff of chalk into a hot cauldron of lead. He then spoke of the effect of soft and hard water on tea, giving his opinion in favour of soft water so far as economics were concerned; and so far as boilers were concerned, and for cooking no doubt the advantages were greatly in favour of soft water over hard water. Then, with regard to the question of health, Dr. King had told them that doctors disagreed. Speaking of the formation of bone and sinew, Professor Attfield said that he did not think such a question need be taken into consideration with reference to this matter, because it was not lime, the partner of chalk, but it was phosphate of lime, that had to do with the formation of bone. And modern discoveries had shown that the substance in vegetables which enabled us to build up bone was not by any means always phosphate of lime, but what was well known to medical men, phosphate of potash, which was the substance they would find in vegetable juices. He then pointed out that the question was primarily a chemical one, and secondly a medical one, and it remained for that meeting to discuss the question from a common-sense point of view founded on science. He hoped that the townsmen of Watford would think, with the Natural History Society, that this was a scientific matter, that the Society represented science in Watford, and that the Society had done its duty in bringing before the town at least some of the scientific advantages and disadvantages attached to the softening of the water.

Mr. Blathwayt said that he would hail with pleasure any scheme which might be brought forward for softening the water. He had been resident in Watford for 10½ years, and during that period had had his hot-water pipes and apparatus renewed three times, which had increased his water-rate at least 100 per cent. per annum.

Mr. Blackburn said he thought that what they had heard that night should satisfy them that it would be policy to soften the water in Watford.

Mr. Ayres differed from what Mr. Blathwayt had said. He had lived in his house 14 years, and his pipes at the present moment were as clear as when they were put up. He was sure that the Urban Council would give the matter their careful consideration, but there were many questions which would have to be considered before the water could be softened, and one very important one was the waste of water. At least one-half or three-fourths of the water now pumped was wasted.

Mr. HILL said that he had now resided in his house nearly 10½ years, and he had the same boiler and the same pipes which had been put in at first by Mr. Ayres. He thought the Watford water was most pleasant to drink. Soft water, to his mind, was flat; there was no life in it.

Mr. VERINI, being asked for his opinion as to the cost of softening the water, said that he had read Dr. King's figures in the 'Watford Observer,' and he thought that they were accurate.

Dr. KING replied, saying that he thought the matter simply resolved itself into pounds, shillings, and pence. If it were cheaper to soften the water, let them do it. Leaving out the medical question, or the question of inconvenience, let them consider the money question, and he believed if they went into the subject thoroughly they would find that it might put a little on the rates, but it would save their pockets in other ways. It would certainly save them a considerable amount in soap, and if they as private individuals did not use so much as washerwomen, he thought they ought to consider the washerwomen as well as themselves, and it would be a considerable saving to them. Another point that he mentioned in his paper was very important, and that was that they could not wash clothes *clean* in hard water. He differed from Mr. Hill as to the taste of the water, preferring soft water.

Mr. HOPKINSON also replied. He said that he was not aware that there had been any cases of lead-poisoning where soft water had been substituted for hard water. He had had no experience of the taste of softened water, but he very much preferred such naturally soft water as a mountainous district usually yields, to the very hard water supplied to Watford and St. Albans, and he believed that drinking such soft water was very beneficial to health.

Professor ATTFIELD remarked that the different experiences with regard to pipes, etc., being choked up could be easily explained. It was necessary for water actually to boil before any appreciable amount of carbonate of lime would be deposited as "scale." Doubtless with Mr. Blathwayt the water boiled, and with Mr. Ayres and Mr. Hill it did not.

Mr. G. H. Wailes and Mr. Thomas Hope were elected auditors of the accounts for 1894.

ANNIVERSARY MEETING, 26TH FEBRUARY, 1895.

(AT WATFORD.)

Sir JOHN EVANS, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., F.L.S., F.G.S., etc., Vice-President, in the Chair.

The Report of the Council for 1894, and the Treasurer's Account of Income and Expenditure, were read and adopted.

George Massee, F.R.M.S., 41 Gloucester Road, Kew, was elected a Corresponding Member of the Society.

A letter was read from the President, Mr. Arthur Stradling, M.R.C.S., F.Z.S., regretting his inability to be present on account of ill-health, and promising to deliver his Anniversary Address at a future meeting of the Society.

Sir John Evans, K.C.B., delivered an Address on "The Stone Age in Hertfordshire." (*Transactions*, Vol. VIII, p. 169.)

Stone implements found in Hertfordshire, etc., were exhibited by the author in illustration of his address.

The following gentlemen were duly elected as the officers and Council for the ensuing year:—

President.—Henry Seebohm, F.L.S., F.Z.S., Sec.R.G.S.

Vice-Presidents.—Professor John Attfield, M.A., Ph.D., F.R.S., F C.S., F.I.C.; Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., etc.; John Morison, M.D., D.P.H., F.G.S.; Arthur Stradling, M.R.C.S., F.Z.S.

Treasurer.—John Weall.

Honorary Secretaries.—John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R. Met. Soc.; F. M. Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S.

Librarian.—W. R. Carter, B.A.

Curator.—A. E. Gibbs, F.L.S., F.E.S.

Other Members.—Alfred T. Brett, M.D.; H. George Fordham; Daniel Hill; Henry Lewis; Edward Mawley, F.R. Met. Soc., F.R.H.S.; William Ransom, F.S.A., F.L.S.; T. Vaughan Roberts; Stephen Salter; Frank W. Silvester; Rev. E. T. Vaughan, M.A.; George Herbert Wailes, Assoc. M. Inst. C.E ; Henry Warner.

The thanks of the Society were accorded to Mr. Arthur Stradling retiring from the office of President; to Mr. Upfield Green, retiring from the office of Vice-President; and to Mr. A. P. Blathwayt, Mr. R. B. Croft, and Mr. George Rooper, retiring from the Council.

Report of the Council for the Year 1894.

The Council of the Hertfordshire Natural History Society, in presenting the 20th Annual Report, may congratulate the members on the continued prosperity of the Society after an existence of twenty years. At the same time it may be pointed out that the number of members who take an active part in the work of the Society is very small, and has considerably decreased within the last ten years, not nearly so many members contributing papers in the second decade of the Society's existence as in the first. This is not due to exhaustion of material, for the investigation of the flora and fauna of the county is very far from completion, and the scope of the Society has lately been much widened, its objects now including the investigation of the Ethnology, Pre-Norman Archæology, and Topography of Hertfordshire, as well as that of its Meteorology, Geology, Botany, and Zoology, and the study of Physical as well as of Biological Science. The Council would, therefore, urge upon the members to do all they can to further the objects of the Society, by delivering lectures, reading papers, or contributing the results of their investigations relating to the county. In this direction there is plenty of scope for bibliographical research as well as for original observation.

During the year thirty-one ordinary members have been elected and one corresponding member, twelve members have resigned, thirteen have been removed from the list for non-payment of subscription for several years, and the Council regrets to have to record the loss of three members by death—Dr. Duncan Scott of Watford, Mr. Robert Smith of Goldings near Hertford (a life-member), and Mr. William Topley, F.R.S., of Croydon.

Mr. Topley was for more than thirty years on the staff of the Geological Survey. From 1862 to 1880 he was engaged in field-work; he was then appointed to superintend the publication of maps and memoirs at the office of the Geological Survey in Jermyn Street; and in 1893 he was entrusted with the entire charge of the office. He was one of our leading authorities on applied geology, especially agricultural geology and water-supply. He became a member of our Society in 1892, and had promised to open the present session with a lecture on Agricultural Geology.

The census of the Society at the end of the years 1893 and 1894 was as follows:—

	1893.	1894.
Honorary Members	20	20
Corresponding Member		1
Life Members	51	50
Annual Subscribers	189	193
	260	264

Although this shows a numerical increase of only four members, the effective increase is really seventeen, for in the 1893 census thirteen members were enumerated who were several years in arrears with their subscriptions and who were removed from our list early in 1894.

The following papers or lectures have been read or delivered at Watford during the year:—

Jan. 23.—The Lower Micro-organisms and their Relation to Every-day Life; by D. Harvey Attfield, M.A., M.B., D.P.H.

Feb. 13.—Crystals and Precious Stones; by G. Herbert Wailes, Assoc. M. Inst. C.E.

—— 27.—Anniversary Address: A Wonderful Animal; by the President, Arthur Stradling, M.R.C.S., F.Z.S.

March 20.—The Natural History of the Salmon; by George Rooper, F.Z.S.

April 17.—Report on the Rainfall in Hertfordshire in the year 1893; by John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

—— Climatological Observations taken in Hertfordshire in the year 1893; by John Hopkinson.

—— Meteorological Observations taken at The Grange, St. Albans, in the year 1893; by John Hopkinson.

—— Report on Phenological Phenomena observed in Hertfordshire during the year 1893; by Edward Mawley, F.R.Met.Soc., F.R.H.S.

April 17.—Notes on Lepidoptera observed in Hertfordshire during the year 1893; by A. E. Gibbs, F.L.S., F.E.S.
—— The Wasp-Visitation of 1893; by A. E. Gibbs.
—— Notes on Birds observed in Hertfordshire during the year 1893; by Henry Lewis.
Nov. 27.—Herbert Spencer: a Sketch of his Life and Work; by William R. Hughes, F.L.S.
Dec. 28.—Report on the Conferences of Delegates to the British Association at Oxford in 1894; by John Hopkinson, F.L.S., F.G S., etc.
—— A Tree-Wasp's Nest at Herga, Watford; by Daniel Hill.

A special meeting was held on the 23rd of January, when certain alterations in the Rules proposed by the Council were passed. The revised Rules were issued to the members with the February part of the 'Transactions.'

The following Field Meetings were held during the year :—

April 28.—Ayot St. Peter and Ayot St. Lawrence.
May 19.—Brocket Park and Wheathampstead.
—— 26.—Luton, Caddington, and Dunstable.
June 23.—Tring.
—— 30.—Stevenage, the Wymondleys, and Hitchin.
Oct. 13.—Aldbury and Ashridge Park.

Visits were also made to the British Museum (Natural History), South Kensington, on the 21st of April, and to the Zoological Gardens, Regent's Park, on the 16th of June; on each occasion demonstrations were made by the President.

The thanks of the Society are due for hospitality kindly afforded at the above meetings to the Rev. H. Jephson at Ayot St. Peter; to Mr. and Mrs. Upton Robins at Delaport, Wheathampstead; to the President and Mrs. Stradling at the Zoological Gardens; to Mr. A. Macdonald Brown at Beech Grove, Tring; to Mr. Charles Sworder at The Priory, Little Wymondley; and to Mr. William Ransom at Fairfield, Hitchin.

The seventh volume of the present series of the Society's 'Transactions' has been completed, and the eighth has been commenced, two parts of each, containing 148 pages and seven plates, having been published during the year. Three-fourths of the papers in the seventh volume are essentially local, and the rest, with two exceptions, have some local bearing. The papers which give the results of investigations in Hertfordshire are, in meteorology and phenology the usual annual reports, eight in all, a paper on the Climate of Watford, and one on Temperature and Rainfall at Throcking, each giving the results of ten years' observations, and a Naturalist's Calendar for Mid-Hertfordshire; in botany a paper on the Mycetozoa, with a list of species found in Herts and Beds, and a list of Hertfordshire Hepaticæ; and in Zoology notes on the Lepidoptera, the Birds, and the Mammalia observed in the county. With local allusions there are two geological papers, one on Ice and the other on Coal, and two zoological papers, one on Terrestrial British Quadrupeds and the other on Bats and some other Beasts. One of the two Presidential Addresses

INCOME AND EXPENDITURE FOR THE YEAR ENDING 31*st* *DECEMBER*, 1894.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1893	46	19	11	By Printing 'Transactions'	56	12	10
,, Entrance Fees	8	0	0	,, ,, Circulars	4	17	6
,, Subscriptions for 1892	1	0	0	,, Miscellaneous Printing	2	11	0
,, ,, ,, 1893	5	0	0	,, Expenses of Meetings	3	3	0
,, ,, ,, 1894	36	10	0	,, Rent: Watford Endowed Schools	7	0	0
,, ,, ,, 1895	9	10	0	,, Library Expenses	7	18	4
,, Dividends on £130 India 3 per cent. Stock.	3	18	0	,, Salary of Assistant	4	11	8
,, Sale of Publications ['Flora of Hertfordshire' 18*s.*; 'Transactions' £1 7*s.* 8*d.*, less expenses]	2	5	8	,, Stationery	2	16	1
				,, Postages	14	1	6
				,, Fire Insurance	0	15	0
				,, Sundry small expenses	1	7	9
				,, Balance at Bank	7	8	11
	£113	3	7		£113	3	7

Amount invested in the purchase of £130 India 3 per cent. Stock . . . £126 15*s.* 6*d.*

Audited and found correct this 15th day of February, 1895, { GEORGE H. WAILES, THOMAS HOPE.

in the volume, on Francis Bacon, is of local interest; the other, on Charles Darwin, though not of local, is of universal interest; and the only other paper having no reference to the county is one, abridged, in the 'Proceedings,' on Man and Ape.

Of the eight plates in the volume, five were produced at the expense of the Society, two are reprints, and one, the frontispiece, was presented by your Editor, Mr. Hopkinson. A feature for the first time introduced is the reproduction of photographs in illustration of the reports of the field meetings, eight of which, taken by your Editor, are shown on four of the plates.

The Library has been open for the exchange of books on the first Tuesday of each month from 7 to 9 p.m., and after the evening meetings of the Society, but the number of members who have borrowed books has been very small. The Librarian regrets that the Catalogue is now out of print, but hopes to be able shortly to prepare a new and revised edition of it. A list of the numerous accessions during the year will be given in the 'Proceedings.'

Specimens of Mycetozoa have been presented by Mr. James Saunders, which are of special value as vouchers for his lists of species in our 'Transactions.'

Additions to the Library in 1894.

Presented.

Title.	Donor.
Australian Association for the Advancement of Science. Report of 1st Meeting, Sydney, N.S.W. 1888. 8vo. Sydney, 1889	*Sir John Evans.*
——. Report of 2nd Meeting, Melbourne, Victoria. 1890. 8vo. Melbourne, 1890	,,
——. Report of 3rd Meeting, Christchurch, N.Z. 1891. 8vo. Wellington, N Z., 1891	,,
——. Report of 4th Meeting, Hobart, Tasmania. 1892. 8vo. Hobart, 1893	,,
Bacon, Francis. Proficience and Advancement of Learning. 8vo. London, 1852	*Mr. J. Hopkinson.*
Baxendall, J. Borough of Southport. Meteorological Department. Report of Observations for 1893. 4to. Southport, 1894	*The Author.*
British Association for the Advancement of Science. Report for 1893. (Nottingham.) 8vo. London, 1894	*The Association.*
British Museum (Natural History). General Guide. 8vo. London, 1893	*Trustees of the British Museum.*
——. Guide to the Mineral Gallery. By L. Fletcher. *Ib.* 1893	,,
——. The Student's Index to the Collection of Minerals. By L. Fletcher. *Ib.* 1893	,,
——. Mineral Department. An Introduction to the Study of Meteorites. . . . . By L. Fletcher. *Ib.* 1893	,,
——. ——. An Introduction to the Study of Minerals. By L. Fletcher. *Ib.* 1894	,,

Title.	Donor.
BRITISH MUSEUM (NATURAL HISTORY). Department of Geology and Palæontology. Guide to the Collection of Fossil Fishes. By H. Woodward. 2nd ed. *Ib.* 1888.	*Trustees of the British Museum.*
——. Guide to the Department of Geology and Palæontology. Part I. Fossil Mammals and Birds. By H. Woodward. *Ib.* 1890	,,
——. ——. Part II. Fossil Reptiles, Fishes, and Invertebrates. By H. Woodward. *Ib.* 1890 . .	,,
——. Department of Botany. Guide to Sowerby's Models of British Fungi. By W. G. Smith. *Ib.* 1893	,,
——. Department of Zoology. Guide to the Shell and Starfish Galleries. By A. Günther. 2nd ed. *Ib.* 1888	,,
——. ——. Guide to the Galleries of Reptiles and Fishes. By A. Günther. *Ib.* 1893	,,
——. ——. Guide to the Galleries of Mammalia. By A. Günther. 4th ed. *Ib.* 1892	,,
CUVIER, Baron. The Animal Kingdom. . . . . With additional Descriptions . . . . . by E. Griffith and others. Vols. ii–x, and xii–xvi. 8vo. London, 1827–35	*Mr. A. R. Gillman.*
——. ——. Supplementary Volume on the Fossils. By E. Pidgeon. *Ib.* 1830	,,
DILLER, J. S. Notes on the Geology of the Troad. (*Quart. Journ. Geol. Soc.* 1883.)	*Mrs. Topley.*
HARRISON, W. J. On the Search for Coal in the South-east of England. . . . . 8vo. Birmingham, 1894 .	*Mr. W. Whitaker.*
JOHNSON, C., and J. E. SOWERBY. Ferns of Great Britain. 8vo. London, 1855	*Mr. J. Hopkinson.*
——. Fern Allies. 8vo. London, 1856	,,
LINDLEY, JOHN. Ladies' Botany. 3rd ed. Vol. i. 8vo. London, N. D.	,,
MONCKTON, CLAUD. Pure Spring Water-supply for London. Proposed by G. Webster. 4to. London, 1890	*Mr. W. Whitaker.*
MOORE, THOMAS. Elements of Botany. 10th ed. 8vo. London, 1865	*Mr. J. Hopkinson.*
NATURAL SCIENCE. Vol. iv. 8vo. London, 1894 .	*Mr. A. E. Gibbs.*
ORMEROD, ELEANOR A. Report of Observations of Injurious Insects, and Common Farm Pests, during the Year 1893. 8vo. London, 1894	*The Authoress.*
PENNING, W. H. A Contribution to the Geology of the Southern Transvaal. (*Quart. Journ. Geol. Soc.* 1891.)	*Mr. W. Whitaker.*
SCIENCE GOSSIP. New Series. Vol. i, Nos. 4–10. 8vo. London, 1894	*Mr. A. E. Gibbs.*
SYMONS, G. J. (Ed.) Monthly Meteorological Magazine. Vol. xix. 8vo. London, 1894	*The Editor.*
TOPLEY, WILLIAM. On Areas of Apparent Upheaval. (*Quart. Journ. Geol. Soc.* 1874.)	*Mrs. Topley.*
——. The National Surveys of Europe. (*Rep. Brit. Assoc.* for 1884.)	,,
——. Report of the Committee on the Erosion of the Sea Coasts of England and Wales. (*Rep. Brit. Assoc.* for 1885.)	,,
——. ——. (. . . for 1888.)	,,
——. Gold and Silver: their Geological Distribution and their Probable Future Production. (*Rep. Brit. Assoc.* for 1887.)	,,

Title.	Donor.
Topley, William. Geology in its Relation to Hygiene. (*Trans. Sanitary Inst.* 1890.)	*Mr. W. Whitaker.*
Whitaker, William. Local Geology from a Sanitary Standpoint. (*Trans. Sanitary Inst.* 1892.)	*The Author.*
——. On Maps showing the Area of Chalk available for Water Supply in the London Basin. (*Ib.* 1892.)	,,
——. On Borings at Culford, Winkfield, Ware, and Cheshunt. (*Quart. Journ. Geol. Soc.* 1894.)	,,

Received in Exchange.

American Museum of Natural History. Bulletin. Vol. v. 8vo. New York, 1893.

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Bath Natural History and Antiquarian Field Club. Proceedings. Vol. viii, No. 1. 8vo. Bath, 1894.

Belfast Naturalists' Field Club. Annual Report and Proceedings. Series 2, vol. iv, part 1. 8vo. Belfast, 1894.

Birmingham Philosophical Society. Proceedings. Vol. viii, part 2. 8vo. Birmingham [1894].

———. Report. [Session 1892–93.] *Ib.*

Birmingham Natural History and Philosophical Society. Journal. Vol. i, No. 1. 8vo. Birmingham, 1894.

Boston (U.S.A.) Society of Natural History. Proceedings. Vol. xxvi, part 1. 8vo. Boston, 1893.

Bristol Naturalists' Society. Proceedings. New Series. Vol. vii, part 3. 8vo. Bristol, 1894.

Caradoc and Severn Valley Field Club. Transactions. Vol. i, No. 1. 8vo. Shrewsbury, 1894.

Cardiff Naturalists' Society. Report and Transactions. Vol. xxv, part 2. 8vo. Cardiff, 1894.

Conchology, Journal of. Vol. vii, Nos. 9–11. 8vo. Leeds, 1894.

Croydon Microscopical and Natural History Club. Proceedings for 1892–93. 8vo. Croydon, 1893.

Edinburgh, Botanical Society of. Transactions and Proceedings. Vol. xix, part 3. 8vo. Edinburgh, 1893.

——— Geological Society. Transactions. Vol. vii, part 1. 8vo. Edinburgh, 1894.

——— Royal Physical Society. Proceedings. Session 1892–93. 8vo. Edinburgh, 1893.

Essex Field Club. Essex Naturalist. Vol. vii, Nos. 10–12. 8vo. Buckhurst Hill, 1894.

Glasgow Philosophical Society. Proceedings. Vol. xxv. 8vo. Glasgow, 1894.

Hampshire Field Club. Papers and Proceedings. Vol. ii, part 3. 8vo. Southampton, 1894.

London, Geological Society of. Abstracts of the Proceedings. Session 1893–94. 8vo. London, 1894.

———. Geologists' Association. Proceedings. Vol. xiii, parts 6–10. 8vo. London, 1894.

———. ———. List of Members, 1894. *Ib.*

———. Quekett Microscopical Club. Journal. Vol. v, Nos. 34 and 35. 8vo. London, 1894.

———. Royal Meteorological Society. Quarterly Journal. Vol. xx. 8vo. London, 1894.

———. ———. The Meteorological Record. Vol. xiii, Nos. 50–52. Vol. xiv, No. 53. 8vo. London [1894].

———. Royal Microscopical Society. Journal. New Series. [Vol. vi.] 1894. 8vo. London, 1894.

Manchester Field-Naturalists' and Archæologists' Society. Report and Proceedings for the Year 1893. 8vo. [Manchester] 1894.

MANCHESTER GEOGRAPHICAL SOCIETY. Journal. Vol. ix, Nos. 7–9. Vol. x, Nos. 1–3. 8vo. Manchester, 1894.
——— GEOLOGICAL SOCIETY. Transactions. Vol. xxii, parts 14–21. Vol xxiii, parts 1, 2. 8vo. Manchester, 1894.
——— LITERARY AND PHILOSOPHICAL SOCIETY. Memoirs and Proceedings. Series 4, vol. viii, Nos. 1–3. 8vo. Manchester, 1894.
MICROSCOPY AND NATURAL SCIENCE, INTERNATIONAL JOURNAL OF. 3rd Series, vol. iv, parts 20–23. 8vo. London, 1894.
NATURALIST. New Series. Vol. xix, Nos. 222–231. 8vo. London, 1894.
NEW YORK ACADEMY OF SCIENCES. Transactions. Vol. xii. 8vo. New York, 1893.
——— STATE LIBRARY. 75th Annual Report. 8vo. Albany, 1893.
——— ———. Bulletin No. 4. State Legislation in 1893. 8vo. Albany, 1894.
——— STATE MUSEUM. Report No. 46, for the Year 1893. 4to. Albany, 1894.
——— ———. Bulletin iii, No. 11. 8vo. Albany, 1893.
NORFOLK AND NORWICH NATURALISTS' SOCIETY. Transactions. Vol. v, part 5. 8vo. Norwich, 1894.
NORTHAMPTONSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB. Journal. Vol. vii, Nos. 53–56. 8vo. Northampton, 1893.
RUGBY SCHOOL NATURAL HISTORY SOCIETY. Report for the Year 1893. 8vo. Rugby, 1894.
SMITHSONIAN INSTITUTION. Annual Report of the Board of Regents to July, 1893. 8vo. Washington, 1894.
UNITED STATES DEPARTMENT OF AGRICULTURE. Bulletin No. 4. The Prairie Ground Squirrels or Spermophiles of the Mississippi Valley. By Vernon Bailey. 8vo. Washington, 1893.
——— GEOLOGICAL SURVEY. 12th Annual Report, 1890–91. Part I. Geology. Part II. Irrigation. 4to. Washington, 1891.
——— ———. 13th Annual Report, 1891–92. Part I. Report of the Director. Part II. Geology. Part III. Irrigation. 4to. Washington, 1893.
——— ———. Bulletin. Nos. 97–117. 8vo. Washington, 1892–94.
——— ———. Monographs. Vol. xix. The Penokee Iron-bearing Series of Michigan and Wisconsin. By R. D. Irving and C. R. Van Hise. 4to. Washington, 1892.
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——— ———. ———. Vol. xxii. A Manual of Topographic Methods. By H. Gannett. *Ib.* 1893.
WILTSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY. Magazine. Vol. xxviii, No. 81. 8vo. Devizes, 1894.
YORKSHIRE GEOLOGICAL AND POLYTECHNIC SOCIETY. Proceedings. New Series. Vol. xii, part 4. 8vo. Halifax, 1894.
——— NATURALISTS' UNION. Transactions. Part 18. The Yorkshire Carboniferous Flora, by R. Kidston. 8vo. Leeds, 1893.
——— PHILOSOPHICAL SOCIETY. Annual Report for 1893. 8vo. York, 1894.

PURCHASED.

BOTANY, JOURNAL OF. New Series. Vol. xxvii. 8vo. London, 1894.
ENTOMOLOGIST. Vol. xxvii. 8vo. London, 1894.
ENTOMOLOGISTS' RECORD. Vol. v. 8vo. London, 1894.
GREVILLEA. Vol. xxii. 8vo. London, 1894.
HERTFORDSHIRE ILLUSTRATED MAGAZINE. Vol. ii. 8vo. St. Albans, 1894.
NATURE NOTES. Vol. v. 8vo. London, 1894.
NOVITATES ZOOLOGICÆ. Vol. i, parts 1–5. 4to. Tring, 1894.
ROYAL NATURAL HISTORY. Vol. i, parts 1–14. 8vo. London, 1894.
SMITH, W. G. Man, the Primeval Savage. 8vo. London, 1894.
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ORDINARY MEETING, 22ND MARCH, 1895, AT ST. ALBANS.

JOHN MORISON, Esq., M.D., F.G.S., Vice-President, in the Chair.

Mr. E. H. Jackson, 5, Lower Derby Road, Watford; Mr. Henry George Moon, London Road, St. Albans; Mr. Thomas Cheadle Myddelton, Spencer House, St. Albans; and Mr. J. B. Russell, B Sc., 17, Lower Derby Road, Watford, were proposed for membership of the Society.

The following lecture was delivered:—

"Extinct Monsters." By the Rev. Henry S. Hutchinson, B.A., F.G.S.

The lecture was fully illustrated by photographs kindly shown by the oxyhydrogen lantern by Mr. T. Askwith.

ORDINARY MEETING, 26TH MARCH, 1895, AT WATFORD.

W. R. CARTER, Esq., B.A., in the Chair.

Mr. E. H. Jackson, Mr. H. G. Moon, Mr. T. C. Myddelton, and Mr. J. B. Russell, B.Sc., were elected Members of the Society.

Sir Henry Bruce Meux, Bart., Theobalds, Waltham Cross, was proposed for membership.

The following papers were read:—

1. "Report on the Rainfall in Hertfordshire in the year 1894." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. VIII, p. 131.)

2. "The Floods of November, 1894, in Hertfordshire." By John Hopkinson. (*Transactions*, Vol. VIII, p. 141.)

3. "Temperature and Rainfall at Hitchin, 1850–94." By Wm. Lucas and John Hopkinson. (*Transactions*, Vol. VIII, p. 203.)

4. "Notes on Birds observed in Hertfordshire during the year 1894." By Henry Lewis. (*Transactions*, Vol. VIII, p. 147.)

5. "Notes on Birds frequenting the neighbourhood of Heronsgate, Herts." By A. Sainsbury Verey, M.B.O.U. (*Transactions*, Vol. VIII, p. 155.)

Letters were read from Mr. J. H. Buxton, Hunsdon Bury, Ware, referring to the powers of the County Council for prohibiting the destruction of wild birds, and suggesting that steps should be taken for the preservation of the rare and beautiful birds of Hertfordshire; and from Mr. T. Fowell Buxton, Easneye, Ware, suggesting that the Society should get up an Association amongst the landowners for the preservation of magpies, kingfishers, and owls, a form of agreement being tendered to them for signature.

Mr. Alan F. Crossman referred to the destruction of the great crested grebe for the purposes of trade, and also of the kingfisher. He thought that the proposed agreement would be valueless in law, but that a circular might be sent to the landlords asking them to prevent, so far as they could, the destruction of certain birds which were becoming extinct in England, and also that the County Council might be called upon to protect such birds.

After further discussion it was resolved, on the proposition of Mr. Crossman, seconded by Mr. Henry Lewis, that a representation in favour of the protection of the nightjar, kingfisher, owls, stone-curlew, kestrel, and large crested grebe, be drawn up by the Secretaries and submitted to the Hon. Walter Rothschild, and with his approval be laid before the Hertfordshire County Council.

ORDINARY MEETING, 23RD APRIL, 1895, AT WATFORD.

DANIEL HILL, Esq., in the Chair.

Sir Henry Bruce Meux, Bart., was elected a Member of the Society.

A Memorial, drawn up by the Secretaries of the Society for presentation to the Hertfordshire County Council, in favour of the protection in Hertfordshire of the following birds and their eggs, was read:—Nightjar, Woodpecker, Kingfisher, Owls, Stone Curlew, Grebes (*scheduled*); Wryneck, Buzzard, Honey Buzzard, Hobby, Merlin, Kestrel (*not scheduled*).

A discussion ensued, and on the proposition of Mr. Alan F. Crossman, seconded by Mr. Henry Lewis, it was decided to substitute the crossbill for the wryneck. It was also decided to represent to the County Council that it was unnecessary for the close time to commence earlier than the 15th of February, but that it should continue until the 31st of August as at present extended in Hertfordshire.

The following papers were read:—

1. "The Gale of the 24th of March, 1895, in Hertfordshire." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. With remarks by Edward Mawley, F.R.Met.Soc., and F. W. Silvester. (*Transactions*, Vol. VIII, p. 199.)

2. "Report on Phenological Phenomena observed in Hertfordshire during the year 1894." By Edward Mawley, F.R.Met.Soc., F.R.H.S. (*Transactions*, Vol. VIII, p. 193.)

3. "Notes on Lepidoptera observed in Hertfordshire during the year 1894." By A. E. Gibbs, F.L.S., F.E.S. (*Transactions*, Vol. VIII, p. 188.)

4. "Note on the Blastopore of the Frog's Egg in Relation to the Hypoblast." By J. B. Russell, B.Sc. (*Transactions*, Vol. VIII, p. 129.)

The following papers were taken as read:—

1. "Climatological Observations taken in Hertfordshire in the year 1894." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. VIII, p. 125.)

2. "Meteorological Observations taken at The Grange, St. Albans, during the year 1894." By John Hopkinson. (*Transactions*, Vol. VIII, p. 161.)

Bye Meeting, 27th April, 1895.

NATURAL HISTORY MUSEUM, SOUTH KENSINGTON.

The Members were received in the Great Hall by Sir William Flower, the Director of the Museum, and were then conducted through the galleries devoted to the collection of fossil Vertebrata by Dr. Henry Woodward, Director of the Geological Department, who drew special attention to the great cast of the iguanodon's skeleton which has recently been set up. The iguanodon, he said, was a huge lizard-like reptile which flourished in the Secondary period. It stood nearly twenty feet high as it hopped or waddled along, kangaroo-fashion, on its hind-legs, while the thumbs of its short fore-limbs were each furnished with a nail, spur, or spine, a foot long. In spite of this formidable armature and its vast bulk, it was not a beast of prey, but a harmless vegetable-feeder, while its feet, ankles, pelvis, and in fact its whole organization, are remarkably bird-like in structure and arrangement. The great difficulties to be encountered in obtaining the skeletons of these enormous fossils were mentioned by Dr. Woodward, who stated that the fossil skeletons of these iguanodons were found at a depth of one thousand feet from the surface of the ground in a coal-mine in Belgium, and two years were spent in bringing them to the light of day; a cast of one of the skeletons was taken at great expense by the authorities of one of the American museums; and for a replica of this cast the British Government gave in exchange a mammoth with tusks eleven feet long, a megatherium (the great extinct sloth), and a mastodon, which were worth together some thousands of pounds.

In connection with this subject it was then pointed out by Mr. Arthur Stradling, the conductor of this meeting, how a scientific discovery may affect the monetary value of a fossil or a fossil-impression. Certain fossilized tridactylous footprints in the Connecticut Red Sandstone, had, he said, until a short time ago, been accepted as those of some gigantic bird. The creature, whatever it was, had evidently walked across soft mud which had subsequently hardened into stone without being disturbed, for on some of the slabs were the pits produced by the rain-drops of a shower which was falling at the time. But the geological formation in which these footprints were found was long antecedent to that which had hitherto been considered to be coincident with the earliest appearance of birds, even in the early stage of their evolution when they were tooth-bearing and featherless. Much discussion naturally arose from this, and the square half-yards of stone so impressed had found eager purchasers at the rate of 200 guineas per footstep. It had, however, now been shown that this great three-toed, bird-footed lizard of the Belgian coal-mine—the iguanodon which Dr. Woodward had just described—belonged to a race which must at one time have reigned as the dominant type over almost the whole surface of the earth, and in its bipedal walk must have left footprints absolutely identical with those of apparent but spurious avian origin; and as there is nothing whatever anomalous in the geological position of this iguanodon, the market value of these footprints has fallen to a few shillings each.

Mr. Stradling then conducted the members to the Osteological Gallery on the top floor of the Museum, where he gave a running commentary on the various groups of animals existing at the present day, represented in this room by their skeletons only, with special reference to the likeness or contrast presented by their feet, horns, antlers, tusks, etc. The collection of human skulls and skeletons was taken first and compared with the similar collections representing the larger apes, which are placed in close juxtaposition. The scientific study of "criminology," from the shape of the head and of certain bones, which has recently come into vogue, was then mentioned, as well as a late extraordinary discovery with respect to "giantism." It has been found that a little gland at the base of the skull, called the pituitary body, for which no use is known, but which seems to be functional in the lower vertebrates and to diminish in importance as we ascend in the scale, until its uselessness would appear to reach a climax in man, in all cases of abnormal development becomes enlarged, and the question has been broached as to whether it might not be susceptible to external influence. Gigantic growth, he said, is an accident of the individual; it is not hereditary, and seems rarely to commence until the age of thirteen.

The entire tour of the gallery was made, Mr. Stradling lightening his discourse with many illustrative anecdotes and reminiscences. The larger skeletons in the wing of the gallery were examined under exceptional advantages, as permission had been obtained for the barrier to be taken down expressly for the Society.

Field Meeting, 11th May, 1895.

TEWIN AND PANSHANGER.

A numerous party, including members from Watford, St. Albans, Harpenden, Hitchin, and Wormley, assembled at Welwyn Station at half-past 3, and, under the direction of Mr. Hopkinson, walked into Tewin Water Park, taking, by permission of the Earl of Limerick, a private path through the wood by the side of the River Mimram. The weather being hot and bright, the privilege of a cool and shady walk was much appreciated.

On entering the grounds of Tewin Water House, the members were received by the Earl and Countess of Limerick, who very kindly and quite unexpectedly invited them in and provided refreshments, after which another pretty walk was taken by the river and through the woods, Lord Limerick accompanying the party and pointing out some of the finest trees, especially the well-grown service-trees near the house, and the avenues of beech-trees which run in different directions forming a kind of pattern. The ash-trees also are particularly fine.

On leaving the park a copse was passed through, and a field-path was taken to Tewin Church. Here the chief object of attraction is the singular tomb of Lady Anne Grimston (*ob.* 1710). From beneath it grow seven ash-trees, apparently springing from one root, and three sycamores, which also seem to be similarly connected. These trees have lifted and broken the stonework of the tomb, and the iron railings which enclose it, pressing against the stems of the trees, are in some places so completely embedded in the wood that they could not possibly be severed from it. In fact the trees have grown around the iron. These old railings are now enclosed within a fence of new ones. There is a popular legend connected with this tomb, as with all similar tombs, but it is so absurd, and in this case so completely without foundation, that it would not be worth notice were it not that thousands of people visit the tomb every year in the firm conviction that Lady Anne Grimston was an unbeliever, and thus, in substituting a supernatural for an evident natural cause of the destruction of her tomb, they do injustice to the memory of a pious lady.

The Church (St. Peter's) was entered, but it presents very little of interest. The interior was partly restored in the year 1864.

Arrangements had been made for tea at Lower Green, but they were not carried out, and the party walked on across the meadows and over Marden Hill, through the beautiful lime-tree avenue, to the River Mimram again. Panshanger Park was then entered, and the walk through this beautifully-undulating and richly-wooded park to the Cole Green Lodge was much enjoyed. Some of the trees near this lodge are very old and quite hollow, but still leafing freely.

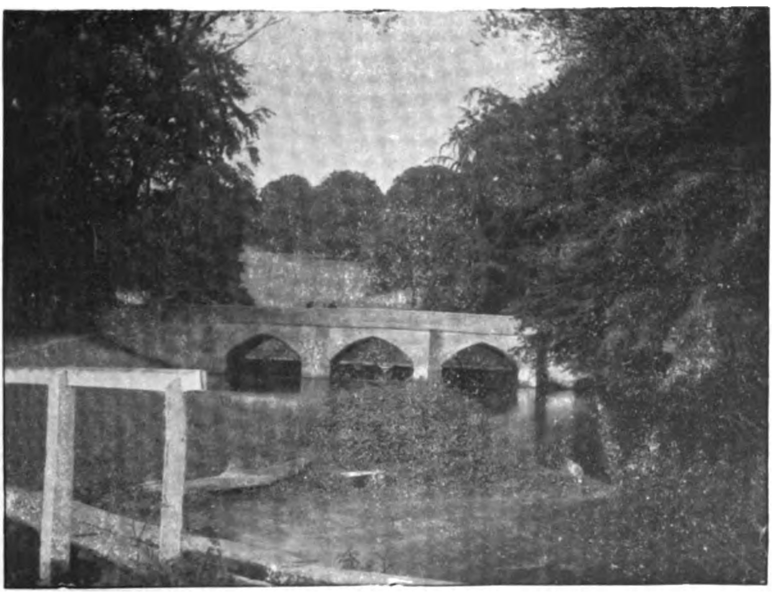
Tea was partaken of at the Cowper Arms, near the station, and it was so promptly and well provided without previous notice that the falling through of the arrangements at Tewin was by no means regretted.

Field Meeting, 8th June, 1895.

GREAT GADDESDEN, NETTLEDEN, AND FRITHSDEN.

It had been intended to hold a Field Meeting once a fortnight during May and June, and this one was first arranged for the 25th of May. Special arrangements having to be made for reduced railway fare, carriages, and tea, members were requested in the circular announcing the meeting to intimate their intention of taking part in it, but so few responded to this request that it was thought advisable to postpone the meeting, and the result was that instead of the party being only six, as it would have been on the earlier date, it was twenty-six. This was a larger number than had been expected, for several who came had not written, and on arriving at Berkhamsted Station at about three o'clock it was found that there was not sufficient carriage accommodation,

TOMB OF LADY ANNE GRIMSTON AT TEWIN.



THE RIVER GADE AT WATER END.

causing a considerable delay before the party could start for the drive across the Common to Water End. Usually at this time of the year the gorse on Berkhamsted Common is in full bloom, but it was only here and there that a few blossoms were seen, for the gorse on our commons had this year nearly all been killed by the severe frost of February, masses of dingy brown taking the place of the usual blaze of golden yellow.

On arriving at Water End, a village which is prettily situated on the River Gade where the road is carried over it by a handsome stone bridge, the carriages were left, and the party crossed the meadows by the side of the river to Great Gaddesden, noticing on the way the numerous springs issuing from the chalk which supply water to water-cress beds, and thence augment the volume of the river.

At Great Gaddesden Church the members were met by the Vicar, the Rev. W. T. Tyrwhitt Drake, and under his guidance the chief objects of interest in the church were examined. It is an Early English edifice, probably erected on the site of an earlier church, for at the time of the Conquest, according to Domesday Book, there was a priest at Gaddesden, and there was a vicarage here before the year 1255, when the records of the See of Lincoln commence. Most of the monuments in the church are to members of the Halsey family, which has been settled at Gaddesden for many generations. The Halsey chapel, built about the year 1730, is on the north side of the chancel. In the year 1877 the wall separating it from the chancel was pulled down and in its place two open arches were erected by Mr. T. F. Halsey, M.P. for the Western Division of Hertfordshire, whose seat, Gaddesden Place, is beautifully situated on the opposite hill. The tower of the church, which was rebuilt not many years ago, has a beacon at the north-east angle. The nave is broad and has a fine oak roof. The capitals of the four arches south of the nave are very handsomely carved in foliage and flowers. The registers, which were shown by the Vicar, date from the year 1559, and are in a good state of preservation.

Accompanied by Mr. Tyrwhitt Drake the party then walked over the hill, along the lane which marks the county boundary, to Nettleden in Buckinghamshire (now transferred to Hertfordshire), and its pretty little church was visited, the chief features of interest in it being pointed out by Mr. Drake, who, on leaving the party, was cordially thanked for his kind attention.

Nettleden is picturesquely situated in a dry chalk valley in which probably once ran a stream; and from it another hill was crossed by a field-path leading by the side of a curiously-constructed hollow way, and by a somewhat steep descent on the other side, the next village, Frithsden, was reached. Here, in a shady spot under the shelter of a wood (Frithsden Copse) on the next hill-side, tea was partaken of, most satisfactorily provided from the village inn.

A pleasant walk through Frithsden Copse and across the Common brought the members to Berkhamsted station, where they separated for their respective destinations.

The following ornithological notes are contributed by Mr. Alan F. Crossman:—

"I think nearly the only thing worth mentioning from the ornithological point of view is about the dabchick. I saw three nests of this bird, but did not ascertain the number of eggs in any case. They were all on the Gade at Water End. I watched the hen bird (?) leave each nest, and only in one case were any of the eggs uncovered. In all the other nests the birds covered the eggs with dead leaves or weeds before leaving, using the beak to do so. I might mention that the bird also uncovers the eggs with her beak, laying each piece of weed or leaf on the edge of the nest to have it at hand to use again. I did not, however, see the bird uncover the eggs on this occasion, but a fortnight ago I watched one doing so at the same place.

"The garden-warbler seemed not uncommon about Potton End, although I am led to believe that in some parts of the county it is comparatively scarce. The nightingale seemed very nearly to have finished singing, showing that in most cases young birds had been hatched. I only heard one all the afternoon. Mr. Brown told me that he thought he heard the nightjar once during the afternoon."

The meeting was under the direction of Mr. Hopkinson.

Field Meeting, 15th June, 1895.

LUTON HOO.

A considerable number of members assembled at the New Mill End Lodge of Luton Hoo Park, where they were met by Mr. James Saunders, of Luton, the Director of the meeting. Several others, who arrived later, only joined the main party at the close of the meeting.

The chief feature of Luton Hoo Park is the lake, which is an artificially-widened portion of the River Lea, a mile and a quarter in length and a tenth of a mile in width at the widest part. The lodge at which the park was entered is at the lower end of the lake, and just below it the embanking of the lake has caused a waterfall to be formed. This was first inspected, and then the members walked by the side of the lake in the direction of Luton, crossed the foot-bridge at its upper end, and returned on the right-hand bank as far as the island. This is a wild spot, overgrown with verdure, where Nature is left to do as she likes, the trees being allowed to grow, and fall, and rot without interference, so that it was quite a paradise for the naturalists, the most enthusiastic of whom spent a considerable time on the island.

Through the kindness of His Excellency, Monsieur de Falbe, the pleasure-grounds, gardens, and conservatories were then visited by those who did not consider the island to be a greater attraction.

Before leaving the park, tea was partaken of by most of the party at the New Mill End Lodge.

Mr. Saunders reports that he found on the island or in the woods around the lake the Mycetozoa *Lycogala epidendron*, *Stemonitis fusca*, var. *confluens* (an unusually large growth of a rare form), and *Trichia varia*. He also reports the finding of the following flowering plants:—*Ervum hirsutum*, *Sambucus ebulus*, *Hippuris vulgaris*, *Symphytum tuberosum*, and *Carex leporina*. And in the lake he found the following fresh-water Mollusca:—*Sphærium corneum*, *Anodonta cygnea*, *Planorbis carinatus*, *P. corneus*, *Limnæa peregra*, *L. auricularis*, and *L. stagnalis*.

The finding of *Helix pomatia* led to a discussion as to the probability of Luton Hoo having been a Roman station; but although the apple-snail is found near many ancient encampments, it is most probably a truly indigenous species which the Romans no doubt used as an article of food, having been accustomed to partake of the representative species, *H. lucorum*, in Italy.

In addition to the plants recorded by Mr. Saunders, the following are the more interesting species which were noticed:—*Euonymus europæus* (spindle-tree), *Trifolium striatum*, *Hippuris vulgaris* (in the water), *Scrophularia aquatica*, *S. nodosa*, *Iris pseudacorus*, *I. fœtidissima* (the former in flower, the latter not yet in bud), *Polygonatum multiflorum* (Solomon's seal), and the Carices *C. riparia*, *C. acutiformis*, *C. hirta*, and *C. glauca*.

Moor-hens with their young were seen on the lake, and the sedge-warbler was heard, evidently being present in considerable numbers.

Field Meeting, 22nd June, 1895.

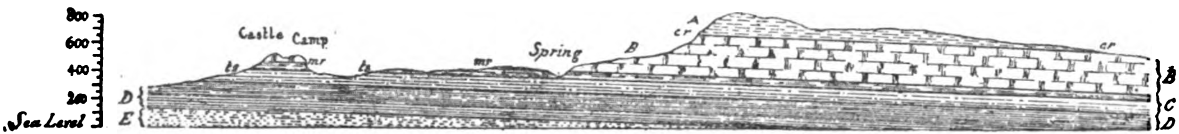
DUNSTABLE AND TOTTERNHOE.

This meeting was organized by the Geologists' Association of London, and was under the direction of Mr. William Hill, F.G.S., of Hitchin, a member of the Geologists' Association as well as of the Hertfordshire Natural History Society. The place of meeting was the London and North-Western station at Dunstable, whence the members of the two Societies, numbering about forty, and each Society being equally represented, walked over the Downs to Totternhoe, visiting on the way the extensive quarries of Messrs. Forder & Co. in the Grey Chalk, which forms the upper portion of the Lower Chalk, its position being between the Totternhoe Stone and the Melbourne Rock, the base of which was seen at the top of one of the quarries. The chalk here is quarried to be burnt into lime.

Maiden Bower, which seems most probably to have been an old British camp, was then visited, and its chief features of interest were pointed out by Mr. Worthington Smith. It forms a level plain, about nine acres in area, nearly circular, and enclosed by a vallum, the banks of which were stated by Britton and Brayley at the beginning of the present century ('Beauties of England and

SECTION THROUGH TOTTERNHOE KNOLL AND KENSWORTH HILL, NEAR DUNSTABLE.

N.W. Totternhoe Knoll. Kensworth Hill. S.E.



Horizontal scale: 1 inch = 1 mile. Vertical scale: 1 inch = 1320 feet (¼ mile).

A. Upper Chalk. *B*. Middle Chalk. *C*. Lower Chalk. *D*. Gault. *E*. Lower Greensand.

cr. Chalk Rock. *mr*. Melbourne Rock. *ts*. Totternhoe Stone.

Wales,' vol. i, p. 29) to be from eight to fourteen feet high, but are now very little raised above the general surface of the ground.

The principal object of the meeting was then carried out, and that was to see an example of the ancient quarries of the Totternhoe Stone, which consisted of galleries tunnelled under Totternhoe Knoll. It is probable that these quarries were worked at least as early as the time of the Norman Conquest. In many Hertfordshire churches early Norman decorative work is of this stone, which is excellent for interiors, admitting of very fine carving, but is of too perishable a nature for exteriors, as may be seen by the present state of the west front of Dunstable Priory Church, which was inspected later in the day.

Most of the tunnels which have been worked for this stone for centuries, up to a comparatively recent period, are now closed by fallen *débris*, and even their entrances are concealed by having become grassed over, but one of them was recently re-opened by Messrs. De Beringer and Gower, the owners of the large quarries at present worked at Totternhoe. Permission for the party to enter this tunnel had been kindly granted by them, and men with lamps conducted the greater number of those present, in several separate parties, through the tunnel and some of its ramifications for a distance of more than 100 yards in a direct line under the hill.

The quarries which are at present being worked were then visited, and several fossils were obtained from the Totternhoe Stone, including part of the jaw of a saurian, with the teeth in position. Mr. Hill states that "Messrs. De Beringer and Co., by means of a trial shaft, have proved the bed of Totternhoe Stone to be at least 32 feet thick" where these fossils were obtained, and that "blocks equal in quality for building purposes to those seen in the pit were obtained at the bottom of their shaft." ('Proc. Geol. Assoc.,' vol. xiv, p. 194.)

Returning across the Downs, Dunstable Priory Church was visited. It is but a small remnant of the original Priory. "The glory of Dunstable," say Britton and Brayley, "was its once celebrated priory, yet of this extensive building little remains but the part now appropriated for the parish church, and a few fragments in the adjoining wall. It was founded by Henry the First, about the year 1131, for black canons, in honour of St. Peter. . . . The priory church was originally in the form of a cross, with a tower in the centre, supported by four lofty arches, parts of which, belonging to the two western pillars, still remain; these are of a large size, with clustered columns, surmounted with hexagonal capitals." ('Beauties of England and Wales,' vol. i, p. 19.)

But by far the most interesting portion of the church is the west front, the whole of the ornamental work in which is carved out of Totternhoe Stone from the ancient workings which had just been visited. "The west front," the same writers say, "has been considered as 'one of our great national curiosities,' from its singular intermixture of *circular* and *pointed* arches, and the curious manner in which its ornaments are arranged. The great doors had four pillars on each side, with Saxon capitals supporting five mouldings, the outermost of which is ornamented with zigzag work; the second has angels and foliage in alternate ovals; the third, beasts' heads, jessant foliage; the fourth, a spread eagle and the signs of the Zodiac, of which Pisces and Capricorn still remain; the fifth, flowers, etc. The capitals have David playing on the harp, a figure prostrate to him; a bishop *in pontificalibus*, with mitre and crosier, and a bearded man in a cap; two more bearded men hold a scroll perpendicularly, on whose top is a headless beast, etc. The lesser door has seven mouldings, on five pillars exclusive of the inner, composed of roses and laced work, and nail-headed quatrefoils. The arch between the two doors is half a zigzag and half a straight moulding, and the interlaced arches within it rest on capitals charged with grotesque figures: one seems to have a number of souls and a devil. The space over the small door is ornamented by various compartments displaying flowers. Above the doors are three rows of arches: the first consists of seven flat arches, with pedestals for statues; the second of six small and two large, open to a gallery leading to the bell-tower, with a seventh arch between the latter, placed over the door, all on treble clustered pillars. The third row has five pointed flat arches with single pillars. Over the west door, under the arch, are three ornamental niches; and under the west windows of the tower are four roses in squares." (*Loc. cit.*, pp. 19, 20.)

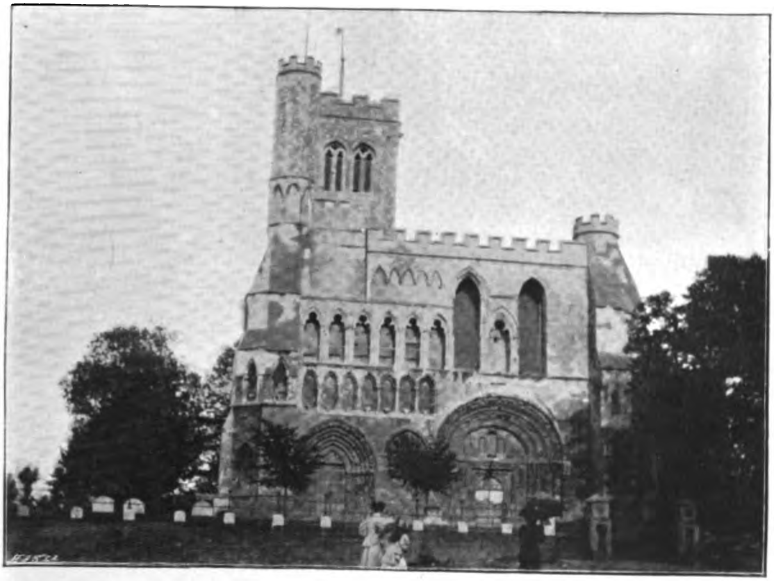
The church was entered, but the interior features have not the same interest, from a geological point of view at least, as that attaching to the exterior of the building.

The members of the Hertfordshire Society then left from the Great Northern station, a few minutes' walk from the church, the members of the Geologists' Association leaving by a later train after having tea in Dunstable.

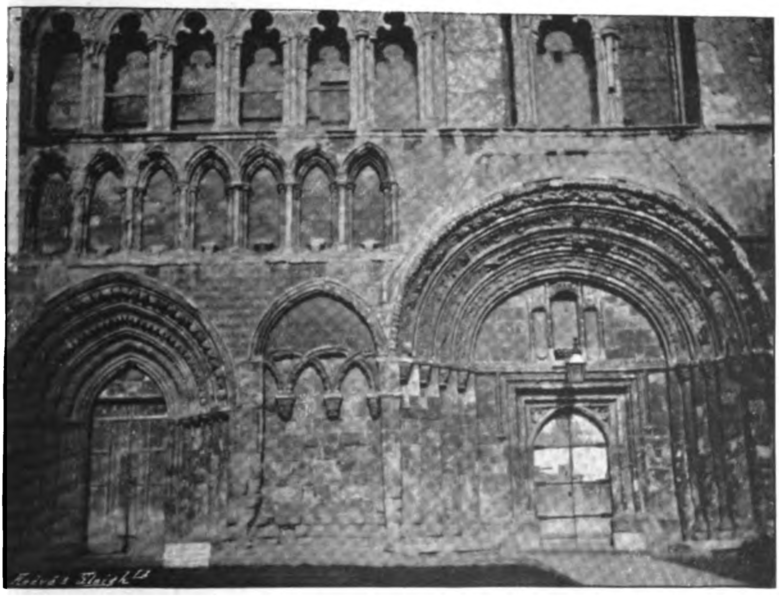
Field Meeting, 19th October, 1895.

THE GROVE, WATFORD.

When a naturalist settles down to work in his study, he knows exactly the amount of material at his command, and under such circumstances he has not the charm of uncertainty, and possibility of a pleasant surprise, so often experienced by the somewhat despised collector. Undoubtedly the type of collector who has no ultimate object in view cannot claim much sympathy from the true student of nature; but, on the other hand, every true student of nature must be a collector, otherwise his field of view must necessarily be narrow, and his power of comparison imperfect, owing to a lack of the knowledge pertaining to the habits and mode of life of the particular group of organisms in which he is interested. Every ramble in the country adds to the knowledge of the student of nature, and although it must be admitted



West Front of Dunstable Priory Church.



Part of West Front of Dunstable Church.

that when a person starts with the object of collecting fungi, and visits suitable localities, and at the proper season, he naturally expects to find at least a certain number, even if the primary object is not realized the attempt is not a failure, as might at first sight be considered. In fact, such partial disappointments often lead to unexpected results; meteoric conditions and other factors likely to account in some manner for the unexpected results are carefully noted, and in course of time repeated observations show that what was at first considered as an anomaly resolves itself into a law.

Whether this problem had been worked out by the members of the Hertfordshire Natural History Society, and as a body they were assured in their own minds that few or no fungi could be found in the autumn of 1895, is not certain; but probably such was the case, for, during the early part of the day set apart for the annual fungus foray, only Mr. Hopkinson and Mr. Massee, with one of the Earl of Clarendon's keepers, rambled through Grove Park and Woods in search of fungi.

The almost entire absence of fungi during the first hour's search seemed to suggest the condition of things already noted; but on entering Grove Park the first surprise of the day manifested itself. Numerous objects scattered amongst the grass under an oak-tree attracted attention, and very soon specimens of the rarest and most interesting of British fungi—*Strobilomyces strobilaceus*, Berk.—were being carefully packed for future study. This species was established by Berkeley on a specimen found near Ludlow many years ago; afterwards a second specimen was collected in Wyre Forest, near Worcester; and the present discovery is of much interest as indicating the tenacity of a fungus belonging to an antiquated and primitive type having its headquarters in Western Australia.

A second rare species—*Collybia longipes*, Bull.—was also found in the same park in considerable abundance.

The real importance attaching to the discoveries indicated above can only be appreciated to its full extent by those interested in the sequence and evolution of life on the globe; and to gain an insight into this most fascinating subject the study of fungi may be strongly recommended.

But although in the morning the search for fungi was carried on by only two members of the Society, in the afternoon they were joined by several others, but not by all who came, for the St. Albans contingent, owing to their train being late, never found the Watford members, who duly met the Director and Referee at the appointed hour and place.

The Editor has to thank Mr. Massee for the foregoing remarks on the collection of fungi, and on the rare species found, and also for the following list which embodies the results of the day's collecting, all but two or three of the species having been found in the morning. Those now first recorded for Hertfordshire are indicated by an asterisk.

HYMENOMYCETES.

Agaricus (Amanita) phalloides, *Fr.*
,, (Lepiota) procerus, *Scop.*
,, ,, rachodes, *Vitt.*
,, ,, hispidus, *Lasch.*
,, ,, lenticularis, *Lasch.**
,, (Armillaria) melleus, *Vahl.*
,, (Tricholoma) sejunctus, *Sow.*
,, ,, albo-brunneus, *Pers.*
,, (Collybia) longipes, *Bull.*
,, (Clitocybe) clavipes, *Fr.*
,, ,, pithyophilus, *Fr.*
,, ,, tuba, *Fr.*
,, ,, laccatus, *Scop.*
,, (Mycena) purus, *Pers.*
,, ,, polygrammus, *Bull.*
,, ,, peltatus, *Fr.**
,, (Omphalia) striæpileus, *Fr.**
,, ,, campanella, *Batsch.*
,, (Inocybe) asterosporus, *Quelet.*
,, (Galera) tener, Schaeff.
,, ,, hypnorum, *Batsch.*
,, (Hypholoma) velutinus, *Pers.*
,, ,, hydrophilus, *Bull.*
Cortinarius talus, *Fries.**
Hygrophorus limacinus, *Fr.**
Lactarius turpis, *Fr.*
,, controversus, *Pers.**
Russula sardonia, *Fr.**
,, fragilis, *Pers.*
Marasmius oreades, *Fr.*
,, peronatus, *Bolton.*
Panus conchatus, *Fr.**
Lenzites flaccida, *Bull.**
Tremella mesenterica, *Retz.*
,, versicolor, *Berk.**
Dacryomyces deliquescens, *Duby.*
Clavaria cinerea, *Bull.**
Thelephora laciniata, *Pers.*
Corticium radiosum, *Fr.**
,, molle, *Fr.*
,, lividum, *Pers.**
,, comedens, *Fr.*
Stereum hirsutum, *Fr.*
Merulius serpens, *Tode.**
Polyporus hispidus, *Fr.**
,, adustus, *Fr.*
Strobilomyces strobilaceus, *Berk.**
Boletus chrysenteron, *Fr.*
,, variecolor, *B. & Br.*

DISCOMYCETES.

Peziza brunnea, *A. & S.*

The thanks of the Society are due to the Earl of Clarendon for kindly allowing the members free access to his woods and park.

With very great regret the Editor here records the death of the Earl of Limerick and of Monsieur De Falbe, to both of whom the Society is indebted for kind assistance at the Field Meetings in 1895, the former at Tewin Water and the latter at Luton Hoo.

ANCIENT BRONZE IMPLEMENTS.

TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

I.

THE BRONZE AGE.

By Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., etc.

The substance of a Lecture delivered at Watford, 14th November, 1893.

PLATES I–III.

As your President has informed you, I was appealed to in the most touching manner to give some kind of an opening lecture at the beginning of the present session of this Society. No subject purely within the province of Natural History seemed available for me, but on looking at the subjects included within the scope of the Society I found that one of them was Pre-historic Archæology, of which you have an official Recorder.

Now Pre-historic Archæology is a comparatively wide term, and embraces all those phases of human civilization which took place prior to the advent of written history in any given country, and I think it is well for any Natural History Society to embrace Pre-historic Archæology within its scope, for, after all, of all created animals, man claims the first place, and anything that relates to the history and development of man and of human civilization ought to be of interest to all, and specially to those who are students of natural history.

I will not apologise in any way for selecting such a subject, but I may say, in the words of an old Roman author, "I am a man, and I regard nothing human as foreign to me," or I may quote one of our English poets, and say,

> "The proper study of mankind is man."

My lecture will be confined to only one of those periods into which Pre-historic Archæology has been divided—the Bronze Period. The question naturally arises—What do we mean by the Bronze Period?

In the first place, what is bronze? Bronze is an alloy of copper and tin in certain proportions—about nine parts of copper to one of tin,—which produces a comparatively hard and malleable metal, and the name of bronze is derived from a source which will not at once be obvious to all. We often, in fact every week we hear of men making the passage to India by Brindisi. The old name for Brindisi was Brundusium, as all who have read their Horace will be well aware; and there is a metal, consisting in the main of copper and tin, which was known as Brundusian metal, and from that came the word "bronze." The Bronze Period is that which is characterized by the use of that particular alloy of copper and tin. In order to make this clear I must go into the question of the division of pre-historic times. We find, if we trace the progress of man backwards in time, that, though we might call the present day the age of steel, of printing, of gunpowder, or what not, yet that, going a little farther back, the principal tools and weapons or other implements in use were not so much made of steel as of iron, and looking farther back still, that the iron tools superseded the use of those made of another metal—bronze. In a similar manner we find bronze weapons coming in and superseding the stone weapons which were in use when no metal whatever was known for cutting purposes. We must not, however, suppose that at what may be termed the close of the Stone Period the use of stone entirely went out. Even at the present day we find stone used, not only for the purpose of striking a light, but by the modern carpenter as a scraping tool in the modified form of a broken bit of glass.

In the same way as stone survived for special purposes when it had gone out of general use in consequence of bronze having come in as the material for cutting tools, so also when bronze went out of use it still to some extent survived, partly for ornamental purposes and partly for religious and ceremonial uses: for in all cases and in all countries we find that the religious ceremonials continue and preserve the usage of former times in a manner which no other usages do. Those Ages, as I said before, overlap one another, though they are as distinct as the three principal colours of the spectrum, while, like them, they blend and intermingle, so that it is hard indeed to say where one ends and the other begins.

We have, in addition to the minor monuments discovered in the soil, historical testimony as to the succession of these three Ages. A great presumed authority on Homer, no less a person than our former Prime Minister, Mr. Gladstone, has said that the poet lived at a time when the use of iron was just commencing, when the commodity was rare and its value very great; and Hesiod looks back with an admiring envy from his Iron Age to the Heroic period, and in glowing terms depicts a time when iron was not known and all implements were made of bronze. Lucretius, in a well-known passage, states that the ancient arms were the hands, nails, and teeth, as well as stones, and occasionally branches torn from the trees. Afterwards the power of iron was discovered, but, he adds, the use of bronze was earlier than that of iron. There is also a very curious memorial of this use of bronze surviving in the Greek language. A blacksmith, a man who works in iron, is called, even in classic times, a *chalkeus*, a man who works in bronze, showing that the name still survived when iron had supplanted bronze. In religious ceremonies we find numerous instances of bronze surviving. The Tuscans, when they laid out the boundary of a new city, employed bronze for the ploughshare; the knives and shears used in ceremonial performances by the Romans were made of bronze; and Medea and Elissa are said to have reaped their harvests with bronze sickles. Though iron came into use in Italy at least 600 years before Christ, bronze survived for battle-axes and spears to a much later period. It is hard to say when iron was first introduced into Egypt, but its use does not go back to the earliest period of Egyptian history, and probably to not farther than 1300 or 1400 years B.C. It was in use in Egypt earlier than in Greece. An early Greek writer, writing B.C. 100, gives an account of bronze wedges being used in ancient Egyptian gold mines, and he subsequently refers to other bronze antiquities. It is now thought that bronze and copper were in use in Egypt probably nearly 4000 years before Christ. In the course of my remarks I shall call attention to a very remarkable spear-head of bronze from Egypt, belonging to a period somewhere between the days of Joseph and of Moses.

But between the Bronze and Iron Ages we have a certain transitional period, from which some examples have been found in Austria, in the neighbourhood of Halstatt. About 2000 graves have there been examined, and in them were found implements, not only of bronze but also of iron, which in form and character had apparently been modelled on those of bronze.

Except in the metal, there is no difference between the bronze sword and the iron one which succeeded it. In our own country we have antiquities to which Mr. (now Sir Wollaston) Franks has given the name of Late Celtic, which belong to a time when iron had come into general use, but prior to the Roman occupation of this country.

Bronze, as I have said before, is a composite metal of copper and tin, and a natural inference would be that at some period of the world's existence there must have been a Copper Age. Of that Copper Age we have in Europe but very little trace. However, in India, where it seems probable that the bronze civilization of Egypt and Europe originated, a number of copper implements have been found, consisting of axes and other tools or weapons in their simplest form. Some copper tools have occasionally been found in other countries, and the question has arisen whether this is not due to the scarcity of tin rather than to the fact that copper was in use prior to bronze. A Copper Age has been claimed for Hungary, but there the copper implements belong to a late period in the Bronze Age, and it appears that the softer metal was probably preferable to bronze for the particular purposes to which these implements were applied.

The question has arisen—Whence did the ancients, whether here, or in Egypt, or elsewhere, derive their tin ? The Egyptians, in all probability, obtained it from the East. Here, not improbably, the tin was procured from Cornwall, where we know that there was an early commerce for tin, even in Phœnician times.

Homer gives an account of bronze casting; that is to say, he gives an account of men throwing into the fire the indomitable copper, and tin with it. The properties of the alloys of copper and tin are very remarkable; a certain amount of tin, up to ten per cent., adds materially to the hardness of the metal, without injuring its malleability. When, however, the mixture contains a larger proportion, 30 or 40 per cent., of the softer and more readily fusible metal, the result is a very hard and very brittle alloy. We employ such an alloy for the specula of telescopes, and it is known as speculum metal. But the old bronze-founders seem to have been aware of the fact that the addition of a greater proportion than usual of the softer metal hardened the copper, and we find hammers and other tools made of this instead of ordinary bronze.

In treating this subject on the present occasion I prefer to regard it from the technological point of view. I will describe most of the different forms of weapons and instruments, more particularly those found in the British Isles, though I may occasionally touch upon those found on the continent of Europe. In Britain we have a considerable number of tools which were used in the arts of peace, some of which, however, were also applicable for the purposes of war; but we have in addition others which were certainly used as weapons of war, and there are certain remains which were strictly personal ornaments.

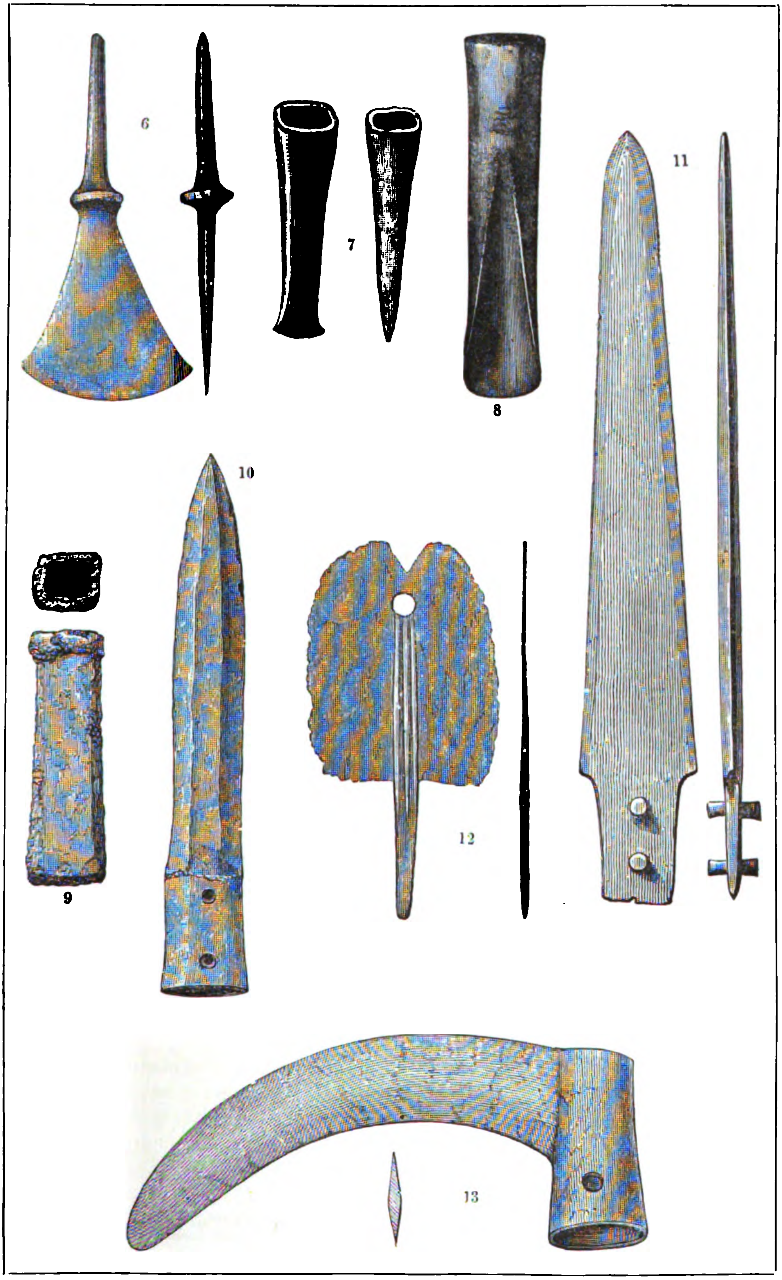
As to the methods of manufacturing the different forms, and the way in which they were produced, I will speak subsequently; I think it well now to give some general view of the different forms of weapons, implements, and ornaments found in this country. Besides the diagrams shown on the walls I have brought a selection of specimens, which may be inspected after the lecture.

The first and simplest form is that known as a celt. Celt is a very improper word to have ever been used in connection with a tool of this kind, for "celt" in English is derived from the Latin word *celtis*, and that only occurs once in the Book of Job, in the Vulgate translation, and is, moreover, merely an error in transcription. But it is supposed to mean a chisel, coming from *cælare*, to carve, the proper word being *cælum*, and that being confused with the word *cœlum*, "the heavens," the word *celtis* has been preserved and used as the name for these bronze implements. There are various forms of these celts. One, as will be seen from Fig. 1, was perfectly plain, having its sides and face nearly smooth and flat, and somewhat curved longitudinally from end to end; another (Fig. 2) will be noticed as having flanges, not unlike the modern rail of the railway; another, known as a palstave, was furnished with a groove on either side ending in a well-defined stop-ridge and with projecting wings, sometimes with and sometimes without a side-loop (see Figs. 3 and 4); and lastly, one furnished with a socket for the reception of the haft and with a loop at the side, is known as a socketed celt. One of these is shown in Fig. 5. The general purpose for which they were used seems to have been that of an ordinary axe or hatchet. They are found in several stages, from a large size, evidently that of the original casting, down to a much smaller size, when they had been worn down by use, and by grinding, and possibly repaired after portions had been broken off. These implements are found over the whole of Europe. They also occur, though rarely, in Asia, and I have seen specimens from China and Yun-nan. The earliest celts are nearly flat and plain at the sides, and were no doubt modelled from those in stone. Here is a stone hatchet from Denmark and a bronze hatchet from Cyprus. As regards the face and sides they are almost identical in form, and the probability is that that of metal was brought in as a substitute for that of stone.

At this point it may be well to consider the probable origin of copper implements. Copper, found in its native state, can be hammered into shape. We can understand a savage regarding a lump of native copper as a stone, trying to chip it into shape, and finding that by blows of his stone hammer he could shape it. As a perfect illustration of this, we find in America and Canada tools and weapons, hammered by means of stone hammers out of native copper, which have reached the required shape probably without the intervention of fire. Frequently European celts were ornamented on the face with very delicate hammered markings, giving them in some cases a surface having the appearance of Morocco leather. The earlier forms were mounted by being inserted in a wooden club, but it was found that they acted as wedges and tended to split the handle, so a stop-ridge was introduced; and at last they reached the palstave form, with a strong cross-ridge, which absolutely prevented their being driven in further than was intended. The sides were sometimes drawn out by hammering, thus forming flanged celts, and in some cases the flanges themselves were bent over.

The next form after the flanged celt was the palstave. The term is Scandinavian in origin, a kind of hoe somewhat similar to these bronze implements, called a paalstab, being still in use in Iceland. The word paalstab is derived from *pæli* to dig, "pall" (like the French *pelle* and Latin *pala*) meaning a kind of spade. The same word still survives in England in "peel," the kind of wooden shovel used by bakers for putting the loaves into the oven. "Stab" is equivalent to our staff. The word paalstab occurs in the Sagas, and is applied to one of the weapons used for battering the shields of the enemy. The flanges were gradually hammered over more and more till they formed a kind of socket on either side of the blade, and at last some clever founder discovered a way of casting one with a single socket, and thus produced the socketed celt, the latest form. We find the flanges of the palstave still surviving in many cases on the outside of the socketed celt, although the necessity for them had disappeared. Most of the socketed celts were provided, like some of the palstaves, with a loop on the side for the insertion of strings to bind them to the handle. To haft any of these celts involved finding a branch of a tree which entered another one at right angles.

Besides the forms already described there was the tanged celt, which approached very closely to the modern chisel. A specimen from Wallingford is shown in Fig. 6. Socketed chisels were more rare, but several specimens have been found. One from Heathery Burn Cave, Durham, is shown in Fig. 7. Besides the ordinary straight chisel they made use of the hollow one or gouge, one of which is represented in Fig. 8. A number of hammers have been discovered made like the socketed celts, so that the handle, instead of going through the head, went into it. They have been often found in bronze-founders' hoards, in which there were also found scraps of old metal, sometimes the moulds in which new objects were to be cast, and occasionally the new article in an unfinished state. A hammer from the Isle of Harty is shown in Fig. 9. Anvils were occasionally found, and doubtless many of the socketed hammers were mounted on stakes so as to serve as anvils. Axes perforated with a hole for the reception of the handle, after the present method of hafting, have not yet been discovered in England, although several have been found on the continent. Knives were of course in use, the ordinary form being straight, double-edged, and fitted with a socket, through which passed one or two rivets, as will be seen from Fig. 10. Another form had a flat tang, sometimes provided with rivets like Fig. 11, and sometimes with a ribbed tang merely driven into the handle. Single-edged blades, like those in use at the present time, are very rare in England, although common on the continent. Occasionally a human figure formed part of the handle, and sometimes a ring was dexterously cast upon it. Implements which have been looked upon as razors have also been found, so that it seems probable that the people of the Bronze Age shaved. A double-edged curved blade with a tang and a perforation through the blade was the usual form in this country, like that from Wallingford (Fig. 12). The blades were frequently ornamented in a very artistic manner. Very few saws have as yet been discovered in England, although several specimens have been found on the continent. I have one in which the teeth are pyramidal and broader than the back of the blade, so that it cleared itself in sawing. Files of bronze have been found, but they belong to a late period, and none have as yet been discovered in England. Awls are found amongst the earliest implements; they were apparently used for sewing. In Denmark a ladies' housewife of that period consisted of an awl, a pair of tweezers, and a knife. The awl was used for boring holes in the leather, through which the thread was passed and caught by the tweezers, and of course the knife was used to cut it off. These appliances are rarely found in this country.



ANCIENT BRONZE IMPLEMENTS.

We have evidence that the people at that time were acquainted with some kind of grain, and that they reaped it in the manner which Pliny describes as practised by the ancient Gauls, namely, cutting off the ears only. In Switzerland a wooden handle designed for a bronze sickle has been found. It has recesses cut in it for the four fingers as well as for the thumb, thus giving a perfect grasp. A socketed sickle from the Thames is shown in Fig. 13. Buttons of bronze are frequently found, and fish-hooks have turned up very similar to those in use at the present day. Among the earliest forms of weapons which were used in the Bronze Age are small daggers, of which it is hard to say whether they were knives or daggers, and to which the term knife-daggers has been applied. They were sometimes socketed and sometimes tanged, but were usually fixed to their handles by two or three rivets. An example from a Yorkshire barrow is shown in Fig. 14. One found in one of the Wiltshire barrows had the handle decorated by driving in tiny gold pins so as to form a delicate pattern, which it would be very hard to reproduce at the present day. A copy of Hoare's figure of it is given in Fig. 15.

Passing to weapons of a more purely warlike character, I will commence with the sword. The bronze swords have been generally regarded as Roman, but long before the Romans appeared in England the Britons were well acquainted with iron, and did not use bronze swords. As a matter of fact they must belong to a much earlier period, being distinctly pre-Roman. They were hafted in various ways, the hilt usually being perforated for the reception of rivets, by means of which handles of stag-horn, cow-horn, or wood were fastened to them. Fig. 16 represents a specimen from the Thames. Occasionally they are found with bronze hilts. Others were smaller, of rapier-like form, with two rivet holes at the base, and these were used more for thrusting than cutting. Many were only fitted for piercing, like the modern bayonet.

There is one curious feature about the bronze swords which has led to much speculation. Many of them have such small handles that the ordinary hand of a modern Englishman is barely capable of grasping them, whereas the thin, wiry hand of a Hindoo or other Eastern is still able to go between the hilt and the pommel. From that circumstance it has been inferred that the bronze-using people were of small stature with very delicate hands, and resembled what some people term "our Aryan ancestors." But this view cannot be thoroughly substantiated. The large swords usually had large handles, into which large hands could go, while small swords had but small handles. The handle seems to have been adapted to the size of the weapon, just as in these days the whole hand can go into the handle of a hand-saw, whereas only two fingers will pass into that of a small key-hole saw. The swords were apparently kept in wooden sheaths provided with plain bronze chapes, which were riveted to the wood. In others the bronze ends for the sheaths were provided with two long projections like the flukes of an anchor, which seem as if they would catch at once in any brushwood the wearer had to march through. Possibly it might have been an advantage to catch them in something to enable the sword to be withdrawn.

After the swords come the spear-heads. These were usually cast with sockets, so that they belong to a comparatively late period, although possibly some of the tanged weapons like daggers were used as spear-heads. They are usually leaf-shaped, and secured to the shaft by rivets, as in the example given in Fig. 17. Another form was provided with two eyes, through which strips of leather could be passed to secure it to the shaft, like Fig. 18; and lastly, there are some with apertures or perforations in the blade, intended to serve the same purpose. I have a spear-head, found in Ireland, no less than 24 inches in length, and in the blade, 17 inches from the point, are two orifices, which were probably intended for the reception of a cord. I showed the blade to Mr. Clibborn, the late Irish curator of the Royal Irish Academy, who asked me if I could tell him the purpose of those orifices. In my innocence I replied that I thought they were for the reception of strings to hold it to the shaft, because there were no rivets. "Nothing of the kind," said Mr. Clibborn. "What then are they for?" I asked. "They're for poison!" he replied. To that I remarked, "Is it not adding insult to injury to poison a man after stabbing 17 inches into his body?"

Arrow-heads of bronze are hardly ever found, inasmuch as flint arrow-heads survived into the days of bronze. There is one form of bronze instrument, a vocal instrument, which occurs more frequently in Ireland than in Britain—a trumpet. Curiously enough in Cæsar's time the ancient Britons still preserved a trumpet, very much of the same kind. On a coin of Tasciovanus struck at Verulam, there is an effigy of a horseman wielding one of these instruments, and they are frequently delineated on Roman coins which commemorate victories over Gauls and Britons. Another weapon of only occasional occurrence in this country is the halberd. It is more common in Ireland, but extremely rare in Western Europe. One or more have been found in Spain, which gives support to the idea that there was communication between Ireland and Spain in these early times.

Turning to weapons of defence, I may describe some shields which certainly belong to the end of the Bronze Age. That shown in the diagram is 14 inches in diameter, and made from a single sheet of bronze, with large bosses stamped out in it. The most common type in the British Isles is one having a series of concentric rings, from 12 to 30 in number, with rings of small studs between them.

Lastly I come to the ornaments, of which the chief were torques or twisted necklaces. Bracelets and armlets are also abundant. Several forms of ear-rings are found, of which one was made in the form of half a tube, with a small projecting hook in the centre to fasten it to the ear. In modern times it might have served to hold a cigarette. Various forms of pins have been found, and in addition to those of bronze and gold many necklaces have been discovered made of amber and jet.

Cauldrons made of a number of thin plates of bronze hammered into shape and riveted together have been found, and in further evidence of the foreign intercourse already noticed, several of them seem to be of Etruscan origin. Some of the trumpets were built up of flat plates hammered over and riveted in a similar manner to the fire-hose of the present day. This implies an immense amount of skill on the part of those who constructed them.

I must now shortly consider what is the chronology of the period, what date is to be assigned to these objects. It must be evident that the Bronze Periods in the different countries of Europe could not chronologically have all been of the same date. We cannot expect that at the time when bronze or copper was first known in Egypt it would have been known in the north of Scotland, in Ireland, or in England, and it must have gradually spread from some centre or other; and though we might say that in Egypt it goes back to 4000 years before Christ, yet iron was found in Egypt 1300 B.C., while in Greece bronze was almost the only metal to about 1000 B.C. Iron was not in common use throughout Europe until some centuries later, and though probably there was a great amount of intercourse along the shores of the Mediterranean, and the civilization of one or another of the southern countries was not very different, yet as we go farther north it is evident that the introduction of iron and the disuse of bronze, and the introduction of bronze and the disuse of stone, must date from a later period than in the more favoured districts bordering on what at one time was the centre of civilization—Egypt. Iron was well known in Britain at the time of Cæsar's invasion. Take that as 50 B.C.; it is evident that it must have been introduced at a considerably earlier period. It had long been known in Gaul and Germany, and I think we may safely say that in this country bronze must have gone out of use some 200 or 300 years B.C., occasionally surviving in remote districts and being occasionally used for ornamental purposes. In this country probably bronze, as also iron, was introduced from Gaul. It seems likely that the original home, both of copper and bronze implements, was in Asia, where both copper and tin are found, and whence we have extremely early examples.

As to the civilization of the people who used the bronze we have very good evidence from some of those Swiss lake-dwellings of which so much has been heard. During dry weather the shores of some of the Swiss lakes have been laid bare, and on them have been found the remains of habitations erected on piles, from which when the water was high a number of implements were lost and buried in the lake, and when from time to time the dwellings were burnt down the whole property of those who lived in them was deposited at the bottom of the lake. These lake-dwellings are of various dates, some belonging to the Stone, some to the Iron, and a certain number to the Bronze Age; and from them we may infer what was the state of civilization of those who occupied them during the Bronze Period of Switzerland. First of all, we know that they were acquainted with fire—they could not work their bronze without it—but as to their means of producing fire, it would appear that they used the ordinary pyrites (sulphide of iron) and a piece of flint. As to their clothes, they employed the skins of animals, which they were able to sew together by means of the awl I have already mentioned, and they wore woollen cloth, of which fragments have been discovered. They also employed flax, not only for weaving purposes, but also for the manufacture of string and net; and they were acquainted with the art of spinning and weaving, as we know from the spindle-whorls which have been found. As to domestic animals, they had the dog, the ox, the sheep, the goat, the pig, and the horse, so that they were not very much behind us at the present day so far as domestic animals are concerned. They hunted the red deer, the roe, the boar, the hare, and other animals; they fished with bronze fish-hooks exactly like those in use at the present day, except as regards the metal of which they were constructed; and they also had nets—I do not know whether they were limited as to the size of the mesh. They used arrows tipped with flint, as bronze was much too precious a metal to be lost; they prepared their skins with stone scrapers, as was done during the Stone Period; and they had the tools which I have mentioned. They had wonderful skill in casting those tools and weapons. They cultivated cereals, principally barley, and made pottery of a superior kind, ornamented with colour and sometimes with tinfoil, although they were unacquainted with the potter's wheel. An amber cup, however, evidently turned in a lathe and provided with a handle, has been found in England, and at the close of the period many articles were turned out of Kimmeridge shale.

The British Bronze-people wore fewer ornaments than the Swiss lake-dwellers, but had more jet and gold. They wore gold torques and bracelets, ear-rings, and pins for the dress and hair. That they had intercourse with other nations is shown by the fact that they had ornaments made of ivory, and also glass beads.

We can in some countries divide the Bronze Age into periods. In England three distinct stages can be traced. The first is characterised by flat or slightly flanged celts and knife daggers, which are found in barrows in connection with perforated stone axes and occasionally knives of flint. Next came the period of more distinctly flanged celts and tanged spear-heads or daggers; and lastly that of palstaves and socketed celts and other tools and weapons. It was only in this last period that the true bronze sword and socketed spear-head made their appearance.

Roughly speaking we may consider that the Bronze period would extend from about 1200 or 1000 B.C. to, say, 200 years, or possibly later, before Christ.

I cannot now go into the manner of the introduction of bronze into this country, nor consider whether it was the result of invasion or of trade, possibly Phœnician, nor can I enter into the anatomical characteristics of the men of this country of the Bronze Age beyond saying that they were dolicho-cephalic—long-headed men.

Some account of the method of casting and making the various weapons may be of interest. In casting the earliest forms, moulds open to the air on one side were used, but the later ones had both sides moulded. Examples in stone of both the single and double moulds have been found. The two halves of the double moulds were tied together with string. The hollow in the socketed celts and spear-heads was produced by means of a clay core, which in some cases may have been kept in position by little scraps of bronze. I have in my collection a most complete set of founder's tools, which were discovered in the Island of Harty, part of Sheppey. Among them are several moulds for socketed celts and one for gouges, and some of the articles have evidently been cast in these moulds. The ordinary method of casting a socketed celt seems to have been to put the two halves of the mould together and then to ram clay into them. The core thus obtained was taken out and cut down so that the walls of the socket would be of the right thickness; it was left full size at the top so as to form a mould for the top edge of the celt, except where channels were cut for the passage of the molten metal. The clay core would be burnt to a hard brick by the heat of the casting, and its extraction would present some difficulty. The workman whose stock-in-trade we are considering had a pointed tool which he drove into the burnt clay and so managed to get it out. Originally he had two, but one of them had the point broken off short, just where it would come against the margin of a socket. The celts cast in this manner were blunt at the edges and had to be hammered out to sharpen them. After this a whetstone would be used to finish the sharpening and to smooth down the rough sides. The small anvil, hammer, and whetstone for doing this were found in the hoard. This workman not only cast hatchets but he moulded gouges, and he has left the only example of a mould for this purpose which has been discovered.

I hope that I have now given a fair idea of how these celts were manufactured, and I will add a few words as to the manufacture of shields. It is very hard to tell how the old workmen obtained the thin sheets of metal necessary for their construction. Moulds have been found intended to form discs of metal like small pancakes, and they would be able to beat these out into sheets on their stone anvils by hammering and constant annealing.

As of great interest, though not immediately connected with my subject, I exhibit a bronze spear-head which once belonged to Kames, a king of Egypt of the seventeenth dynasty, who lived about 1750 years B.C., or between the times of Joseph and of Moses. Inscribed in hieroglyphics on the blade is the whole of his name and titles. It seems probable that it was not originally of

Egyptian origin, but was imported from some place further east. This is, in all probability, the first bronze weapon to which an approximately exact date can be assigned. I have also in my possession a flat axe which bears the same name. Even in Mesopotamia, where not improbably this spear-head was made, the method of coring could not at that time have been known, and the socket has been made by bending over a flat plate. The socket having been made in this manner and the blade cast, the two were laid in position in a mould, and hot metal was poured in till the joint was made fast. That they were acquainted with the art of burning bronze to bronze in Ireland at a very early date is proved by the fact that swords have been discovered with a small portion of the blade burnt on to the hilt.

The subject of which I have treated represents a long and important phase in the progress of human civilization, the various instruments discovered affording a most complete record of the mode of life of those who made them.

Even supposing that the chronology of the Bronze Age is in some degree speculative, I trust the slight sketch I have given of the habits, methods of life, and personal equipment of those who occupied our country from 2000 to 3000 years ago has not been devoid of some general interest.

EXPLANATION OF THE PLATES.

PLATE I.

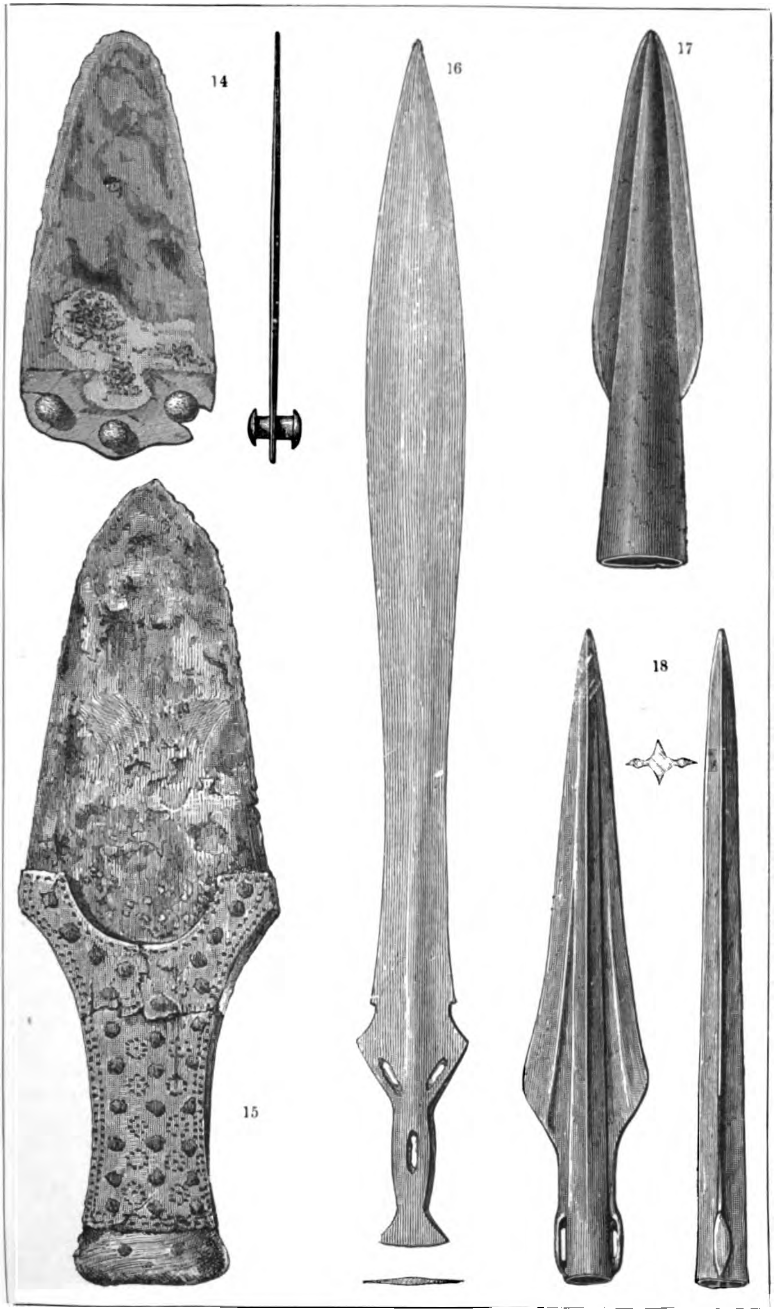
1. Plain Celt.
2. Flanged Celt.
3. Palstave without side loop.
4. Palstave with side loop.
5. Socketed Celt.

PLATE II.

6. Tanged Chisel from Wallingford.
7. Socketed Chisel from Durham.
8. Socketed Gouge.
9. Hammer from the Isle of Harty.
10. Knife with socket.
11. Knife with flat tang.
12. Razor from Wallingford.
13. Socketed Sickle from the Thames.

PLATE III.

14. Knife-dagger from a Yorkshire Barrow.
15. Knife-dagger from a Wiltshire Barrow.
16. Sword from the Thames.
17. Spear-head with rivet-holes.
18. Spear-head with loops.



ANCIENT BRONZE IMPLEMENTS.

II.

THE LOWER MICRO-ORGANISMS AND THEIR RELATION TO EVERY-DAY LIFE.

By D. Harvey Attfield, M.A., M.B., C.M., D.P.H. (Cantab.).

A Lecture delivered at Watford, 23rd January, 1894.

(Abridged.)

My subject is so extensive that anything like a comprehensive survey of it would require not merely one lecture but a series. Hence the particular micro-organisms I can deal with are only those which one is constantly hearing of, either as our kindly friends or fierce foes. To the naked eye they are invisible, yet they are quite capable of working an infinity of good or harm that might well have earned for them in years gone by, before their corporeal existence was demonstrated, the names of good and evil spirits. One at least really was, as we now know, of service to the old miracle-mongers—I allude to the micro-organism which is the cause of what they termed the "Blood-portent on Bread," and the cause of milk changing into so-called blood. This is the *Bacillus prodigiosus*, which, when growing on bread or milk gives to either a reddish appearance.

To micro-organisms we owe that conversion of sugar into alcohol which is essential to the production of wine, beer, and spirits, and they are essential to that rising of dough which is a part of the every-day process of bread-making. There is one bacterium which lives, moves, and multiplies in alcohol. So far from being a teetotaler, it swallows or absorbs nothing but alcohol from birth to death. I allude to the *Bacterium aceti*, the active principle of the so-called vinegar plant, whose life-work is to convert the alcohol of beer and wine into the acetic acid characteristic of vinegar; indeed, ordinary vinegar cannot be produced without this micro-organism.

The greater number of these very important yet excessively minute bodies are plants of the simplest structure, with the most elementary modes of propagation, but yet with extraordinary powers of multiplication. With regard to this latter statement I may say that in the course of some experiments made by Professor Watson Cheyne with a microbe known as the *Staphylococcus pyrogenes-aureus*, 248 individuals became over 20,000,000 in the short space of twenty-four hours.

These micro-organisms are often, though from an etymological point of view incorrectly, designated under the general title of Bacteria. As far back as 1728, Leuwenhoeck saw something in putrid water, but in those early days microscopes were poor, and though he may have seen bacteria his observations were far from definite. Not till 100 years later were any authenticated observations made, when Ehrenberg stated that we were surrounded on all sides by micro-organisms. Schwann, a few years after this, stated that the air constantly contained various putrefactive and fermentative germs, and also that fermentative processes were dependent on the access of living organisms. Since that time, owing to the labours of such renowned workers as Pasteur, Koch, Klebs, and Du Bary abroad, and Klein, Crookshank, Sims-Woodhead, Watson Cheyne, and many others in our own country, steady progress has been made in the knowledge of these organisms, which may be well termed, as I have said, our invisible friends and foes.

As to a classification of the micro-organisms for general purposes, the best will be that depending on their physical form. Microbes consist of single cells composed of that wonderful complex organic substance called protoplasm, surrounded with an envelope of a cellulose-like substance, and may be thus classed:—

(I.) Cells more or less spherical, termed cocci.

(II.) Cells more or less cylindrical, known as bacilli.

The first class, with spherical cells, is divided into several groups. (*a.*) Single separate round cells known as micrococci. (*b.*) Two such cells in more or less close contact; these are termed diplococci. (*c.*) Several cells joined one to the other to form a chain; these are therefore called streptococci. (*d.*) A large number of cells in close contact with each other, forming an irregular bunch, of grape-like structure, known as staphylococci. (*e.*) Spherical cells grouped in a peculiar way, resembling a bale or bundle of goods corded round in three directions, and known as sarcinæ.

The second main division, with cylindrical cells, has a number of subdivisions depending on the various length, thickness, or curvature of the members, and contains such genera as *Bacillus*, *Leptothrix*, *Spirillum*, and some others which need not be mentioned here.

Having thus roughly classed the microbes, I will say a few words as to how they are grown for experimental purposes and also shortly touch on the methods of bacteriological research. This is all the more necessary owing to the fact that *Bacteriology*, the name of the science which deals with these micro-organisms, is of quite recent growth, and is but little understood except by those who make the subject a special study. Everyone can imagine how the scientific chemist works with his test-tubes, and stills, and so on; most people understand or can picture how the anatomist works by aid of his knife and microscope; but the case is quite different when we come to study the methods of the bacteriologist, whose science, as I have said, being of much more recent date, the various terms used by him convey but little information to the uninitiated. These micro-organisms are not only ubiquitous, but are present also in enormous quantities. In our food, and on our bodies and clothes, they are met with in vast numbers. The mouth is a very good forcing-ground for several species. If one is unfortunate enough to have a decayed tooth the bacteria thrive all the better. A tiny drop of moisture from such a carious cavity is spread over a thin microscopic cover-glass, dried, and then treated with a colouring solution of gentian-violet. The excess of staining material is washed off and the preparation again dried and mounted in Canada-balsam. The various micro-organisms are thus fixed and coloured, and hence may easily be seen. A somewhat special microscope is necessary for their examination; it must have what is known as a one-twelfth-inch oil-immersion lens, and also must carry a good substage condenser. Any less powerful objective is almost useless for observing these microbes, the largest of which are only what is known in microscopical nomenclature as 5μ, that is, five micromillimetres in diameter. A micromillimetre or Greek *m* is the one-thousandth of a millimetre, and a yard is nearly 1000 millimetres. To make these mathematics less troublesome to grasp, I may say that if the largest of the microbes were placed side by side, over 5000 of them would be necessary to give a line one inch long. To occupy the same space about fifty times as many, that is, over a quarter of a million, of the smallest would be required.

A few words now as to the methods employed in bacteriological research and analysis, and as to the principles on which are established the causal, or at any rate intimate relation of micro-organisms with disease in its various forms. As a typical case, the procedure in the bacteriological examination of water may be taken. The first object is to ascertain the number of bacteria present, and then to isolate and identify the various species. With these objects in view, plate-cultivations are made. Into a tube of sterile melted nutrient jelly, a small quantity of water, say one or two cubic centimetres, is introduced. The water and jelly are thoroughly mixed so as to equally distribute the micro-organisms through the melted jelly. This is now poured out on to a glass plate—hence the term "plate-cultivation"—and placed in an apparatus to set. When cold the plate is transferred to a moist chamber and placed in the incubator, which is kept at a certain temperature. In the course of from 12 to 36 hours a number of little white or faintly-coloured spots are seen on the surface of the gelatine. Each microbe in the water has set to work, and by rapid reproduction has given rise to a colony of its own species. The colonies may now be counted, and the approximate number of microbes in the original water be so ascertained. While these colonies are small they can be easily picked up with a platinum needle, and cover-glass preparations may then be made from them. When a tube of sterile jelly is inoculated with one of these little colonies, a pure culture is obtained. This can be recultivated and examined, when its various characteristics are recognised, and its possible identity with a known species established. Before we can say that a certain micro-organism is actually the *causa causans* of any particular disease it must respond to Koch's four postulates: (*a*) The micro-organism must be found in the blood, lymph, or diseased tissues of man, or other animal, suffering from, or dead from, the disease. (*b*.) The micro-organism must be isolated from the blood, lymph, or tissues, and cultivated in suitable media outside the animal body, and these pure cultivations must be carried on through successive generations of the organism. (*c*.) A pure culture thus obtained must, when introduced into the body of a healthy animal, produce the disease in question. (*d*.) Lastly, in the inoculated animal the same micro-organism must again be found.

[In the course of the lecture a large number of photographs of the better-known bacteria were shown by the aid of the oxy-hydrogen lantern. The following are a few of the species exemplified, with the remarks made upon them.]

Proteus vulgaris, *Bacterium termo*, and *Spirillum undula*.—These are intimately associated with the phenomena of putrefaction. They are of the highest importance to man, and may well come under the title of invisible friends; for they utilise the excretions of living beings and the carcases of dead animals and plants, after breaking them down into their simplest constituents, to supply those elements which are necessary for the nutrition of plants; thus, from dead organic matter producing the food which is necessary for the vegetables, which are in their turn the food of animals.

Sarcinæ, *Bacterium figurans*, *Spirillum tenue*, and *S. volutans*.—These are, if not active friends, certainly not dangerous enemies.

Bacillus anthracis.—This is the direct cause of wool-sorters' disease in man, and what is known as splenic fever in cattle.

Koch's "*comma bacillus*."—Whether this is the true cause, or only an attendant circumstance, of Asiatic cholera, is still the subject of active discussion. Professor Max von Pettenkofer used to say of this bacillus, of which both he and his colleague, Professor Emmerich, of Munich, ate a considerable quantity without developing cholera, or indeed suffering from any unpleasant consequences: "To produce an attack of cholera three things are necessary—(1) the bacillus, (2) a suitable soil for it to grow on, that is, a person in a susceptible condition, and (3) a *tertium quid*." What this "third something" was, my old master Von Pettenkofer did not pretend to say, but he was convinced that without it one did not catch cholera.

The "*tubercle bacillus*."—This is perhaps one of the most dreaded of our foes among the micro-organisms. It is the cause of that fatal and widespread disease, consumption, or, as it is more scientifically termed, tubercular disease.

III.

THE NATURAL HISTORY OF THE SALMON.

By George Rooper, F.Z.S.

Read at Watford, 20th March, 1894.

Shakespeare tells us that there are "Seven Ages" of man. There are, too, seven ages of the salmon. The first is the egg. The eggs are deposited, some time in the winter months, in beds of gravel over which a rapid stream flows, principally in the upper reaches of the river, where the water is more aerated than it is lower down, and free from pollutions of any sort; for clay, earth, or any extraneous substance would choke and destroy the embryo fish. Indeed, from the time of entering the river, the object of the fish seems to be to arrive at its source. Until they have spawned they never descend, but, resting at times in favourite pools, continually struggle upwards. Only the late fish spawn in the lower waters.

To such as have only seen the salmon in prime condition, the appearance of the fish when on the eve of spawning would indeed be a surprise. The female is dark in colour, almost black, and her shape sadly altered for the worse from that which she presented when in condition. As for the male, he is about as hideous a beast as can well be imagined. His general colour is a dirty red, blotched with orange and dark spots. His jaws are elongated, and the lower one is furnished with a huge "beak," as thick and nearly as long as my middle finger; his teeth are sharp and numerous; and his head, from the shrinking of his shoulders, appears disproportionately large. His skin is slimy and disagreeable to handle. In fact a more repulsive creature in appearance does not exist.

Arrived on the spawning ground, the female, then called a baggitt, alone proceeds to form the nest—the "redd" it is termed. This she effects by a sort of wriggling motion of the lower part of her body working on the loose gravel. Many authors state that this is effected by the action of the tail, but I do not think so; the convex formation of the body at that period would prevent the tail from touching the gravel unless the fish stood at an angle of 45°, in which case the stream would carry her down. The "redd," a deep trench, being formed, she proceeds, attended by the male fish, frequently by two "kippers," as they are called, to deposit her eggs. This she does, not all at once, but in small quantities at intervals, frequently returning to the redd for the purpose. The eggs are at once fecundated by the milt of the kipper. This process goes on for two or three days, the fish sinking down occasionally into the pool below to rest and recover their strength. The effect of the fertilization of the ova is to add greatly to their specific gravity; the eggs sink, and are at once covered with gravel by a similar motion on the part of the baggitt to that used in the formation of the redd. Here, the process being completed, the eggs remain during a period of from 120 to 140 days, according to the temperature of the water. At the expiration of that time, the little fish come into existence, and after a few days wriggle out of their gravelly bed and seek refuge under some rock or stone adjacent, where they remain in safety for 12 or 14 days longer.

The appearance of the young fish at that time gives little promise of the beautiful form which they subsequently attain. They are indeed shapeless little monsters, more like tadpoles than fish, each furnished with a little bag of nutriment forming a portion of the abdomen. On this, for two or three weeks, they subsist, until, on its being absorbed, they take the form and assume the rank of fishes. They are then about one inch in length, and are known as salmon fry or samlets—the second stage. Some of the eggs are washed down the stream during the process of spawning, and become the prey of trout and other fish which swim near the redds for the purpose of feeding on them. In this they do no harm whatever, for these eggs, being uncovered and unfecundated, could never arrive at maturity.

The kippers, when not actually engaged in the spawning process, swim rapidly about the redd, fighting fiercely with one another. The use of their beak, which I have described, appears to me then to come into operation. Mr. Pennell, in his volume of the Badminton Library, and many other authors, erroneously describe this beak either as a weapon of offence, or as a sort of pickaxe used in digging out the redd. It seems to me that nature has provided this singular excrescence as a protection and safeguard against the savage attacks made by the fish on each other. So large is its size, and so closely does it fit into a hole or socket formed in the upper jaw, that it would appear almost impossible for the fish even to open his mouth; but he does so, to some extent at least, and with his cat-like teeth inflicts deep, and sometimes dangerous, wounds on his antagonists. As for its alleged use as a digging implement, it is out of the question. The substance of the beak is cartilaginous, not horny, and by no means hard; it would be worn down in the process of digging in ten minutes, and, as I said, the female alone prepares the redd. This suggestion, I may remark, is entirely original.

After leaving the stone or rock under which it has sought protection, the growth of the young fish is very rapid, as is natural in a creature destined to attain such huge dimensions as the salmon is capable of: one of 83lbs. in weight is recorded by Yarrell as having been captured. In the course of a month or six weeks the fry have attained to the length of four inches, and are then called "parr"—the third stage in their existence. The parrs bear conspicuously on their bodies transverse marks or bars, which are common to the young of every member of the salmon family. Unfortunately, there is another little fish, a humble relation of the lordly salmon, also barred, very similar in appearance, which too is called a parr, and the identity in name and similarity in appearance has occasioned great confusion and much heated controversy, especially as they are inhabitants of the same waters, and affect, to some extent, each other's company.* The time of their remaining in the parr stage is also a subject of dispute: Mr. Pennell says two or three, sometimes four, years, but my own opinion is that they remain one year only.

In the second April of their existence a change in the appearance of the parr occurs; he assumes the silvery scales of the adult fish, wearing his new apparel over his old barred coat He is now called a "smolt"—the fourth stage; and perhaps, with a wish to exhibit himself in his new and beautiful apparel, he evinces a daily-increasing restlessness and desire to quit his home and to go forth into that world of waters he may have dreamed of in his ante-natal tomb. The wish is soon realized. With the first floods in May myriads of these lovely little fishes start on their downward journey towards the sea. It is a beautiful sight to watch their movements when descending. For many days the river teems with them, and not a square foot of water is without one, each, when the stream is at all rapid, swimming tail first; and as they are carried down, fighting against the stream, as it were, darting upwards for a foot or two, again to be carried a yard downwards.

As fry the smolts were exposed to many dangers, but they are nothing to those which beset them as parrs on their journey towards the sea. Their enemies are legion. Trout and pike devour them; gulls flop down and swallow them wholesale. Herons, standing mid-leg deep in the water, pick them out as they pass, and even their blood-relations—fathers, mothers, uncles, aunts—"kelts," as the fish after spawning are called, devour them without scruple. Unluckily too for them, a certain number of these hungry kelts, having recovered to a great extent their condition, and being convalescent as to their appetite, accompany them on their seaward journey, and prey upon their young companions as they travel. I believe that a hungry old kelt will devour forty or fifty smolts in a day. It is illegal to capture, or at least to appropriate if caught, one of these little fish, or the ravenous monsters who prey on them—a useless and mischievous prohibition to my thinking. Smolts are capital eating, and for the boys great fun in catching. Of course if 100 or 1000 are taken out of the river there are 100 or 1000 fewer in it, but the same may be said of the river itself; take 100 or 1000 buckets-full out, and there will be that number of buckets-full fewer in it. But the abstraction would make no appreciable difference in the volume of water. As for the kelts they are for the time barren fish. Strange that the law should protect the multitudinous fry and the spent fish, and permit the destruction of the baggitts, heavy in spawn, the teeming mothers of millions.

* In the Ythan, a river in Aberdeenshire, a portion of which I now rent, *all* the trout are barred, and so remain, whatever their size. They are, however, genuine trout (*Salmo fario*), having the distinctive blood-red mark on the adipose fin.—G. R.

Arrived at the sea, the little fish are met by a fresh array of enemies. The army of gulls is always with them, and it is re-inforced by cormorants, divers, and other sea-birds, besides which shoals of ravenous fish await their arrival, and assist in thinning their ranks. It is wonderful that any should escape; indeed, but for the extraordinary fecundity of the salmon, they would speedily be annihilated, but such is their prolific nature that a remnant always survives, to return to the spawning beds and keep up the supply. Mr. Frank Buckland calculated that the number of eggs laid by a salmon was about 1000 to the pound weight, a fish of 15 lbs. therefore producing 15,000 eggs.

The food of the smolts during their sojourn in the sea is abundant, consisting chiefly of sand-eels, molluscs, and marine insects. They increase accordingly very rapidly in size, and in three or four months the fish that came down five or six ounces in weight returns to the river from which he came, a grilse of from four to six pounds.

The grilse is the fifth stage of the salmon's existence. Unless accidentally prevented, the grilse always returns to his native river, and, after spending the autumn and winter at home, and providing for the continuance of the family by spawning, as already described, he returns as a kelt—the sixth stage—to the sea in the following year, reappearing the next year as a salmon of at least ten or twelve pounds weight—the seventh and last stage.

Such is a short history of the salmon, from "the cradle to the grave," for his life, if he escape the manifold dangers to which he is exposed, is but a repetition of what I have stated. I should have mentioned that, after spawning, the fish speedily recovers his colour, and to a great extent his condition; the baggitt at once loses her dark complexion, the kipper discards his hideous livery, his great beak is rapidly absorbed, his sides become silvery, and his back assumes a dark bluish tinge.

After spawning, the fish are called kelts, whether they are male or female; there is little difference in their appearance. Both are gifted with an inordinate appetite, and, as the river furnishes an abundance of food, they speedily assume very symmetrical proportions, and are really, at least the majority of them, extremely handsome fish—in fact, excepting to a practised eye it is difficult to distinguish between a well-mended kelt and a clean fish. There is a prejudice against them as food, and, as I said, the law requires that, when caught they shall be put back into the river—a great mistake, I think. Besides that they are really wholesome, if not dainty food, they are greatly appreciated by fishermen and others to whom they may be given. Moreover, at least nine out of ten that have been caught with a fly or spinning-tackle die from exhaustion, having been pulled about for an hour or more in the water before they were landed, for they are very strong, and they fight to the last. They are, also, too generally landed with the help of a gaff.

Mr. Pennell describes the kelt as "unfit for food, almost poisonous," but I fancy that he has had little practical experience with kelts. Before the Act protecting them was passed, one could not make a more acceptable present to a gillie or labourer than a good kelt, and despite the Act they are still eaten stealthily by the fishermen, and anyone who can get hold of one. For myself, unless a water-bailiff is in sight, I never return a really good kelt to the water; I just slip him "cannily" into the bushes, and a gillie or shepherd comes and takes him home, when opportunity offers, and feasts with his family right royally upon him. Hundreds, indeed, are sold at a high price, even in London. The flesh, I admit, is soft and light-coloured, instead of being firm and red, and the flavour is very inferior to that of a clean fish, but it is not bad eating, and it is just as wholesome as a clean fish. To talk about it as "almost poisonous" is simply nonsense.

There are many statements published about the salmon which must be taken *cum grano*, indeed, with a very big pinch of salt. It is stated in many books that from the time of his entering the fresh water he never eats. It is odd, if this be the fact, that there is no more killing bait for a salmon than a gudgeon, a parr, or a great dollop of earthworms. In the volume of the Badminton Library, to which I have alluded, the pace at which the salmon swims is given as wonderfully rapid. Mr. Pennell puts it at 1500 feet a minute; and although this high rate of speed is not attributed to him on all occasions, it is no doubt implied that his ascent of the river is at some such rate. Now, the fact is that the pace at which the salmon travels up the river, the water being in swimming order, is just one mile an hour, neither more nor less. The same author tells us that the fish will jump to a height of 10 or 12 feet out of the water, a fact which must have been drawn from imagination, not observation. I venture to say that no salmon that ever swam jumped out of the water more than, perhaps, four feet. The ascent of the rapid, almost perpendicular, streams which the fish surmounts is effected by the immense power of the tail. Give him but "black" water to swim in, and the fish will surmount an obstacle of any reasonable height; but this is effected by swimming, not jumping.

[Mr. Rooper gave two animated accounts of his capture of a salmon, one being the record of a fish caught in a river, the other that of one caught in a lake. They will be found in his book 'Thames and Tweed.'—Ed.]

IV.

THE WASP INFESTATION OF 1893.

By A. E. Gibbs, F.L.S., F.E.S.

Read at Watford, 17th April, 1894.

It is hardly right that the abundance of wasps in 1893 should pass unnoticed by our Society. Both the tree- and ground-wasps were particularly troublesome, invading our dinner-tables, stripping our fruit trees, taking possession of the grocers' and confectioners' shops, and indeed making their unwelcome presence felt almost everywhere. It is not my intention to enter upon any description of our British Vespidæ, nor to discuss their habits. This has been done so admirably by Miss Ormerod in her 'Report on Injurious Insects for the year 1893,' that little is left to be said. She has gathered some valuable reports from various parts of the country, which show how general the infestation was. I have simply endeavoured to collect notes from correspondents with regard to the plague of wasps in our own county.

St. Albans.—I had two nests in my garden wall at Avenue House in such a position as to make it almost impossible to destroy them. Mr. H. Lewis says: "Considerable damage was done by the plague of wasps to our garden fruit last summer. Especially was this the case with the Victoria plums. Those left on the trees were quite spoilt, and when we attempted to gather the fruit we found in many instances only the skins left; the rest were in nearly every case full of wasps. When on a fishing expedition, the wasps attacked the fish as soon as caught, and every few yards along the river's bank wasps' nests were observed, although many had been destroyed but a short time before. On relating this to Mr. G. Dickinson, of Dyers Hall, Harlington, Beds, I found that his experience was much the same. He told me of a friend whose roach were attacked almost as soon as caught, and said that the wasps will very soon eat away a hole in the fish." Miss Ormerod, in her report, also gives some information with regard to the wasp-plague at St. Albans. Mr. Nutting writes from the Gardens, Childwickbury: "We suffered, as others did, more than usual last year from the depredations of wasps, but I think not so much so as those living on a lighter, warmer soil. I have invariably noticed that the warmer the soil the more wasps there are. As we are on a cold stiff clay, we are not so much troubled with them. With regard to exceptional damage done, beyond the destruction of more fruit than usual, especially plums, I do not think that I have anything to report. We prevented them from getting into the vineries, otherwise we should have sustained a loss there, as they seem to be particularly fond of grapes. Next to grapes, plums seem to be favoured by them, and the manner in which they work together and clean out the fruit is interesting. They usually cut into the fruit a short distance from the stem, on what might be termed the shoulder of the fruit, and clean it out thoroughly, leaving only the bare skin. I have taken out 20, and sometimes more, from a single fruit; they seem to get intoxicated. Certainly, if careful, one may take the whole lot one by one, and destroy them without being stung. I have cleared out several in this manner without being attacked. I do not know of any attack on man or beast, nor, with the exception of the cases I have read about, have I ever known wasps to attack anyone unless in self-defence. I do not consider them to be half so pugnacious as bees, and personally the sting from a wasp is not nearly so bad as that from a bee. When gathering fruit I have had them walk over my hands and arms and never offer to sting. A great many ways and means of destroying them were advanced last season, but the most effective and least dangerous is gas-tar. I have destroyed many nests, and have always found this to be the safest method. If you suffocate them with powder, cyanide of potassium, or anything else, the chances are that some recover. To be sure of them they have to be dug out, and this means labour and often disfigurement of surroundings, whereas gas-tar carefully poured into the hole finds its way into the nest, and does its work effectually; only in cases where tar cannot be applied would I use anything else. It is generally supposed that whatever you use to exterminate the wasps must be used after dark, otherwise you lose a quantity of them, but this is not the case where tar can be applied, as I found out last summer. I discovered a strong nest in the park here one day, and poured the tar in about seven o'clock in the evening. I may here add a word as to wasps attacking people. Although scores were hovering over the hole, not one offered to attack me. Had I attempted to drive them in any way I should have probably got the worst of it. I besmeared the ground around the hole, and the next morning it was covered with wasps which had exhausted themselves in attempting to get into the nest; the whole lot were totally destroyed. Only two unfinished nests of tree-wasps came under my observation. Some years ago, when living in Lancashire, we often noticed them suspended in big rhododendron bushes." Mr. F. W. Silvester, of Hedges, St. Albans, tells me that there was a wasps' nest in one of his fields, and that the insects attacked the horses and men so severely that he was obliged to leave a piece of land unploughed until the nest had been destroyed. Mr. Silvester, like most of my correspondents, complains of the destruction of his plums and apples, but informs me that the peaches were not so badly injured.

BERKHAMSTED. — Mr. F. Q. Lane, of The Nurseries, writes: "There was here as elsewhere an enormous number of nests, and we never before saw so many nests built in trees; one in a small spruce-fir was quite as large as a football, which is unusual about here, the nests mostly being about the size of a cricket-ball."

WATFORD.—Dr. Brett has favoured me with the following notes: —"Mr. D. Hill, of Herga, Watford, said that he destroyed about seventy queen wasps in the spring of 1893, and at least twelve nests during the summer. His method was to place a piece of cyanide of potassium about the size of a walnut into the hole, and then a little water. It should be done twice occasionally, because the cyanide does not always kill the grubs, and then they come out afterwards. A wasp never comes out again. Mr. Sainsbury, next door, had two nests in a shed. Mr. W. E. Moore, of Westfield, had one built on a tree. The specimen is in the Public Library now. Much injury was done to wall-fruit. The tom-tits began eating the fruit and the wasps finished it off."

Elstree.—Mr. W. J. Belderson says: "The antiquated methods of pouring tar into the hole and firing it, and of making a 'devil' with gunpowder (gunpowder damped, put in the mouth of the hole and fired, and a clot of dirt placed over it), have been superseded by a more effectual means. A table-spoonful of cyanide of potassium put into the hole completely destroys every wasp that comes near it, and there is no danger from the wasps. I destroyed one nest (of many) last year, a strong one. I put in the chemical, and stood for about five minutes watching the wasps. They kept coming to the nest in swarms. After that time Mr. Beckett, the head gardener at Aldenham House, suggested that we should count them. He timed while two of us counted, and in two minutes 270 entered the nest. The wasps flew to the hole, and then, seeing their dead companions, hovered around, but after a second made a dart into the hole, and not one came out again. After an hour had elapsed we dug them out to destroy the comb, and had about a pint of wasps, all dead. At a grocer's shop in the neighbourhood a two-cwt. bag of sugar was warehoused amongst others. Wasps got in, and when the bag was weighed there were barely six stones left, including dead wasps."

Barnet.—The following description of an encounter between a wasp and a bee is written by Mr. Frank F. Sherriff, of Brightside, Ravenscroft Park, High Barnet:—"I witnessed last autumn a fierce encounter between a wasp and a bee. I was attracted to a flower-bed by what I presumed to be the noise and turmoil of a humble-bee in the web of a spider, but which proved to be a savage attack upon a honey-bee by a hungry wasp. I am inclined to believe that the bee was surprised by the wasp on a neighbouring flower, and that robbery, instigated by the bee's load of honey, was the inciting cause. The rapid movements of the combatants as they tumbled over one another amid the flowers rendered it difficult at first to distinguish bee from wasp. But as the fight proceeded, and the fury of the fray gradually subsided, I could see the two insects in deadly embrace struggling to bring their stings into play. The bee, encumbered by its honey, to which it still clung with fatal tenacity, was evidently at a disadvantage, and endeavoured in vain to escape from the relentless clutch of its assailant. The wasp, on the other hand, holding its antagonist firmly between its fore-legs, brought its sting into action and drove it repeatedly into the body of its victim. At this period I interfered and tried to drive away the victor, but it returned again and again to the spot, and tearing open the body of its victim, devoured the greater portion of it, leaving only the head, legs, and wings, and the shell of its body. Once more I drove away the wasp, and buried the remnants of its barbarous feast, but it again returned, and for some time afterwards hovered about the flower-bed, seeking the remains of its prey."

SMALLFORD.—Mr. Arthur Smith writes: "I did not see any tree-wasps' nests, but I took a large one from the inside of a hollow tree. The greatest damage here was done to apples. In a small orchard of about a dozen trees I should think there were quite a dozen bushels of apples completely eaten, besides those which were commenced, and thereby prevented from keeping. With regard to plums I have to thank the wasps for teaching me a "wrinkle" as to fruit-preservation. We had the greater part of the plums picked before they were anything like ripe, in the case of greengages when they were just hard, before they were good enough for wasps to eat, and bottled them, without cooking, by merely pouring over them hot syrup, and they have during the winter turned out splendidly. Had these means not been adopted, I do not suppose the wasps would have allowed one to ripen. We were fortunate to escape any attacks either upon man or beast, but every nest was treated with a pint or so of gas-tar as soon as discovered, a remedy, or rather destroyer, which we found both the cheapest and most efficient. I am sorry I did not keep an account of the number of nests destroyed."

HATFIELD.—Mr. T. Brown, of Symonds Hyde, Hatfield, informs me that he destroyed a great number of nests during the season. His method was to work at night by the aid of a lantern, when the insects would fly to the light and not attack the person operating. He recommends cyanide of potassium, and to use it effectually he stops the entrance to the nest up, ascertains the exact position of the nest, and makes a hole direct into it, through which he pours the cyanide. The stragglers may be killed in the morning. Nests should be destroyed early, before the colony gets strong. No hanging nests were noticed. He found the wasps very troublesome in destroying the fruit crop. Three trees of Quarrendon pippins, an early sweet apple, were attacked first. The apples that fell during the night had a place as big as the tip of the finger eaten in them by six or seven o'clock in the morning, and during the day the apple was almost entirely cleared out. Two hornets were killed in the house.

WELWYN.—Mr. T. B. Blow writes that his experience was as follows:—"Though we had a perfect plague of wasps, yet my bees did not suffer at all. When the wasps appeared so plentifully we narrowed all the entrances to the hives, and thus stopped any attempt of the wasps to enter the hives. A large number of wasps' nests were destroyed, and in this way the numbers were rapidly diminished."

HITCHIN.—A most interesting report comes from Mr. Richard Shillitoe, of Bancroft, Hitchin. It is as follows:—"The number of ground-wasps' nests in our neighbourhood was, of course, exceptionally large, as many as twenty or more nests having been destroyed in a single bank. We also had an unusual number of pensile or hanging nests, taken from hedges, bushes, outbuildings, etc. I have six or eight very beautiful specimens in glass cases. I do not think that there was any increase in the number of hornets. One or two interesting points in reference to the hybernation of the queen wasps have lately come under my observation, which I think rather tend to show that queen wasps are not so easily destroyed by hard frosts as some people imagine. Instead of hybernating in solitary state under the bark of trees, etc., they appear to have swarmed together this year in large numbers. In a heap of stones near Ickleford Gate-house on the Bedford Road, large numbers were found by the road-men who were turning the stones over before putting them on the road. The wasps had simply crept into the interstices between the stones, and there established themselves for the winter. In another place, at St. Ibbs, near Hitchin, a quantity (said to be about 200) of queen wasps were found in an old piece of sail-cloth or canvas that had been put outside upon the roof of a shed. It was blown off during a gale of wind, and was found to be saturated with rain-water, and a 'teapotfull' of wasps was taken out of it and thrown into the fire. They had evidently passed through the severe frosty weather that we had about Christmas, on the top of the roof with no other protection than a piece of canvas. If queen wasps are capable of hybernating safely under such circumstances, and in such numbers, I am afraid we are likely to have a greater wasp-plague than ever next year, unless the nests and young are destroyed by unfavourable weather in the spring."

The above reports show how very general the infestation was. I fear that we shall not escape very easily this year, for the number of queens flying about just now is unusual. I found one queen hybernating among my botanical specimens. They will creep into any convenient corner, and I fancy the "swarming" alluded to by Mr. Shillitoe is accidental rather than intentional, and that the queens found that the spots mentioned would make convenient winter quarters, and therefore took possession singly and not *en masse*. I beg to thank my correspondents for the trouble they have taken to send me information.

V.

REPORT ON PHENOLOGICAL PHENOMENA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1893.

By EDWARD MAWLEY, F.R.Met.Soc., F.R.H.S.,

Phenological Recorder to the Royal Meteorological Society.

Read at Watford, 17th April, 1894.

I AM pleased to be able to record that since the last Report was issued there has been a welcome increase in the number of observers, the following new stations having been added to the list—Broxbourne, Watford, Radlett, and Baldock. The distribution of the observing stations is also very satisfactory, the southern part of the county being represented by Watford and Radlett, the south-east by Broxbourne, the west by Berkhamsted, the north by Hitchin and Baldock, while the central portion finds representatives at St. Albans and Hertford.

The following list shows the localities represented, their approximate heights above sea-level, and the names of the observers.

STATION.	Height above Sea-level.	OBSERVER.
Broxbourne (Wormley Bury)	150 feet.	Lady Frances Bushby.
Watford (The Platts)	240 „	Mrs. G. E. Bishop.
Radlett (Newberries)	320 „	H. J. Lubbock.
St. Albans (The Grange)	380 „	Mrs. J. Hopkinson.
St. Albans (Addiscombe Lodge)	400 „	Miss E. F. Smith.
St. Albans (Worley Road)	300 „	Henry Lewis.
Berkhamsted (Rosebank)	400 „	Mrs. E. Mawley.
Harpenden	370 „	J. J. Willis.
Hertford	140 „	W. Graveson.
Hitchin	230 „	J. E. Little, M.A.
Baldock (Odsey)	260 „	H. G. Fordham.

The plants on the list came into flower as a rule in the different localities in the following order—Hertford 1, Hitchin 2, St. Albans 3, Broxbourne 4, Harpenden 5, Great Berkhamsted 6, and Watford 7. Placed in this way all the old stations arrange themselves, as in the two previous years, according to their respective heights above sea-level, the lower levels giving the earlier, and the higher the later, dates. This, however, is not the case with the new stations, judging by the observations sent in last year.

THE WINTER OF 1892–93.

During December the weather remained fairly mild until just before Christmas, when a severe frost set in which lasted four weeks. After this long frost had broken up, mild weather again mostly prevailed until the close of the season. The memorable frost of this winter proved very trying to vegetation generally, but

TABLE I.—DATES OF FLOWERING OF PLANTS OBSERVED IN 1893, WITH THE MEAN DATE FOR 1876–1892.

Species.	Broxbourne.	Watford.	Radlett.	St. Albans.		Berkhamsted.	Harpenden.	Hertford.	Hitchin.	Odsey.	Mean, 1876–92.
			New-berries.	The Grange.	Addiscombe Lodge.						
Hazel (*Corylus avellana*)	....	Feb. 6	....	Feb. 5	....	Feb. 5	Jan. 20	Feb. 5	Feb. 4	....	Jan. 27
Coltsfoot (*Tussilago farfara*)	....	....	....	....	Mar. 17	Feb. 26	Mar. 2	Feb. 19	Feb. 17	....	Feb. 25
Wood Anemone (*Anemone nemorosa*)	Mar. 12	....	Mar. 20	Mar. 13	Mar. 18	Mar. 24	Mar. 27	Mar. 12	Mar. 10	....	Mar. 19
Blackthorn (*Prunus spinosa*)	Mar. 26	Mar. 27	Mar. 28	Mar. 28	Mar. 22	Mar. 29	Mar. 31	Mar. 9	Mar. 24	Mar. 28	Apl. 3
Garlic Hedge Mustard (*Alliaria officinalis*)	....	Apl. 13	Apl. 19	Apl. 10	Apl. 6	Apl. 4	Apl. 4	Mar. 31	Apl. 6	....	Apl. 20
Horse Chestnut (*Æsculus hippocastanum*)	Apl. 21	Apl. 24	Apl. 21	Apl. 15	Apl. 18	Apl. 27	Apl. 24	Apl. 23	Apl. 25	....	May 12
Hawthorn (*Cratægus oxyacantha*)	Apl. 24	Apl. 22	Apl. 27	Apl. 23	Apl. 25	Apl. 24	Apl. 22	Apl. 16	Apl. 16	Apl. 20	May 15
White Ox-Eye (*Leucanthemum vulgare*)	....	....	May 10	May 10	May 2	May 11	May 9	May 11	May 9	....	May 20
Dog Rose (*Rosa canina*)	May 22	May 24	May 16	May 13	May 11	May 10	May 17	May 19	May 13	May 13	June 5
Black Knapweed (*Centaurea nigra*)	....	....	....	....	May 31	May 29	June 5	May 31	May 18	....	June 21
Harebell (*Campanula rotundifolia*)	....	....	....	....	....	July 10	....	July 6	....	....	July 5
Greater Bindweed (*Calystegia sepium*)	....	....	....	....	....	May 26	June 1	May 28	June 18	....	July 8
Ivy (*Hedera helix*)	....	....	....	Aug. 30	Sept. 24	Sept. 9	....	Sept. 10	Sept. 4	....	Sept. 26

TABLE II.—EARLIEST DATES OF OBSERVATION OF BIRDS AND INSECTS IN 1893, WITH THE MEAN DATE FOR 1876–1892.

Species.	Broxbourne.	Watford.	Radlett.	St. Albans.		Berkhamsted.	Harpenden.	Hertford.	Hitchin.	Odsey.	Mean, 1876-92.
			Newberries.	Addiscombe Lodge.	Worley Road.						
Birds.											
Song-Thrush (*Turdus musicus*)	.....	Jan. 24	.....	.....	Jan. 29	Jan. 29	.....	.....	Feb. 1	.....	Jan. 15
Swallow (*Hirundo rustica*)	.....	Apl. 15	Apl. 8	.....	Apl. 8	Apl. 15	Apl. 18	.....	Apl. 8	Apl. 10	Apl. 12
Cuckoo (*Cuculus canorus*)	Apl. 18	Apl. 14	Apl. 14	Apl. 23	Apl. 9	Apl. 10	Apl. 7	.....	Apl. 19	Apl. 17	Apl. 13
Nightingale (*Daulias luscinia*)	Apl. 18	Apl. 16	Apl. 18	Apl. 21	Apl. 16	Apl. 19	Apl. 18	.....	Apl. 14	Apl. 16	Apl. 15
Spotted Flycatcher (*Muscicapa grisola*)	.....	.....	May 7	.....	May 28	May 11	.....	.....	.....	May 16	.....
Swallow (last seen) (*Hirundo rustica*)	.....	.....	.....	.....	Oct. 10	.....	.....	Oct. 19	.....	Oct. 12	.....
Insects.					The Grange.						
Honey Bee (*Apis mellifica*)	.....	.....	.....	.....	Feb. 19	Feb. 19	.....	.....	Jan. 31	Feb. 19	Jan. 27
Wasp (*Vespa vulgaris*)	Apl. 18	.....	Mar. 23	Apl. 6	.....	Mar. 16	Apl. 29	.....	Apl. 4	.....	Apl. 6
Small White Butterfly (*Pieris rapæ*)	Apl. 1	Mar. 20	Apl. 2	Mar. 25	Mar. 25	Mar. 21	Mar. 30	.....	Apl. 3	.....	Apl. 2
Orange-Tip Butterfly (*Anthocaris cardamines*)	.....	Apl. 17	.....	Apl. 16	.....	Apl. 13	Apl. 22	.....	Apl. 22	.....	May 9
Meadow-Brown Butterfly (*Epinephele janira*)	.....	.....	.....	.....	.....	.....	May 8	.....	.....	.....	May 17

was, on the whole, less destructive than the frosts of either of the two previous winters. Two half-hardy plants growing in my own garden at Berkhamsted, however, which had passed without serious injury through the previous eight winters, fell victims to this one, viz., montbretias and globe artichokes. This was no doubt owing to the exceptional depth to which the frost penetrated the ground, and to the long period the soil around their roots remained frozen. To the agriculturist this was a very unsatisfactory season. The prolonged frost not only prevented the working of the land, but also destroyed the turnips, and in February the ground was again rendered unworkable owing to the continuous and heavy rainfall. In the gardens the winter frosts, for the third year in succession, committed sad havoc among the vegetables. The last rose blooms of the season were destroyed by cold and wet in my garden at Berkhamsted on the 6th of December, which is twelve days earlier than the average date of their destruction in the previous eight years.

In all parts of the county the hazel was backward in flowering. According to the mean date given at the end of the table it was, at five of the six stations sending in returns, from a week to ten days late. The song-thrush was first heard about a fortnight later than usual, while the honey-bee visited flowers, at three out of the four stations recording its first appearance, on the same day, February 19th, which is rather more than three weeks behind the average date.

The Spring.

This was a most remarkable season. In March there occurred only two unseasonably cold days, in April but four, and in May again but two. The total rainfall amounted to less than one-fourth of the mean for the quarter, while the sun shone on an average for rather more than seven hours a day.

The greatest sufferers from the continued drought were shallow-rooted plants. Trees and shrubs, on the other hand, appeared to be in no way injuriously affected, having at that time an abundant supply of moisture to draw upon in the subsoil, owing to the heavy February rains. Most of the spring wild flowers made their appearance singularly early, but the continued heat and drought caused them to fade rapidly, and to make but poor growth. The spring corn was planted in most places under very favourable conditions, but germinated very slowly, while the grass made but very little progress. The observer at Addiscombe Lodge, St. Albans, states that some sweet-peas which were sown on March 20th did not appear above ground until April 18th. The fruit trees and other flowering trees and shrubs blossomed abundantly, but the display of bloom was soon over.

The coltsfoot, as usual, flowered very irregularly, being earlier than the average in some districts, and later in others, and the same may be said of the wood-anemone. But towards the end of March the continued heat began to tell, and from that time the flowering of all plants took place in advance of the mean. For instance, blackthorn blossomed from a week to ten days earlier than usual, garlic hedge-mustard about a fortnight earlier, horse-chestnut about three weeks earlier, hawthorn from three weeks to a month earlier, the white ox-eye about ten days earlier, the dog-rose more than three weeks earlier, and the black knapweed also fully three weeks in advance of its average date.

The swallow was reported as having been first seen at four stations a few days earlier, and at three a few days later, than the mean date. The cuckoo was first heard at most stations a few days behind its usual time. The nightingale at all but one station was a few days late.

The dates sent in for the first wasp vary greatly, ranging from March 16th to April 29th, but the small white butterfly was seen in most districts from a few days to a fortnight early, while the orange-tip butterfly was about three weeks early.

THE SUMMER.

This proved another very dry and warm season, while the record of bright sunshine was greater than in any summer since that of the Jubilee year, 1887. June and August were singularly hot and dry months, but during the greater part of July the weather was only moderately warm, and rain fell at frequent intervals.

Owing to the continued drought, which may be said to have lasted from the beginning of March until the end of the first week in July—or for eighteen weeks—vegetation suffered severely. The grass was burnt up in the pastures, and where cut for hay yielded one of the lightest crops on record. In Sir John Lawes' grass experiments at Rothamsted, the plot which never receives any manure yielded 3 cwt. of hay per acre instead of its usual average of 21 cwt.; and the plot the most heavily manured yielded 23 cwt. per acre instead of an average of 57 cwt. The corn made but poor growth, and came to maturity remarkably early. At Harpenden the cutting of winter oats began during the first week in July. The refreshing rains of July improved the grass lands for a time, but towards the end of the season they were becoming as bare as ever, owing to the dry weather again setting in during August. Strawberries proved in most places a poor crop, while bush-fruits on the other hand were as a rule abundant.

Two of the summer plants on the list having flowered during the previous season, only two others remain for notice here —the harebell and the greater bindweed. The harebell was a few days late in flowering at the only two stations at which it was noted. This plant, owing no doubt to its shallow roots, suffered more than any of the others. In fact the great dryness of the ground appeared to retard both its growth and flowering considerably. The greater bindweed, on the contrary, being deep-rooted, came into blossom more in advance of its average date than any of the other twelve plants—the variation from the average amounting at two stations to as much as six weeks.

THE AUTUMN.

The weather was moderately warm during September and October, but in November there occurred frequent slight frosts at night. Indeed, November was the first month which had been in any way unseasonably cold for ten months. The second drought of the year, which set in during the second week in August, lasted throughout September, and was more distressing to vegetation generally than the previous one, owing to the greater dryness of the subsoil. Between April 2nd and July 31st no rain-water at all came through the 2½ feet of uncropped soil in either of my percolation-gauges. This may be regarded as the first drought of the year. Again, in part of August and the whole of September, or during the second drought, no measurable quantity of water passed through either of these gauges. Pastures were again brown and parched, the root-crops were at a standstill, apples and pears ripened prematurely, and few flowers were to be seen in either hedgerows or gardens. The frequent and heavy rains of October, coming upon ground singularly warm for the time of year, the whole aspect of the landscape was soon transformed. The pastures became green again, the roots improved rapidly, and the land was soon in splendid order for getting in the autumn corn. The second flowering of many trees and shrubs, as well as of some herbaceous plants, was one of the most noteworthy features of this season, and was almost everywhere noted. All wild fruits, except holly-berries, were unusually plentiful.

The yield of the corn crops of all kinds was much below the average, but the grain, as a rule, proved of excellent quality. Apples and pears yielded somewhat irregularly, but were on the whole good crops.

The last plant on the list, the ivy, came into flower about a fortnight in advance of its average date.

Swallows took their departure nearly a week earlier than in 1891, and more than three weeks earlier than in 1892.

VI.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN THE YEAR 1893.

By JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 17th April, 1894.

THE number of our rainfall observers in the year 1893 is greater than in any previous year, the records entered in our principal table being 40, an increase of four upon the number for the year 1892. The number of daily records received shows a still greater increase, being 33, or six more than that for the previous year.

Of the stations for which records appeared in the table for 1892, one only is omitted this year,—Kytes, Watford,—no reply to my applications having been received from the observer there. Against this one loss there are five additions, records having been received from Bancroft, Hitchin; Pendley Manor, Tring; Frogmore, and the Colne Valley Water Works, Watford; and Brocket Hall, Welwyn.

These alterations increase the number of stations in the river-district of the Hiz from three to four, in that of the Upper Thame from one to two, in that of the Lower Colne from three to four, and in that of the Mimram also from three to four.

Particulars of the 40 rainfall stations, and the monthly and total rainfall and number of days on which at least 0·01 inch of rain fell, or, when the measurement is taken to thousandths of an inch, 0·005 inch, are given in Tables I and II, pp. 35–37.

A supplementary table (Table III, p. 38) gives five other records of the total rainfall in the year. Two of these are the records of additional gauges at Rothamsted, and three are taken from 'British Rainfall, 1893.' The rainfall returned for Aldenham House, Elstree, is not here given, the record being incomplete.

The mean rainfall in the county in the year 1893 was 22·56 inches. This is 4·18 inches below the mean for the decade 1880–89, and 3·87 inches below that for the half-century 1840–89.* The year was therefore a decidedly dry one.

This is the third year in succession with about twice as much rain in the second half as in the first. The fall in the first half of 1891 was 9·57 ins., in the second half, 20·05 ins.; in the first half of 1892, 8·67 ins., in the second half, 16·07 ins.; in the first half of 1893, 7·35 ins., in the second half, 15·21 ins. The defect in the first six months of 1893 is entirely due to the dryness of the four months March to June, January and February having together 4·98 ins., or 2·49 ins. per month on the average, while March, April, May, and June had an aggregate rainfall of 2·37 ins., giving an average monthly fall of only 0·59 in.

Droughts in 1893.—According to the definitions of Mr. Symons (in 'British Rainfall') an "absolute drought" is a period of *more*

* See 'Trans. Herts. Nat. Hist. Soc.,' Vol. VI, p. 84.

than 14 consecutive days without any rain, and a "partial drought" is a period of *more than* 28 consecutive days with an aggregate rainfall not exceeding 0·01 in. per diem. The great dryness of the spring of 1893 will be best brought out by an analysis of such droughts which have occurred in it at the 33 stations for which we have daily records of the rainfall.

Of absolute droughts there were three: (1) in March and April, (2) in May, (3) in June. The first of these was an absolute drought at all stations, lasting for

31	days,	March	17	to	April	16,	at	2 stations.
30	,,	,,	17	,,	,,	15,	,,	19 ,,
29	,,	,,	18	,,	,,	15,	,,	10 ,,
24	,,	,,	23	,,	,,	15,	,,	2 ,,

The two stations at which rain is not recorded to have fallen on the 16th of April are Cowroast and Welwyn Rectory; rain (0·01 in.) fell on the 22nd of March at Odsey and Bennington House, reducing the length of the drought at those stations to 24 days. The average duration of this drought was 29½ days.

The second absolute drought lasted for

16	days,	April	30	to	May	15,	at	1 station.
15	,,	,,	30	,,	,,	14,	,,	6 stations.

The third lasted for

16	days,	June	6	to	June	21,	at	1 station.
15	,,	,,	6	,,	,,	20,	,,	1 ,,
15	,,	,,	7	,,	,,	21,	,,	3 stations

The Old Nurseries, Cheshunt, is the station at which no rain fell on the 15th of May; Frogmore, Watford, is that at which none fell from the 6th to the 21st of June.

A partial drought extended throughout the months of March and April and through the greater part of May, its duration being from about eleven to thirteen weeks. It prevailed at all the stations, and lasted for

89	days,	March	1	to	May	28,	at	3 stations.
88	,,	,,	2	,,	,,	28,	,,	3 ,,
78	,,	Feb.	28	,,	,,	16,	,,	10 ,,
77	,,	March	1	,,	,,	16,	,,	8 ,,
76	,,	,,	2	,,	,,	16,	,,	9 ,,

The difference of ten days or more in the duration of the partial drought at the different stations is chiefly due to the variation in the fall of rain during a thunderstorm which occurred on the 17th of May. The average rainfall on this day at the six stations with a partial drought of 88 or 89 days was 0·30 in.; at the twenty-seven stations with a partial drought of 76 to 78 days it was 0·47 in. The stations at which the partial drought lasted for 89 days are Royston, Odsey, and New Barnet; those at which it lasted for 88 days are Therfield, Much Hadham, and Bayfordbury, Hertford. Its average duration was 79 days.

TABLE I.—HERTFORDSHIRE RAINFALL STATIONS, 1893.

District.	STATION.	OBSERVER.	Diameter of Gauge.	Height of Gauge above Ground.		Height of Gauge above Sea-level.
			ins.	ft.	ins.	ft.†
1.	*Royston	Hale Wortham	8	0	6	269 T̄
,,	*Odsey	H. George Fordham	5	1	0	260 T
3.	*Hitchin—The Firs	William Lucas	5	2	1	238 T̄
,,	,, The Maples	William Hill	8	1	1	220 T̄
,,	* ,, Baucroft	Francis Ransom	5	0	9	212 T
,,	* ,, High Down	Joseph Pollard	5	1	1	422 T̄
4.	*Tring—Elm House	E. J. Le Quesne	5	1	2	460
,,	,, Pendley Manor	J. G. Williams	5	2	0	500 ?
6.	*Cowroast	Rupert Thomas	5	4	2	345 L
,,	*Berkhamsted—Rosebank	Edward Mawley	8	1	0	401 T̄
,,	* ,, Fairhill	W. Bonner Hopkins	5	1	0	550 T
7.	*Great Gaddesden Vicarage	Rev. W. T. Drake	8	1	0	427 T̄
,,	*H. Hempstead—Apsley Mills	J. Dickinson & Co.	24	0	9	260
,,	* ,, Nash Mills	,,	12	3	9	237 T̄
8.	*Kensworth—The Grove	Miss S. Grace Jones	5	1	0	630 B
,,	Harpenden—Rothamsted	Lawes and Gilbert	5	0	9	420 T
,,	*St. Albans—Gorhambury	Hon. Wm. Grimston	5	1	0	425 T
,,	* ,, The Grange	John Hopkinson	5	1	0	380 T̄
10.	*Watford—Oaklands	Edward Harrison	5	5	6	273 T
,,	* ,, Frogmore	Arthur P. Blathwayt	5	1	0	182
,,	,, ColneVal.WaterW'ks	William Verini	5	1	0	220
,,	Rickmansworth—Moor Park	Lord Ebury	5	2	0	340 T̄
12.	*Welwyn Rectory	Rev. Canon Wingfield	5	0	4	228 T
,,	*Hatfield—Brocket Hall	Lord Mount Stephen	8	1	0	250
,,	*Datchworth Rectory	Rev. J. Wardale	5	1	0	386 T
,,	Hertford—Marden Hill	Richard Hoare	5	0	6	257 T
13.	*Stevenage—Weston Park	M. R. Pryor	5	0	8	470 T
,,	* ,, Bennington House	Rev. Dr. Parker	5	1	0	408 T̄
14.	*Therfield Rectory	Rev. J. G. Hale	5	4	3	500
,,	*Throcking Rectory	Rev. C. W. Harvey	5	1	0	484 T
,,	*Buntingford—Hamels Park	E. Wallis	5	1	0	400 T
15.	*Much Hadham	T. Woodham Mott	5	1	0	222 B
17.	*Hertford—Bayfordbury	W. Clinton Baker	8	1	2	250
,,	*Ware—Red House	Joseph Francis	5	0	9	112 T
,,	* ,, Fanhams Hall	Miss Joyce Croft	8	1	0	253 T
18.	*Broxbourne—Stafford House	G. J. Newbery	5	1	0	118 T
,,	*Cheshunt—Old Nurseries	Paul and Son	5	1	0	92 T
,,	,, College	Rev. Dr. Reynolds	5	1	1	94 T
,,	*New Barnet—Gas Works	T. H. Martin	8	0	9	212
,,	*Southgate—The Lawns	George A. Church	5	0	6	240 T

* Daily fall received for these stations.
† For explanation of these symbols see Vol. VII, p. 53.

TABLE II.—RAINFALL IN

River District.			Station.	Jan.	Feb.	Mar.
				ins.	ins.	ins.
OUSE	Cam	1. Rhee	Royston	1·63	2·92	·17
			Odsey	1·61	2·63	·26
	Ivel	3. Hiz	Hitchin—The Firs	1·65	3·08	·38
			,, The Maples	1·35	3·09	·35
			,, Bancroft	1·88	3·16	·44
			,, High Down	1·95	2·60	·30
THAMES	Thame	4. Up. Thame	Tring—Elm House	1·97	3·46	·36
			,, Pendley Manor	2·15	3·61	·34
	Colne	6. Bulbourne	Cowroast	2·05	3·57	·62
			Berkhamsted—Rosebank	2·05	3·69	·46
			,, Fairhill	2·12	3·63	·56
		7. Gade	Great Gaddesden Vicarage	2·01	3·48	·49
			Hemel Hempsted—Apsley Mills	1·93	3·24	·52
			,, Nash Mills	1·76	2·98	·47
		8. Ver	Kensworth—The Grove	1·93	3·80	·44
			Harpenden—Rothamsted	1·91	3·46	·35
			St. Albans—Gorhambury	1·96	3·52	·55
			,, The Grange	2·01	3·36	·51
		10. Lo. Colne	Watford—Oaklands	2·05	3·61	·48
			,, Frogmore	1·87	3·37	·43
			,, Colne Valley Water Works	1·55	3·31	·32
			Rickmansworth—Moor Park	2·18	3·92	·69
	Lea	12. Mimram	Welwyn Rectory	1·91	3·24	·35
			Hatfield—Brocket Hall	1·94	2·84	·38
			Datchworth Rectory	1·79	3·06	·24
			Hertford—Marden Hill	1·60	3·14	·41
		13. Beane	Stevenage—Weston Park	1·88	2·99	·44
			Bennington House	1·69	2·91	·39
		14. Rib	Therfield Rectory	2·13	3·17	·29
			Throcking Rectory	1·78	2·89	·33
			Buntingford—Hamels Park	1·80	2·72	·40
		15. Ash	Much Hadham	1·88	2·87	·39
		17. Upper Lea	Hertford—Bayfordbury	1·67	3·00	·37
			Ware—Red House	1·74	2·46	·54
			,, Fanhams Hall	1·45	2·68	·41
		18. Lower Lea	Broxbourne—Stafford House	1·58	2·85	·39
			Cheshunt—Old Nurseries	1·65	3·01	·45
			,, College	1·63	2·83	·44
			New Barnet—Gas Works	1·61	3·20	·38
			Southgate—The Lawns	1·59	3·03	·34
Mean for the County				1·82	3·16	·41

HERTFORDSHIRE IN 1893.

APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR.	DAYS.
ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	
·13	1·15	·66	3·48	2·49	1·01	3·11	2·15	1·62	20·52	146
·15	·77	·92	3·60	3·15	1·29	3·34	1·86	1·43	21·01	167
·25	·93	·78	2·34	2·40	1·10	3·62	2·34	1·90	20·77	155
·26	·91	·74	2·37	2·42	1·39	3·65	2·35	2·04	20·92	145
·31	1·02	·85	2·59	2·51	1·27	3·56	2·22	1·72	21·53	160
·16	1·42	·89	3·16	2·52	1·23	3·98	2·19	1·74	22·14	159
·18	·83	·55	2·52	1·65	·89	3·88	2·70	2·13	21·12	155
·25	1·10	·66	2·68	1·05	1·04	4·20	2·92	2·60	22·60	178
·18	·96	·64	2·75	1·83	1·21	3·91	2·62	2·46	22·80	
·20	·86	·98	2·14	2·33	1·10	4·21	3·17	2·75	23·94	163
·19	1·26	·85	2·17	2·31	1·03	4·05	3·09	2·85	24·11	168
·25	1·01	·83	2·65	2·54	·90	4·25	3·30	2·66	24·37	159
·15	1·02	·90	2·12	2·18	1·11	4·59	2·52	2·50	22·78	153
·10	·96	·72	2·24	2·18	1·24	4·96	2·74	2·43	22·78	151
·32	·94	1·30	2·88	2·33	1·10	4·43	2·81	2·17	24·45	144
·22	1·20	·95	2·92	2·28	1·09	4·35	2·58	2·51	23·82	151
·15	1·05	·89	3·48	3·02	1·10	4·85	3·06	2·81	26·80	
·14	1·65	·72	3·06	2·10	1·08	5·07	2·89	2·41	25·00	170
·10	1·16	·97	2·63	2·42	1·42	5·89	2·80	2·75	26·28	157
·06	1·07	·83	2·97	2·24	1·55	5·80	2·41	2·70	25·30	150
·05	·98	·87	2·66	1·60	1·23	6·06	2·26	2·72	23·61	
·06	1·02	·81	2·78	2·20	1·39	6·75	3·11	3·86	28·77	165
·13	1·32	·69	2·40	3·16	1·23	2·95	2·58	2·22	22·18	146
·14	1·15	·54	3·03	2·35	1·16	3·96	2·81	2·38	22·68	
·09	·95	·60	2·39	3·45	·89	4·09	2·15	2·10	21·80	149
·18	·96	·68	2·37	3·01	·87	3·11	2·74	2·15	21·22	148
·15	1·24	·59	4·08	3·61	1·13	4·16	2·33	1·95	24·55	152
·08	1·20	·58	2·74	2·73	·88	3·56	2·53	2·25	21·54	159
·15	·81	·72	4·01	3·40	1·22	3·88	2·20	1·55	23·53	161
·14	·95	·73	3·86	3·00	1·32	3·10	2·16	2·08	22·34	168
·11	1·21	·88	3·09	2·15	·93	3·06	2·46	2·13	20·94	137
·16	1·02	·82	2·48	2·58	·85	2·94	2·84	2·52	21·35	143
·11	·94	·55	2·61	2·35	·88	2·91	2·60	2·39	20·38	152
·10	1·15	·53	2·18	2·55	·78	3·20	2·33	2·23	19·79	135
·11	1·23	·63	2·57	2·78	·71	3·28	2·59	3·06	21·50	159
·11	·99	·51	2·40	2·75	·79	3·42	2·55	2·22	20·56	162
·10	1·14	·81	2·85	2·56	·83	3·41	2·39	2·12	21·32	141
·10	·91	·84	2·90	2·35	·67	3·34	2·33	2·24	20·58	138
·04	·57	·64	2·44	2·08	·93	3·69	2·32	2·52	20·42	125
·21	1·00	·76	2·38	1·72	1·07	3·58	2·31	2·33	20·32	180
·15	1·05	·76	2·78	2·46	1·08	4·00	2·56	2·33	22·56	154

TABLE III.—SUPPLEMENTARY TO TABLES I AND II.

District.	Station.	Observer.	Gauge. Dia-meter.	Gauge. Height above Sea.	Rain-fall.	Days.
			ins.	feet.	ins.	
8.	Harpenden—Rothamsted	Sir J. Lawes and	8	420	23·80	145
,,	,, ,,	Sir H. Gilbert......	72×87	420	25·10	156
10.	Watford—Kytes	Mrs. Horsman	5	239	23·89	141
12.	Welwyn—Danesbury	A. M. Blake..........	5	405	22·72	145
17.	Hertford—Haileybury.....	A. A. Lea..............	5	260	22·38	142

Distribution of Rainfall throughout the Year.—Of the total rainfall 32½ °/ₒ fell during the winter months (Jan., Feb., and Dec.), 7 °/ₒ during the spring (March to May), 26½ °/ₒ during the summer (June to Aug.), and 34 °/ₒ during the autumn (Sept. to Nov.). The fall during each quarter and each season, and the deviation from the mean for the half-century 1840–89, was as follows:—

	Fall.	Diff.		Fall.	Diff.
1st quarter........	5·39 ins.	—0·24 in.	Winter	7·31 ins.	+1·68 in.
2nd ,, ...	1·96	—4·05	Spring	1·61	—4·40
3rd ,, ...	6·32	—0·99	Summer..............	6·00	—1·32
4th ,, ...	8·89	+1·41	Autumn	7·64	+0·17

April was excessively dry; March and June also were very dry; February was very wet; October was excessively wet. The difference in each month from the mean for the half-century was—

	in.		in.		in.		in.
Jan.	—0·49	April.....	—1·63	July	+0·28	Oct.	+1·06
Feb.	+1·45	May	—1·08	Aug.	+0·08	Nov.	=
Mar.	—1·20	June.....	—1·34	Sept.....	—1·35	Dec.	+0·35

Thus the fall for the first two months was about an inch above the mean for the period, for the next four months *more than five inches below the mean*, and for the last six months nearly half an inch above the mean.

The absolute maximum fall in any one day in each month, and the station recording it was—

	ins.		ins.
Jan. 26—Bancroft, Hitchin.....	0·39	July 12—Gorhambury..............	2·18
Feb. 21—Bennington House..	0·69	Aug. 30—Datchworth Rectory	0·92
Mar. 1—Red House, Ware....	0·38	Sept. 8—The Maples, and Bancroft, Hitchin	0·69
April 20—The Grove, Kensw'th	0·17		
May 17—The Grange, S. Alb'ns	0·93	Oct. 9—Moor Park	3·11
June 27—Colne Valley Water Works	0·38	Nov. 14—Much Hadham.........	0·85
		Dec. 20—Red House, Ware	0·66

The wettest day in each month at the 40 stations was—

January 9th at 2 stations, 26th at 37, 6th and 26th at 1.

February 21st at 28, 22nd at 1, 26th at 4, 27th at 3, 2nd and 21st at 1, 21st and 27th at 2, 22nd and 26th at 1.

March 1st at 34, 3rd at 3, 16th at 2, 1st and 3rd at 1.

April 16th at 20, 17th at 2, 19th at 2, 20th at 3, 29th at 10, 16th and 29th at 2, 17th and 29th at 1.

May 17th at 32, 20th at 1, 29th at 7.

June 3rd at 1, 6th at 2, 10th at 1, 22nd at 23, 27th at 11, 6th and 27th at 2.

July 9th at 3, 12th at 11, 19th at 8, 23rd at 4, 25th at 2, 26th at 10, 30th at 1, 19th and 26th at 1.

August 1st at 5, 3rd at 5, 4th at 1, 5th at 1, 9th at 4, 22nd at 1, 23rd at 5, 31st at 16, 1st and 9th at 1, 1st and 23rd at 1.

September 8th at 13, 19th at 11, 26th at 5, 28th at 8, 8th and 25th at 1, 19th and 28th at 2.

October 9th at all stations.

November 14th at 19, 18th at 1, 25th at 20.

December 8th at 1, 12th at 21, 13th at 1, 20th at 16, 8th and 12th at 1.

The day in each month on which a heavy fall of rain was most general over the county was therefore—

Jan. 26th	April 16th	July 12th	Oct. 9th
Feb. 21st	May 17th	Aug. 31st	Nov. 25th
March 1st	June 22nd	Sept. 8th	Dec. 12th

The number of wet days in the year (average of 36 gauges) was 154, being 14 below the mean for the 20 years 1870–89. Of the total number there were 57 (or 37 per cent.) in the winter months, 16 (or 10½ per cent.) in the spring, 39 (or 25½ per cent.) in the summer, and 42 (or 27½ per cent.) in the autumn.

The average number of wet days in each month, and the deviation from the mean for the 20 years 1870–89, was as follows:—

Jan.	20	+5	April	3	—10	July	18	+4	Oct.	16	+1
Feb.	21	+7	May	8	— 5	Aug.	12	—1	Nov.	15	—1
March	5	—8	June	9	— 4	Sept.	11	—2	Dec.	16	=

Distribution of Rainfall throughout the County.—The following table (Table IV) gives the mean fall for each month and for the year in each of the five river-districts represented, and in the two main hydrographical divisions of the county, the catchment-basins of the Great Ouse and the Thames, and also the difference in the year from the mean for the decade 1880–89.

TABLE IV.—RAINFALL IN THE RIVER DISTRICTS.

MONTHS.	CAM.	IVEL.	THAME.	COLNE.	LEA.	OUSE.	THAMES.
	ins.	ins.	ins.	ins.	ins.	ins.	ins.
Jan.	1·62	1·71	2·06	1·95	1·74	1·68	1·85
Feb.	2·77	2·98	3·53	3·50	2·94	2·91	3·20
March	·22	·37	·35	·49	·38	·32	·43
April	·14	·24	·22	·14	·12	·21	·14
May	·96	1·07	·96	1·08	1·04	1·03	1·05
June	·79	·82	·61	·88	·67	·81	·75
July	3·54	2·62	2·60	2·70	2·82	2·92	2·76
August	2·82	2·46	1·35	2·22	2·70	2·58	2·44
Sept.	1·15	1·25	·96	1·18	·96	1·22	1·05
October	3·22	3·70	4·04	4·94	3·42	3·54	4·08
Nov.	2·01	2·27	2·81	2·81	2·46	2·19	2·63
Dec.	1·52	1·85	2·37	2·68	2·25	1·74	2·43
Year	20·76	21·34	21·86	24·60	21·50	21·15	22·81
Diff. from 1880-89	—2·74	—3·93		—4·37	—4·05	—2·38	—4·33

The mean rainfall in each of the minor river-basins or sub-districts represented was as follows:—

River	Sub-district	ins.
CAM	Rhee	20·76
IVEL	Hiz	21·34
THAME	Upper Thame	21·86
COLNE	Bulbourne	23·62
COLNE	Gade	23·31
COLNE	Ver	25·02
COLNE	Lower Colne	25·99
LEA	Mimram	21·97
LEA	Beane	23·05
LEA	Rib	22·27
LEA	Ash	21·35
LEA	Upper Lea	20·56
LEA	Lower Lea	20·64

The total yearly fall ranged from 19·79 ins. at the Red House, Ware, to 28·77 ins. at Moor Park, Rickmansworth; and the total monthly fall from 0·04 in. at New Barnet in April, to 6·75 ins. at Moor Park in October. The greatest fall in any one day was 3·11 ins. at Moor Park on the 9th of October.

Distribution of Rainfall in each Month.—The nomenclature used in the following account of the chief falls of rain is the same as in my previous reports, falls of at least ½ inch being styled considerable, ¾ inch very considerable, 1 inch great, 1¼ inch very great, 1½ inch heavy, 1¾ inch very heavy, and of 2 inches and upwards excessive. This analysis only applies to the 33 stations for which I have returns of the daily rainfall.

JANUARY.—Rainfall a little below the average, but on an unusually large number of days, nearly all for the first two or three weeks in the form of snow, which was sometimes several inches deep. On no day was there a *considerable* fall of rain recorded. There was a silver thaw on the 18th.

FEBRUARY.—Rainfall very heavy, and again on a very large number of days, only seven days being without a sufficient fall to record. Very little on a few days only fell as snow. On 21st the fall was *considerable* at fourteen stations, and on 26th at one station.

MARCH.—A very dry month, with rain on very few days, nearly all falling before the 5th, after which date there was a measurable quantity only on two days on the average throughout the county, yielding less than a tenth of an inch (exactly 0·087 in.). On no day was there a *considerable* fall of rain recorded.

APRIL.—An excessively dry month, with rain on even a smaller number of days than in March, at nearly all stations rain falling only on 16th, 20th, and 29th. At most stations an absolute drought of thirty days terminated in the middle of this month. No *considerable* fall of rain was recorded.

MAY.—Another very dry month, with rain on very few days, but not so exceptional in either respect as March or April. About half the rain recorded in the month fell on the 17th, on which day the fall was *very considerable* at three stations and *considerable* at six. There was also a *considerable* fall at four stations on 29th.

JUNE.—The fourth very dry month in succession, and with rain on very few days, nearly all falling after the 21st. At no station was a *considerable* fall recorded.

July.—A rather wet month, with rain on a large number of days, mostly between 8th and 26th. On 9th the fall was *considerable* at one station; on 12th it was *excessive* at Gorhambury (2·18 ins.), *great* at Brocket Hall (1·10 in.), *very considerable* at three stations, and *considerable* at one; and on 19th there was a *considerable* fall at two stations. On 25th the fall was *great* at Royston (1·04 in.), and *considerable* at two stations; on 26th it was *great* at the Old Nurseries, Cheshunt (1·04 in.), and *considerable* at three stations; and on 30th it was *considerable* at one station. Severe thunderstorms occurred in several parts of the county on the 8th and 9th (Saturday and Sunday). At Royston on the Saturday a house was struck by the lightning and much damaged. The chimney was partly demolished, a large portion of the brickwork of the outer wall being forced out, and the bricks sent flying a considerable distance. The window-frames were shattered, and the water-supply pipe was cut in two. At Hertford on the same day the storm is reported as exceptionally severe, the rain falling in torrents and some of the rain-drops being as large in diameter as a shilling. At Bengeo two horses were struck by the lightning and killed, and at Thundridge two stacks of straw were set on fire and totally destroyed. The greatest fall of rain in either of the two days was 0·52 in. at High Down, Hitchin, on the Sunday. Thunderstorms also occurred on 25th, 26th, and 31st.

August.—Rainfall a little above the average, on about the usual number of days. There was a *considerable* fall on the 1st at four stations; on the 3rd, 4th, and 5th, at one; on the 9th at four; and on the 22nd at one. On the 31st the fall was *very considerable* at six stations and *considerable* at six. There were thunderstorms on 4th and 10th with heavy rain. On the 4th, at Datchworth Rectory, 0·44 in. fell in 20 minutes; and on the 10th, at Rosebank, Berkhamsted, 0·52 in. fell in the same time. At St. Albans on the 10th the lightning was very vivid, the rain torrential for a few minutes, and large hailstones fell. As this storm occurred at about 3 a.m. the rain was of course registered to the 9th.

September.—Rainfall very small, and on rather less than the average number of days. Most of the rain fell during the latter part of the month. On 8th the fall was *considerable* at three stations, and on 26th at two. On 23rd there was a gale with heavy rain and hail in many places in the county.

October.—Rainfall very heavy, but on little more than the usual number of days. The first half of the month was much wetter than the second half, but the excess was chiefly due to the fall on one day (the 9th). On 5th the fall was *considerable* at three stations; on 6th at one; and on 7th *very considerable* at one, and *considerable* at six. On 9th the fall was *excessive* at Oaklands, Watford (2·72 ins.), Frogmore, Watford (2·51 ins.), Nash Mills, Hemel Hempstead (2·16 ins.), and The Grange, St. Albans (2·02 ins.); *very heavy* at Apsley Mills, Hemel Hempstead (1·92 in.); *heavy* at Gorhambury, St. Albans (1·74 in.), Rothamsted, Harpenden

(1·63 in.), Rosebank, Berkhamsted (1·62 in.), Weston Park, Stevenage (1·55 in.), Great Gaddesden Vicarage (1·50 in.), and Brocket Hall, Welwyn (1·50 in.); *very great* at Fairfield, Berkhamsted (1·48 in.), High Down, Hitchin (1·36 in.), Kensworth (1·32 in.), Bennington House (1·29 in.), and Cowroast (1·25 in.); *great* at New Barnet (1·21 in.), The Firs, Hitchin (1·19 in.), Bancroft, Hitchin (1·19 in.), The Rectory, Welwyn (1·15 in.), Fanhams Hall, Ware (1·13 in.), Throcking Rectory (1·12 in.), Broxbourne, (1·11 in.), Datchworth Rectory (1·10 in.), Therfield Rectory (1·07 in.), Hamels Park (1·06 in.), Southgate (1·05 in.), and Odsey (1·02 in.); and *very considerable* at six stations. On 17th there was a *considerable* fall at two stations, and on 21st at one. A very violent thunderstorm occurred on the 7th. The wind rose to a gale, many trees were blown down, and other damage was done. The gale was most destructive in the neighbourhood of Bushey. An account of its effects there is appended.

November.—Rainfall rather heavy but not exceeding the average, November being usually a wet month, and although rain was recorded on half the days in the month, the usual number was not quite reached. On 14th the fall was *very considerable* at seven stations and *considerable* at fifteen; on 18th *considerable* at seven; and on 25th *very considerable* at two and *considerable* at thirty. The fall on the 18th was due to a snowstorm which commenced on that—Saturday—night and continued into Sunday morning. The wind being very high, the snow drifted, and blocked roads and railway lines all over the county, from Hitchin and Royston in the north to Rickmansworth in the south-west and Bishop's Stortford in the east. To clear the line between Hitchin and Royston a snow-plough had to be employed, and the line between Bishop's Stortford and Takeley (in Essex) was so completely blocked that trains could not be worked over it on the Monday morning. The roads were in places blocked with snow several feet in depth. At Throcking no service could be held on the Sunday owing to the approach to the church being snowed up. At Rickmansworth the gale was so violent that windows were blown in, fences were blown down, chimney-pots fell in all directions, and trees were uprooted.

December.—Rainfall rather above the average, but less than in November, and on the usual number of days. On 12th there was a *considerable* fall at four stations, and on 20th at three. The fall on the 12th was accompanied with a furious gale which blew down many trees and did other damage, but not so great as that done by the gale of the 18th of November. The fall of a large fir tree blocked the railway-line between Cole Green and Hertingfordbury, and the London Road near Hertford was blocked by a tree falling right across it, while some damage was done to houses in Hertford and other places. Rickmansworth again suffered severely, chimney-pots and tiles being blown off the houses, fences being blown down and conservatories damaged, some trees being uprooted, and others having large branches broken off them.

The Storm of the 7th of October at Bushey.—Between 6 and 7 p.m. on Saturday the 7th of October, a terrific thunderstorm, accompanied by a violent gale, or whirlwind as it would appear to have been, swept across the centre of the parish of Bushey. It seems to have commenced near Pinner, and it exhausted its energies a little to the east of St. Albans, its direction being almost in a straight line from S.S.W. to N.N.E. The night was intensely dark, the lightning most vivid, like balls of fire, and the peals of thunder were very loud. Rain fell in torrents, and water rushed through the village of Bushey in streams in its course towards the Colne.

The following account is slightly condensed from a report which appeared in the 'Watford Observer' of the 14th of October.

The storm came from the direction of Pinner, swept across Hartsbourne Manor Park and over Merry Hill Lane, crossed the top of Clay Hill by the spring-hole inscribed "Pro bono publico," and, continuing straight across Mr. Fowler's meadows, leaving Cold Harbour Farm on the left and Hart's Farm on the right, passed on to Tyler's Farm and straight towards Letchmore Heath, between Delrow on the left and Hillfield on the right. In Hartsbourne Park much damage was done to the trees and fences, one large tree in the park being torn right up and carried a considerable distance; and at Merry Hill much damage was done to fences, chimney-stacks, windows, roofing, etc. The terrific force of the gale here was evident from a quantity of galvanized iron roof-sheeting being stripped off sheds at Merry Hill Lane and some of it carried a long way and deposited in Mr. Fowler's meadow. On Clay Hill the dwelling-house of Mr. W. Ashby, jun., was partly unroofed, windows were blown in, and tiles and glass fell in all directions. The large gates to the hay-yard of Mr. W. Ashby, sen., were burst open and split, the roof of his stables was completely stripped, and the tiles, bricks, and even large pieces of timber from the stables were hurled into the adjoining meadows. Portions of the fence and porch, and some of the slates of the next house, Lismore Cottage, were blown away, some of the woodwork being carried half-a-mile. Several other houses near were also damaged. A holly tree was suddenly snapped off from the bottom of the trunk and hurled against a man and a boy, carrying them several yards down the road against a bank on the south side. They were much hurt. A heavy hay-cart was swept from the middle of Mr. Ashby's yard against the wall. On Mr. Fowler's farm large trees were uprooted, and the tops of others weighing nearly a ton were twisted off and carried away. On Tyler's Farm several large trees were blown down, one, with its immense roots, being lifted completely out of the ground; buildings also (houses, cow-sheds, etc.) were damaged. Similar damage was done to trees, buildings, etc., at Letchmore Heath.

Since the above was in type I have received from Mr. K. J. Tarrant, of Craven Cottage, Bushey Heath, the following further account, also slightly abbreviated.

"The thunderstorm was a very remarkable one, being of a true cyclonic character, a tornado in fact. During the whole afternoon electrical tension had been extreme, the instruments here, especially the electrometer, being much disturbed. Distant thunder was heard about 3.30 p.m., and a sharp fall of the barometer set in. At about 6.5 the storm broke out to the S.W. It appeared to have originated to the south of the village of Pinner, but did not then develop the energy it afterwards displayed, the first case of damage being the partial unroofing of a barn near Pinner Church. It then passed at the back of Woodridings, where several large trees were torn up and garden-fences and roofs broken, and crossed the L. and N.W. main line at Pinner Station, lifting up the seats on the platform and carrying the corrugated-iron roof of a shed nearly a mile, depositing it in a field, where also were found the tops of two fir trees which must have been blown a mile and a half. After crossing the Watford road near Burnt Oak Farm, it passed up the valley below Græme's Dyke to Hartsbourne. (Its further track is given above.)

"The width of the whirlwind was only about 50 yards, and outside this track nothing was touched, but within its influence the effects were remarkable. It appeared to have exerted the greatest force in the hollows, nearly all the trees blown down being in the lowest positions; in many cases where the trunks were too firmly rooted they were wrung in half about eight feet from the ground, the fibres of the wood being twisted like the strands of a rope. A line of trees standing parallel to the course of the storm had all the branches on one side broken, on the other untouched, while some of the trees uprooted were lying with their tops to the direction from which the wind had come.

"As seen from here the cyclone appeared as a very low cloud, absolutely black, and apparently reaching the ground. It appeared to completely envelop the trees, and travelled with great velocity, while the enormous speed with which it rotated on its axis is shown by the damage done. The noise when distant was like that produced by a large flock of starlings in flight; as it approached, however, the roar resembled that of a train, but at this point, some 800 yards distant from the track of the storm, the air was perfectly still. The electrical phenomena accompanying it were very intense, but I have not been able to trace any actual damage by lightning, although the close proximity of the storm is proved by the fact that three of the fuses in the electric-lighting engine-room in the garden were melted, probably by induction, as there was no sign of the building having been struck. From 6.40 the barometer commenced to recover itself. I am strongly of opinion that a so-called cyclone is simply an effect of electrical tension, and that any thunderstorm of sufficient energy is likely to be accompanied by a 'wind-spout' similar to the above."—*K. J. Tarrant.*

VII.

CLIMATOLOGICAL OBSERVATIONS TAKEN IN HERTFORDSHIRE IN THE YEAR 1893.

By JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 17th April, 1894.

OBSERVATIONS continue to be made at the five stations for which the six previous annual reports have been drawn up, and therefore I give for the year 1893 the usual series of tables.

The mean temperature of Hertfordshire in 1893, deduced from these observations, was 2°·6 above that of the six previous years, and 1°·2 above the mean of 1882–86. The year was therefore decidedly warm. The mean daily range was very great, being 2°·7 greater than in 1887–91, and 2°·1 greater than in 1882–86. The extreme range was greater than in any previous year. The air was much less humid than the average of the six previous years, the amount of cloud was rather less, and the rainfall was considerably less, and on a much smaller number of days. The weather was very warm in spring and summer, excessively dry in spring and the early part of summer, but cold and rather wet in autumn.

All the observations are made at 9 a.m., the maximum temperature and rainfall being entered to the previous day.

ROYSTON.

(London Road.)

Latitude: 52° 2′ 34″ N. Longitude: 0° 1′ 8″ W. Altitude: 301 feet.

Observer: *Hale Wortham, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·0	29·5	38·4	8·9	15·5	50·0	88	6·7	1·63	21
Feb.	40·5	34·6	46·4	11·8	24·0	58·1	81	6·9	2·92	19
March	45·9	35·0	56·8	21·8	24·2	68·0	85	4·5	0·17	4
April	52·0	37·8	66·3	28·5	26·2	82·9	67	3·1	0·13	2
May	56·7	44·6	68·8	24·2	32·1	79·3	72	5·7	1·15	7
June	61·7	48·9	74·6	25·7	36·8	88·0	71	5·1	0·66	11
July	63·7	53·0	74·5	21·5	43·9	90·3	78	6·3	3·48	17
August	65·5	54·9	76·1	21·2	42·0	93·0	73	5·3	2·49	11
Sept.	55·3	47·1	63·4	16·3	37·1	78·5	70	5·5	1·01	9
Oct.	51·2	43·3	59·1	15·8	27·0	67·1	82	5·6	3·11	17
Nov.	40·4	34·0	46·8	12·8	24·7	60·0	87	7·2	2·15	11
Dec.	39·3	33·4	45·2	11·8	20·2	55·1	89	6·3	1·62	17
Year	50·5	41·3	59·7	18·4	15·5	93·0	79	5·7	20·52	146

BERKHAMSTED.

(Rosebank.)

Latitude: 51° 45′ 40″ N. Longitude: 0° 33′ 30″ W. Altitude: 400 feet.

Observer: *Edward Mawley, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·6	30·1	39·1	9·0	12·4	51·7	93	8·6	2·05	21
Feb.	40·3	34·8	45·7	10·9	25·3	57·1	92	8·3	3·69	21
March	45·0	33·7	56·4	22·7	21·9	66·8	75	4·4	0·46	5
April	50·9	37·3	64·5	27·2	24·9	78·7	62	4·1	0·20	3
May	56·2	44·9	67·5	22·6	35·7	80·6	67	5·9	0·86	9
June	60·2	48·4	72·0	23·6	34·0	87·5	65	6·3	0·98	8
July	62·3	52·9	71·7	18·8	45·5	85·5	71	6·8	2·14	20
August	63·9	53·5	74·3	20·8	39·8	91·0	70	6·6	2·33	12
Sept.	56·6	46·8	66·4	19·6	37·1	79·5	77	5·9	1·10	13
Oct.	50·3	42·5	58·0	15·5	26·4	66·3	85	4·9	4·21	16
Nov.	40·4	34·4	46·5	12·1	24·1	59·7	90	8·9	3·17	16
Dec.	39·1	32·8	45·4	12·6	18·3	55·1	93	7·1	2·75	19
Year	50·0	41·0	59·0	18·0	12·4	91·0	78	6·5	23·94	163

ST. ALBANS.

(The Grange.)

Latitude: 51° 45′ 9″ N. Longitude: 0° 20′ 7″ W. Altitude: 380 feet.

Observer: *John Hopkinson, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·4	30·1	38·8	8·7	14·7	50·2	90	7·7	2·01	24
Feb.	39·7	34·2	45·2	11·0	22·9	56·3	90	7·6	3·36	23
March	45·6	35·9	55·3	19·4	25·4	65·5	80	4·7	0·51	6
April	52·2	39·4	65·0	25·6	28·8	77·7	69	3·6	0·14	2
May	56·1	45·7	66·5	20·8	37·4	78·3	70	5·0	1·65	8
June	60·6	49·6	71·7	22·1	37·9	86·1	67	6·3	0·72	8
July	62·6	54·0	71·2	17·2	47·1	84·6	69	5·8	3·06	22
August	64·7	55·1	74·2	19·1	42·9	91·0	66	6·1	2·10	13
Sept.	56·3	47·6	65·0	17·4	38·9	78·6	78	5·5	1·08	11
Oct.	50·3	43·2	57·5	14·3	30·0	64·7	86	4·3	5·07	17
Nov.	40·9	34·8	47·0	12·2	26·1	59·2	91	7·9	2·89	19
Dec.	39·0	33·2	44·8	11·6	20·1	54·8	91	6·6	2·41	17
Year	50·2	41·9	58·5	16·6	14·7	91·0	79	5·9	25·00	170

BENNINGTON.

(Bennington Lodge.)

Latitude: 51° 53′ 45″ N. Longitude: 0° 5′ 20″ W. Altitude: 407 feet.

Observer: *Rev. J. D. Parker, LL.D., F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·4	30·1	38·6	8·5	17·5	50·9	93	8·1	1·69	21
Feb.	39·7	34·3	45·1	10·8	22·3	57·1	91	7·8	2·91	21
March	45·8	35·8	55·9	20·1	25·3	65·4	75	4·5	0·39	7
April	51·0	38·7	63·2	24·5	31·7	78·6	66	3·8	0·08	2
May	55·8	45·1	66·6	21·5	37·5	76·8	67	6·2	1·20	9
June	60·3	49·1	71·4	22·3	39·8	87·1	64	6·8	0·58	8
July	62·2	53·1	71·4	18·3	45·7	85·9	67	6·8	2·74	18
August	64·1	54·4	73·7	19·3	44·1	90·9	70	6·5	2·73	13
Sept.	56·2	47·8	64·7	16·9	38·1	77·0	75	6·4	0·88	10
Oct.	50·3	43·4	57·1	13·7	29·9	64·8	83	5·2	3·56	17
Nov.	40·2	34·6	45·9	11·3	27·3	58·5	87	8·5	2·53	16
Dec.	38·9	32·9	44·9	12·0	21·4	55·3	90	7·1	2·25	17
Year	49·9	41·6	58·2	16·6	17·5	90·9	77	6·5	21·54	159

NEW BARNET.

(Gas Works.)

Latitude: 51° 39′ 5″ N. Longitude: 0° 10′ 15″ W. Altitude: 212 feet.

Observer: *T. H. Martin, C.E.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·5	28·8	40·2	11·4	12·0	53·0	88	7·5	1·61	14
Feb.	40·1	33·4	46·8	13·4	17·0	57·8	90	7·5	3·20	19
March	44·0	31·0	56·9	25·9	17·0	68·0	76	4·3	0·38	4
April	49·3	33·9	64·6	30·7	22·0	78·8	72	2·7	0·04	2
May	55·7	42·1	69·3	27·2	30·0	79·0	86	5·3	0·57	7
June	60·0	45·7	74·3	28·6	29·0	90·0	81	5·3	0·64	6
July	62·5	51·1	73·8	22·7	39·0	87·8	69	5·6	2·44	15
August	63·9	51·3	76·5	25·2	35·0	94·5	62	4·5	2·08	11
Sept.	56·1	44·6	67·7	23·1	33·8	80·5	77	5·7	0·93	9
Oct.	50·8	41·6	59·9	18·3	28·0	68·0	82	4·6	3·69	15
Nov.	40·8	33·8	47·8	14·0	20·5	61·8	84	7·5	2·32	11
Dec.	38·1	30·9	45·3	14·4	12·0	57·1	87	5·6	2·52	12
Year	49·6	39·0	60·2	21·2	12·0	94·5	79	5·5	20·42	125

HERTFORDSHIRE.

Means of Climatological Observations (with extremes of temperature) in 1893, at Royston, Berkhamsted, St. Albans, Bennington, and New Barnet.

Months	Temperature of the Air						Humidity	Cloud, 1–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·4	29·7	39·0	9·3	12·0	53·0	90	7·7	1·80	20
Feb.	40·1	34·3	45·9	11·6	17·0	58·1	89	7·6	3·21	21
March	45·3	34·3	56·3	22·0	17·0	68·0	78	4·5	0·38	5
April	51·1	37·4	64·7	27·3	22·0	82·9	67	3·5	0·12	2
May	56·1	44·5	67·7	23·2	30·0	80·6	72	5·6	1·08	8
June	60·5	48·3	74·8	24·5	29·0	90·0	70	6·0	0·72	8
July	62·6	52·8	72·5	19·7	39·0	90·3	71	6·3	2·77	18
August	64·4	53·8	74·9	21·1	35·0	94·5	68	5·8	2·35	12
Sept.	56·1	46·8	65·4	18·6	33·8	80·5	75	5·8	1·00	11
Oct.	50·6	42·8	58·3	15·5	26·4	68·0	84	4·9	3·93	16
Nov.	40·5	34·3	46·8	12·5	20·5	61·8	88	8·0	2·61	15
Dec.	38·9	32·6	45·1	12·5	12·0	57·1	90	6·5	2·31	16
Year	50·0	41·0	59·1	18·1	12·0	94·5	78	6·0	22·28	152

Results of Climatological Observations, 1887–92.

Stations.	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Royston	48·1	40·1	56·0	15·9	4·3	89·4	84	6·3	22·23	160
Berkhamsted	47·0	39·5	54·5	15·0	11·1	85·0	83	7·3	25·66	182
St. Albans	47·4	40·4	54·4	14·0	11·8	86·0	83	6·8	26·30	185
Bennington	47·1	40·0	54·2	14·2	14·4	85·1	82	7·4	24·78	192
New Barnet	47·2	38·2	56·2	18·0	7·5	88·5	84	6·3	23·79	144
County	47·4	39·7	55·1	15·4	4·3	89·4	83	6·8	24·55	173

VIII.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1893.

By Henry Lewis.

Read at Watford, 17th April, 1894.

When I last had the honour of presenting my annual report on the birds observed in Hertfordshire, I was enabled to increase our register by the addition of three species. On the present occasion I have two species to add, raising the number recorded for the county to 207. Several rare birds already on our register have also been observed during the year. I will at once proceed to refer to the two additional species.

1. The Black Redstart (*Ruticilla titys*).—This welcome addition to my report I recently received in a letter from Mr. A. Sainsbury Verey, of Heronsgate, Herts, enclosing a cutting from the 'Watford Observer' of 1st April, 1893, which runs thus:—"Sir,—Watching for the wheatears in my field at an early hour this morning, the note of a redstart attracted my attention, and looking about I was immediately struck with the dark back of the bird as it sat perched on a wire fence not very far away. It permitted a near approach, and then, with obliging courtesy facing round, the very dark colour of the throat and body at once confirmed my first impression, it being undoubtedly a specimen of the black redstart (*Ruticilla titys*). I copy a brief account of the distribution of the bird from the 'List of British Birds,' compiled by the British Ornithologists' Union (p. 9): 'A winter visitant to the south-west of Great Britain; occasional elsewhere, and in Ireland; has been known to breed in Notts. Breeds all over Central and Southern Europe. Winters in North Africa.'—Yours, etc., A. Sainsbury Verey, Heronsgate, Herts."

In his letter to me Mr. Verey states: "The bird was observed on the 28th of March. It stayed with me two days, and was very tame, enabling me to determine clearly that it was really the black redstart, as I had many opportunities of seeing the grey throat and the dark sooty appearance of the whole of the front of the body."

2. The Canada Goose (*Bernicla canadensis*).—When on a recent visit to Royston, Mr. W. Norman, naturalist, of that town, showed me a well-mounted and fine specimen of this rare bird, which was shot on the 6th of June, 1893, from a flock of about ten observed in a field on the estate of Mr. W. B. Green, Cockenack, near Barkway, early in the morning. The bird was found to weigh twelve pounds, and measured across the wings 5ft. 6ins., and from tip of tail to bill, 3ft. 3ins.

This bird is the common wild goose of the United States. I quote the following from Gray's 'Birds of the West of Scotland' (p. 354). "In writing of the vernal flight of this species, Wilson, the American ornithologist, says:—'It is highly probable that they extend their migration under the very pole itself, amid the silent desolation of unknown countries, shut out . . . from the prying eye of man by everlasting and insuperable barriers of ice. That such places abound with their suitable food we cannot for a moment doubt, while the absence of their great destroyer, man, and the splendours of a perpetual day, may render such regions the most suitable for their purpose.' This restlessness of the species," Gray then remarks, "becomes apparent in April, and continues until the middle of May, when the great body has passed northwards for the purposes of incubation. There can be no doubt that on their return southwards many birds are driven out of their reckoning, and find their way to the shores of Great Britain." According to the late Sir John Richardson this species occasionally breeds in trees on the banks of the Saskatchawan, taking possession of and depositing its eggs in the deserted nests of ravens and eagles. A raven's nest is no doubt a bulky enough structure, but after having been sat upon by a fat goose during the period of incubation it must have greatly perplexed the original proprietor on visiting it the following spring when trying to identify its own property. Dr. Coues, in his 'Birds of the North West' (p. 554) reports that the Canada goose nests "in trees, the old birds carrying their young when hatched down to the water in their bills." This habit of carrying their young is possessed by a number of other birds. The woodcock is a well-known instance. In case of danger the bird will convey her young in her claws to a place of safety. Mr. John Watson, in 'Sylvan Folk' (p. 92), says: "Not only do swans, coots, grebes, and moor-hens carry their young on their backs whilst swimming, but the same birds transport their young whilst flying." He also states that the mallard or wild duck has been known to convey its young from an elevation of at least thirty feet from the ground; and that "another duck, the golden-eye, which builds in trees, has been seen to transport its young to the water." "Young guillemots," he says, "are carried by their parents to the water from the beetling sea-cliffs where they breed, though in what manner is not yet definitely known. The same set of facts apply to the herring-gull and other sea-birds which build on high rocky headlands."

Mr. Arthur Lewis has given me an amusing instance of the nesting of a mallard or wild duck, in his possession, on his bee-house. The bird enticed her young to the edge of the roof, gave one a push with her beak, and over-toppled the youngster on to the grass; she flying down, the rest were precipitated pell-mell after her.

. I will now refer to the occurrence during the past year of a few rare birds which are already on our register.

The Waxwing (*Ampelis garrulus*).—In January (1893) Mr. Seymour received for preservation a specimen of this beautiful bird which had been picked up dead on the side of the River Lea, near Hertford; and Mr. Norman Thrale, of Enfield Lock, wrote to me to the following effect: "Two waxwings were shot by Mr. E. Jackson, of Potter's Bar, at Northaw, Herts, on the 27th of February. There were five of them feeding off the hips." This bird appears at uncertain intervals during the winter months, and although it has been recorded on several previous occasions, its erratic wanderings are always well worthy of notice in our 'Transactions.'

THE WHOOPER OR WHISTLING SWAN (*Cygnus musicus*).—Last Christmas twelvemonth, Mr. Seymour, in company with many other persons, noticed about thirty of these magnificent birds flying over Hertford. He heard the noise made by their wings in cleaving the air. They stopped at Woodhall a short time, but as soon as one was shot by Mr. Noble, jun., of Woodhall, Watton, they were off. Like the wild geese, these birds fly in the fashion of a wedge. (I may add that the singular windpipe of this bird was sent to King's College, London, and that considerable credit is due to Mr. Seymour in the mounting of this specimen.)

Mr. W. Warde Fowler, in his delightful book 'A Year with the Birds,' remarks: "Swans are frequently mentioned by Virgil, as by other Latin and Greek poets. This splendid bird must have been much commoner then throughout Europe than it is now, and accordingly attracted much attention. It doubtless abounded in the swampy localities of the north of Italy, and at the mouths of the great rivers of Thrace and Asia Minor, as well as in the north of Europe, where it came to be woven into many a Teutonic fable. Homer has frequent and beautiful allusions to it; and the town of Clazomenæ, at the mouth of the river Hermus, has a swan stamped upon its coins. This swan of the old poets is without any doubt the whooper, whose voice and presence are still well known in Italy and Greece."

THE SMEW (*Mergus albellus*).—We are indebted to Mr. George Rooper, of Watford, for the following particulars respecting one of these rare ducks (in a letter dated 7th October, 1893): "A young smew was caught the other day in a water-cress bed. My groom bought it. . . . The bird seems tame enough, and I think must have escaped from captivity. It feeds well on refuse fish." The smew has but rarely been reported in our 'Transactions,' and no doubt Mr. Rooper is correct in regarding this young bird as being an escaped prisoner, the species being a winter visitor to our shores.

THE LITTLE AUK (*Mergulus alle*).—One of these rare birds, Mr. W. Norman informs me, was picked up on the 22nd of November on the borders of Hertfordshire, between Royston and Litlington, having evidently been knocked down by coming in contact with the telegraph wires, its breast-bone being broken. The little auk is only a winter visitor to the British Isles, and when observed inland it is generally supposed to have been blown from the sea in stormy weather. This bird has only on two previous occasions been reported in our 'Transactions,' but the late Mr. Thrale, of No Man's Land, had in his collection (which I have seen) one which was obtained on the mill-head at Wheathampstead. This is the specimen mentioned by Yarrell in his

'History of British Birds.'* He also mentions another as having been picked up alive between Baldock and Royston.†

The Puffin (*Fratercula arctica*).—About the end of last year Mr. Seymour received a specimen of this singularly comical-looking bird, shot by the keeper on Roxford Farm, Bayfordbury.

This quaint bird has been recorded in our 'Transactions' on several occasions. On Lundy Island it is abundant, with other species of sea-birds, as I once had an opportunity of observing. Mr. Seebohm states: "There can be little doubt that the puffin is more or less a resident in the British seas, but it is less frequently observed in winter, when it is scattered over a large area, seldom approaching the land." He further informs us: "Notwithstanding its somewhat small and narrow wings, which seem almost incapable of bearing such a plump little body through the air, it is a bird of remarkably rapid and powerful flight."‡ Possibly this may account in some way for its comparatively frequent occurrence in our county.

Miscellaneous Notes.

Fieldfare (*Turdus pilaris*).—On the 7th of January, 1893, Mr. Arthur Lewis observed continued flights of fieldfares coming from the north flying over his house, Sparrowswick, St. Albans.

Redbreast (*Erythacus rubecula*).—Mr. J. Mills kindly presented me with a robin's nest (containing five white eggs), built last spring in an old tin pint mug. It was taken from the fork of a laurel, about five feet from the ground, close to Lord Grimthorpe's house, Batchwood, St. Albans. If the eggs are carefully examined, a very few faint red markings will be seen. The ground-colour of a redbreast's egg is shiny white, it is usually speckled, and streaked or blotched with light red.

Wood-Wren (*Phylloscopus sibilatrix*).—We were enabled last spring to identify the wood-wren's song in Verulam Woods, St. Albans, and again heard the same bird's song when on a pilgrimage to Selbourne early last June.

Tree-Creeper (*Certhia familiaris*).—Mr. Hopkinson observed a tree-creeper last spring at Bricket Wood. I also noticed a pair, and heard the bird's loud and pleasing song. From its small size and sober colouring, and habit of ascending the trunk of a tree in a spiral fashion, suddenly stopping and then making a fresh start, it is often overlooked.

Hawfinch (*Coccothraustes vulgaris*), and Tree-Sparrow (*Passer montanus*).—Mr. Spary has received specimens of these birds taken in Hertfordshire during the year.

Chaffinch (*Fringilla cœlebs*).—On the 17th of May Mr. Arthur Dickinson informed me that he had noticed a chaffinch repeatedly carrying away barley-meal to feed its young ones.

Snow-Bunting (*Plectrophanes nivalis*).—Mr. W. Norman reports having received two or three snow-buntings, one knocked down

* 1st Ed., vol. i, p. 360. † *Ib.*
‡ 'British Birds,' vol. iii, p. 365.

in flying against the telegraph wires on Royston Heath on the 6th of December; one shot at Triplow, Cambridgeshire, as early as the 15th of September; and another shot in January last at Sandon, Herts, by Mr. Lees.

JACKDAW (*Corvus monedula*).—A keeper informed Mr. G. Gooch, of St. Albans, that last spring he lost a number of young pheasants, and it was some time before he became aware who the thief was. At last a jackdaw was caught in the act of killing one. I have but little doubt the species had to suffer on account of his good taste. Canon McLean informs me that he observed on several occasions at Caistor in Lincolnshire a jackdaw with legs feathered down to the toes.

ROOK (*Corvus frugilegus*).—Last spring both I and my son noticed the rooks breaking the small branches of the trees in the Abbey Orchard, to mend or construct their nests with.

NIGHTJAR (*Caprimulgus europæus*).—At the kind invitation of Mr. Charles Dickinson, I visited the wood where this bird last year safely reared its young, and found close to the same spot two young ones squatting on the ground. When I saw them they were always head and tail together, the head of one bird situated against the tail of the other. I am not aware if this is their usual position or was merely accidental.

WOODPECKERS and KINGFISHER. — Last March Mr. Arthur Dickinson observed a pair of the lesser-spotted woodpeckers in his wood near St. Albans. Mr. Seymour has received, amongst a number of other specimens, both the greater and lesser-spotted woodpeckers (*Dendrocopus major* and *minor*), as well as the green woodpecker (*Gecinus viridis*), and I am very sorry to add a large number of kingfishers (*Alcedo ispida*). Mr. Seymour also informs me that he has seen the kingfisher use its feet to remove the earth from its nest-hole. I mention this to corroborate a former statement to the same effect.

LITTLE OWL (*Athene noctua*).—Mr. W. Norman mentions: "On Monday, the 12th of March, I was delighted to have brought in a lovely specimen of that rare bird the little owl (*Athene noctua*), killed at Wimpole, Cambridgeshire, and sent to me by the Rev. E. L. Fellows." I mention this as it is somewhat singular that the only specimen I can find mentioned in the late Mr. J. E. Littleboy's register is reported by Mr. W. Norman as having been obtained in May, 1877, at Ashwell, near Royston. I regret that we cannot place this recent record on our register, the occurrence being outside the limits of our county.

PHEASANT and PARTRIDGE.—Mr. Seymour has shown me several varieties of the pheasant (*Phasianus colchicus*); and last October Mr. Arthur Spary showed me a singularly marked (pied would perhaps be the right word to use) partridge (*Perdix cinerea*), killed by Mr. Lattimore on his farm near Wheathampstead. When walking one summer's evening in Gorhambury Park, a partridge suddenly arose at my feet. I was surprised to see her tumble and flutter along as if wounded just in front of me, but was very soon aware of her deception, as I saw her young ones dodging hither and thither to hide out of my way.

SNIPES, etc.—During the past year Mr. Spary has received both the common snipe (*Gallinago cœlestis*) and jack snipe (*Gallinago gallinula*), taken in our county; and amongst other specimens a dunlin (*Tringa alpina*) shot at Redbourn, a sanderling (*Caledris arenaria*) shot in December near St. Albans, and a green sandpiper (*Totanus ochropus*).

COMMON TERN (*Sterna fluviatilis*).—A common tern was brought to Mr. Norman on the 19th of October; it was taken alive, quite exhausted, within a stone's throw of Hertfordshire.

CRESTED GREBE (*Podiceps cristatus*).—Mr. W. Norman also writes to say: "A beautiful specimen of the crested grebe was brought to me for preservation, and it proved to be a young male bird." Unfortunately it was killed at Orwell, Cambridgeshire, and therefore its occurrence cannot appear on our register; but the bird breeds abundantly at Tring Park, the residence of the Hon. Walter Rothschild.

MIMICKING OF SONG.—I have before alluded to the mimicking by certain birds of the song of others. I have frequently heard the great tit in the spring utter the "wink-wink" of the handsome chaffinch, and I once heard the chiff-chaff commence the willow-wren's song, but it instantly ceased as if aware of its mistake and commenced its chiff-chaff as merrily as ever.

ALBINISM AND ALBINO SPORTS.—Miss Ada Selby last August informed me that Mr. Roffe, of Garston Farm, wrote to her to say that he had seen a white sparrow on his premises. Mr. Spary has received two blackbirds with white heads. Mr. Michael Ryder, of Watford, shot in his garden a black and white rook; and two albino sparrows were seen near White Hall Farm, Bishop's Stortford; one was captured and lived but a short time, the other was shot by Mr. Cutler soon afterwards. Mr. W. Norman received an albino skylark for preservation; also a hen chaffinch with a mixture of white and grey, and sparrow-colour markings.

I now give the usual list of dates on which the arrival and departure of our summer and winter visitants have been reported, with the names of the observers. Undoubtedly the lovely spring favoured the exceptionally early arrival of many of our summer migrants in this country.

SUMMER MIGRANTS.

SPECIES.	LOCALITY.	DATE.	OBSERVER.
SONG-THRUSH	Watford	Jan. 24	Mrs. Bishop.
(*Turdus musicus*)	Berkhamsted	„ 29	Mrs. E. Mawley.
	St. Albans	„ 29	H. L.
REDSTART	St. Albans	April 6	Arthur Lewis.
(*Ruticilla phœnicurus*)			
NIGHTINGALE	St. Albans	„ 9	Arthur Spary.
(*Daulias luscinia*)	Bricket Wood	„ 12	H. Sexton.
	Sandridge	„ 14	Miss Chorler.
	Hitchin	„ 14	J. E. Little.

Species.	Locality.	Date.	Observer.
NIGHTINGALE (*Daulias luscinia*)	Watford	April 16	Mrs. Bishop.
	St. Albans	,, 16	H. L.
	Odsey	,, 16	H. G. Fordham.
	Newberries, Radlett	,, 18	H. J. Lubbock.
	Harpenden	,, 18	J. J. Willis.
	Broxbourne	,, 18	Lady F. Bushby.
	Berkhamsted	,, 19	Mrs. E. Mawley.
WHITETHROAT (*Sylvia cinerea*)	St. Albans	,, 16	H. L.
BLACKCAP (*Sylvia atricapilla*)	St. Albans	,, 16	H. L.
CHIFF-CHAFF (*Phylloscopus rufus*)	St. Albans	Mar. 16	H. L.
WILLOW-WARBLER (*Phylloscopus trochilus*)	Verulam Woods, St. Albans	,, 31	H. L.
SEDGE-WARBLER (*Acrocephalus phragmitis*)	St. Albans	April 20	H. L.
GRASSHOPPER-WARBLER (*Locustella nævia*)	Harpenden Common	,, 27	H. L.
YELLOW WAGTAIL (*Motacilla Raii*)	Near Batch Wood, St. Albans	,, 19	Arthur Dickinson.
TREE-PIPIT (*Anthus trivialis*)	Oaklands, St. Albans	,, 14	H. L.
SPOTTED FLYCATCHER (*Muscicapa grisola*)	Newberries, Radlett	May 7	H. J. Lubbock.
	Berkhamsted	,, 11	Mrs. E. Mawley.
	Odsey	,, 16	H. G. Fordham.
	St. Albans	,, 28	Arthur Dickinson.
SWALLOW (*Hirundo rustica*)	Newberries, Radlett	April 8	H. J. Lubbock.
	Beaumont's Farm, St. Albans	,, 8	John Boyes, Jun.
	Hitchin	,, 8	J. E. Little.
	Watford	,, 10	Daniel Hill.
	St. Albans	,, 10	Arthur Dickinson*
	Odsey	,, 10	H. G. Fordham.
	Munden Park, St. Albans	,, 12	Hon. A. H. Hibbert.
	Watford	,, 15	Mrs. Bishop.
	Berkhamsted	,, 15	Mrs. E. Mawley.
	Harpenden	,, 18	J. J. Willis.
(Last seen)	St. Albans	Oct. 10	Arthur Dickinson*
	Odsey	,, 12	H. G. Fordham.
	Hertford	,, 19	W. Graveson.
	Hemel Hempstead	,, 24	T. Hope.
HOUSE-MARTIN (*Chelidon urbica*)	Redbourn	April 15	A. E. Gibbs.
	St. Albans	,, 18	H. Allenby.
(Last seen)	St. Albans	Oct. 10	Arthur Dickinson*
SWIFT (*Cypselus apus*)	St. Albans	May 6	H. L.
NIGHTJAR (*Caprimulgus europæus*)	Harpenden	,, 8	J. Dickinson.
WRYNECK (*Iÿnx torquilla*)	Bricket Wood	April 3	A. E. Gibbs.
	Verulam Woods, St. Albans	,, 3	John Lewis.
CUCKOO (*Cuculus canorus*)	Harpenden	,, 7	J. J. Willis.
	Childwick, St. Albans	,, 9	R. H. Weatherley.
	Watford	,, 14	Mrs. Bishop.
	Oaklands, St. Albans	,, 14	H. L.
	Watford	,, 17	John Weall.

* And H. L.

Species.	Locality.	Date.	Observer.
Cuckoo	Broxbourne	April 18	Lady F. Bushby.
(*Cuculus canorus*)	Hitchin	,, 19	J. E. Little.
	Berkhamsted	,, 22	Mrs. E. Mawley.
Turtle-Dove	Smallford, St. Albans	,, 23	Arthur Smith.
(*Turtur communis*)	St. Albans	,, 25	H. L.
Corncrake or Landrail	St. Albans	May 2	H. L.
(*Crex pratensis*)			
Sandpiper	Redbourn Bury, St. Albans	April 3	E. W. Arnold.
(*Totanus hypoleucus*)			

Winter Visitants.

Species.	Locality.	Date.	Observer.
Redwing	St. Albans	Sept. 24	Arthur Dickinson.
(*Turdus iliacus*)			
Grey Wagtail	St. Albans	Oct. 1	H. L.
(*Motacilla melanope*)			

Mr. Warde Fowler, in his book 'A Year with the Birds,' so aptly expresses my views and feelings with regard to our feathered songsters that I cannot do better than quote his words. He says (page 44): "Nothing but a personal acquaintance—a friendship as I must call it in my own case—with these little birds, as they live their every-day life among us, will suffice to fix the individuality of each species in the mind: not even the best plates in a book, or the faded and lifeless figures in a museum. You may shoot and dissect them, and study them as you would study and label a set of fossils: but a bird is a living thing, and you will never really know him till you fully understand how he lives." And I may add that the more we thus become acquainted with nature so much the more must our minds expand. Mr. Thomas Edison, the greatest of modern inventors, has spoken thus: "I tell you that no person can be brought into close contact with the mysteries of nature, . . . without being convinced that behind it all there is a supreme intelligence."

I cannot conclude without thanking those ladies and gentlemen, especially Mr. T. Hope, who have so kindly assisted me with extracts, information, and records, without which it would have been impossible for me to have written this report.

IX.

METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, DURING THE YEAR 1893.

By JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 17th April, 1894.

Longitude of Station, 0° 20′ 7″ W.; Latitude, 51° 45′ 9″ N. Cistern of barometer 388 feet, ground-level at thermometer-screen 380 feet, and at rain-gauge 379 feet, above Ordnance Datum. Thermometers (in Stevenson screen) 4 feet, and top of rain-gauge 1 foot, above the ground. Observations taken at 9 a.m.

The accompanying tables (pp. 58, 59) give the monthly means, etc., of the daily observations in 1893, and the following is the usual summary for the seasons:—

MEANS FOR THE SEASONS FROM DEC. 1892 TO NOV. 1893.

Seasons, 1892–93.	Pressure.	Temperature. Mean.	Temperature. Daily Range.	Humidity.	Cloud, 0–10.	Force of Wind.	Rainfall. Total.	Rainfall. Days.
	ins.	°	°	%		0–12	ins.	
Winter	29·932	36·3	10·0	90	7·1	1·8	6·87	61
Spring	30·137	50·9	21·9	73	4·4	1·6	2·30	16
Summer......	29·991	62·8	19·5	67	6·1	1·6	5·88	43
Autumn......	29·940	48·9	14·6	85	5·9	2·1	9·04	47

In the next table the chief results, monthly and annual, are compared with the means for the ten years 1877–86 at Watford.

DIFFERENCE IN 1893 FROM MEANS OF 1877-86 AT WATFORD.

Months.	Pressure.	Temperature. Mean.	Temperature. Daily Range.	Humidity.	Cloud, 0–10.	Force of Wind.	Rainfall. Total.	Rainfall. Days.
	in.	°	°	%		0-12	ins.	
January......	+·050	−2·2	−0·5	=	+0·1	+0·2	−0·58	+ 7
February	−·259	−0·3	+0·7	+ 1	=	+0·5	+0·77	+ 6
March	+·171	+3·9	+4·6	− 3	−1·6	−0·3	−1·15	− 6
April	+·314	+5·4	+9·2	− 7	−2·9	−0·5	−2·24	−13
May	+·109	+4·1	+2·7	− 2	−1·4	−0·3	−0·76	− 7
June	+·053	+2·1	+4·0	− 6	=	−0·1	−2·14	− 6
July	−·051	+1·4	=	− 5	−0·7	=	+0·53	+ 7
August	+·119	+4·1	+2·8	−11	−0·8	+0·1	−0·52	− 1
September	−·082	−0·3	+1·1	− 5	−0·9	+0·1	−1·53	− 2
October	−·005	+1·8	+0·8	− 1	−2·2	+0·1	+2·01	=
November	+·097	−1·5	+0·2	+ 2	+1·4	+0·8	−0·13	+ 1
December	+·062	+1·5	+1·5	+ 1	−0·7	+0·4	−0·22	=
Year	+·049	+1·3	+2·2	− 3	−0·8	+0·1	−5·96	−14

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, IN 1893.

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.	Temperature of		Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.		Evaporation.	Dew-point.	
	ins.	°	°	°	°	°	°		°		°	°	°	%
January	30·079	34·4	30·1	38·8	34·4	8·7	14·7	5th	50·2	31st	35·5	33·5	31·9	90
February	29·700	39·1	34·2	45·2	39·5	11·0	22·9	6th	56·3	19th	33·4	37·9	36·3	90
March	30·147	43·9	35·9	55·3	45·0	19·4	25·4	19th	65·6	31st	40·1	41·2	38·0	80
April	30·190	50·2	39·4	65·0	51·5	25·6	28·8	14th	77·7	20th	48·9	45·4	40·3	69
May	30·074	56·3	45·7	66·5	56·2	20·8	37·4	8th	78·3	15th	40·9	51·3	46·6	70
June	30·022	60·2	49·6	71·7	60·6	22·1	37·9	1st	86·1	17th	48·2	54·5	49·5	67
July	29·901	62·6	54·0	71·2	62·6	17·2	47·1	28th	84·6	7th	37·5	57·0	52·2	69
August	30·050	65·9	55·1	74·2	65·1	19·1	42·9	29th	91·0	18th	48·1	59·4	54·1	66
September	29·889	55·8	47·6	65·0	56·1	17·4	38·9	24th	78·6	6th	39·7	52·3	49·0	78
October	29·923	49·5	43·2	57·5	50·1	14·3	30·0	31st	64·7	16th	34·7	47·4	45·1	86
November	30·009	39·6	34·8	47·0	40·5	12·2	26·1	1st	59·2	3rd	33·1	38·5	37·1	91
December	30·028	38·5	33·2	44·8	38·8	11·6	20·1	3rd	54·8	13th	34·7	37·5	36·1	91
Year	30·001	49·7	41·9	58·5	50·0	16·6	14·7	Jan.	91·0	Aug.	76·3	46·3	42·7	79

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, IN 1893—*(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	2·01	·38	26th	24	10	7·7	4	20	1·9	3	4	2	3	2	4	6	5	2
February	3·36	·40	21st	23	5	7·6	4	16	2·2	1	2	0	4	4	8	6	1	2
March	·51	·26	1st	6	2	4·7	11	7	1·7	2	3	4	3	3	4	7	2	3
April	·14	·08	29th	2	0	3·6	13	5	1·6	7	8	8	1	0	0	3	1	2
May	1·65	·93	17th	8	0	5·0	8	6	1·6	7	5	3	2	3	3	4	2	2
June	·72	·16	22nd	8	0	6·3	6	10	1·5	2	8	3	4	4	3	4	1	1
July	3·06	·87	12th	22	0	5·8	5	9	1·5	3	2	2	4	6	4	4	2	4
August	2·10	·38	1 & 23	13	0	6·1	2	7	1·9	1	1	1	3	4	12	5	3	1
September	1·08	·20	19 & 28	11	0	5·5	6	7	1·8	1	2	1	2	4	8	7	3	2
October	5·07	2·02	9th	17	0	4·3	10	9	1·9	1	0	0	2	5	10	7	2	4
November	2·89	·75	14th	19	4	7·9	3	14	2·6	7	3	3	1	1	6	5	3	1
December	2·41	·44	12th	17	1	6·6	7	14	2·0	2	1	0	4	8	7	5	2	2
Year	25·00	2·02	Oct.	170	22	5·9	79	124	1·9	37	39	27	33	44	69	63	27	26

The year 1893 was remarkably warm, especially during the spring. The mean daily range of temperature was large; the absolute range also was great, the rather low minimum of 14°·7 occurring in January, and the high maximum of 91°·0 in August. The temperature was above the average in every one of the six months of spring and summer (March to August); as much as 4½° above it in the spring, and 2½° above it in the summer. The only months with a temperature appreciably below the average were January and November. The change from summer to autumn was marked, September being 9° colder than August. The mean pressure of the atmosphere was considerably above the average of that of the ten years 1877–86 at Watford. The lowest pressure recorded at 9 a.m. was 28·753 ins. on 21st February, and the highest was 30·750 ins. on 30th December, giving a range of 1·997 in.* The rainfall was much below the average of that of the ten years 1877–86, and considerably below a long-period average. The number of wet days also was small. March, April, June, and September were very dry months; October was very wet. The air was dry and the sky bright. The prevailing direction of the wind was south-west and west.

In the winter of 1892–93 (Dec. to Feb.) the mean pressure of the atmosphere was rather low, the mean temperature was rather low, with an average mean daily range, and the humidity, cloud, and rainfall were about the average, but rain fell on an unusually large number of days. There was a month of very cold weather (22nd Dec. to 13th Jan.), and on the other hand there were fifteen days in succession in February (8th to 22nd) without a single night on which the temperature of the air fell below freezing-point.

In the spring (March to May) the mean pressure of the atmosphere was very high, the mean temperature was excessively high, with a very great mean daily range, the air was very dry, the sky very bright, and the rainfall excessively small, on an unusually small number of days. This spring will for long be memorable for its warmth, brightness, and dryness, being probably the warmest, brightest, and driest since the year 1840, or for more than half a century. While, however, the days were abnormally warm, the nights were rather colder than usual. We had only, at 9 a.m., two-thirds the average amount of cloud. The rainfall was only about one-third the average for this part of Hertfordshire for the last half-century, and the number of rainy days was even smaller in proportion than the amount of rain.

In the summer (June to August) the mean pressure of the atmosphere was rather high, the mean temperature was a little above the average, with a large mean daily range, the air was very dry, the sky rather bright, and the rainfall very small, but on an average number of days. The nights were considerably colder than usual, the excess of temperature being entirely due to the warmth of the days.

* The pressure at 3 p.m. on 21st February was 28·689 ins., increasing the range for the year to 2·061 ins.

In the autumn (Sept. to Oct.) the mean pressure of the atmosphere was about the average, the temperature was just the average, with a considerable mean daily range, the air was rather dry, the sky rather bright, and the rainfall was about the average and on an average number of days. As in spring and summer, the nights were, on the whole, colder than usual.

The difference between these seasons and the means of the seasons for 1877–86 at Watford is shown in the following table:—

DIFFERENCE IN 1892–93 FROM MEANS OF 1877–86 AT WATFORD.

Seasons, 1891–92.	Pressure.	Temperature.		Humidity.	Cloud, 0–10.	Force of Wind.	Rainfall.	
		Mean.	Daily Range.				Total.	Days.
	ins.	°	°	%		0-12	ins.	
Winter	—·052	—1·6	=	=	—0·3	+0·1	—0·94	+10
Spring	+·198	+4·5	+5·5	— 4	—2·0	—0·4	—4·15	—26
Summer	+·050	+2·5	+2·3	— 8	—0·5	=	—2·13	=
Autumn	—·044	=	+0·7	— 1	—0·6	+0·3	+0·35	— 1

NOTES ON THE MONTHS.

JANUARY.—Cold, with a small daily range of temperature, an atmosphere of average humidity and rather high pressure, a rather cloudy sky, and about an average rainfall on an unusually large number of days. Coldest day 2nd, mean 23°·0; warmest day 31st, mean 46°·4. Min. below 32° on 16 days, below 22° on 5 (1st to 5th); max. above 42° on 11 days (below 32° on 4). The first five days were very cold, having a mean temperature of 24°·9 (9 a.m. 24°·9, min. 18°·0, max. 32°·0). Rain, or snow, fell every day from 11th to 19th (9 days), and from 25th to 3rd February (10 days), snow falling on 3rd, 5th, 6th, and 12th to 18th.

FEBRUARY.—Rather warm, with about an average daily range of temperature, an atmosphere of average humidity and very low pressure, a cloudy sky, and a very heavy rainfall on an unusually large number of days. Coldest day 6th, mean 31°·4; warmest day 19th, mean 49°·7. Min. below 32° on 8 days; max. above 42° on 20 days, above 52° on 2 (18th and 19th). Rain (occasionally snow) fell every day for the 11 days 8th to 18th, and, with the exception of 9th and 24th, every day from 8th February to 4th March, snow falling on 12th, 21st to 23rd, and 27th. There was a gale of wind on 10th, and on 21st barometric pressure was unusually low, being 28·753 ins. at 9 a.m., 28·702 ins. at noon, and 28·689 ins. at 3 p.m. At 9 a.m. on the following day it had only risen to 28·979 ins.

MARCH.—Warm, with a large daily range of temperature, a dry atmosphere of considerable pressure, a bright sky, and a very small rainfall on very few days. Coldest day 19th, mean 35°·2; warmest day 31st, mean 52°·7. Min. below 32° on 7 days; max. above 52° on 23 days, above 62° on 6 (24th to 26th, and 29th to 31st). There was one rather cold week, 17th to 23rd, with a mean temperature of 39°·7 (9 a.m. 37°·6, min. 30°·6, max. 51°·0). Rain fell only on the first four days, and (chiefly as snow, with some hail) on 16th and 17th. There was thus a period of eleven days without rain in the first half of the month, and of fourteen days in the second half.

April.—Exceptionally warm, with an excessively large daily range of temperature, an exceedingly dry atmosphere of very high pressure, a bright sky, and scarcely any rain. Coldest day 13th, mean 41°·6; warmest day 20th, mean 61°·4. Min. below 42° on 21 days, below 32° on 2 (13th and 14th); max. above 52° every day but 3 (11th to 13th), above 62° on 17 days, above 72° on 6 (19th to 21st, and 23rd to 25th). The warmest period was from 19th to 26th, the mean temperature during these eight days being 59°·0 (9 a.m. 57°·7, min. 45°·3, max. 74°·0), about an average summer temperature. Rain fell only on 16th and 29th (0·06 in.), an absolute drought of 29 days ending on the 15th.

May.—Very warm, with a large daily range of temperature, a dry atmosphere of high pressure, a bright sky, and a very small rainfall on very few days. Coldest day 31st, mean 48°·1; warmest day 15th, mean 66°·5. Min. below 42° on 6 days (above 52° on 20th); max. above 52° every day, above 62° on 26 days, above 72° on 5 (5th, and 12th to 15th). The warmest period was from 9th to 16th, the mean temperature during these eight days being 59°·2 (9 a.m. 59°·2, min. 45°·9, max. 72°·5), thus only a little warmer than the warmest eight days in April. Rain fell only on 1st, 15th to 20th, and 29th. A partial drought of 75 days, with an aggregate rainfall of only 0·45 in., ended on the 15th. During a thunderstorm on 17th nearly an inch fell (0·93 in.), being considerably more than half the rainfall of the month. The fall on 29th was also due to a thunderstorm.

June.—Warm, with a large daily range of temperature, a very dry atmosphere of rather high pressure, a sky of average brightness, and an exceedingly small rainfall on very few days. Coldest day 1st, mean 51°·2, warmest day 17th, mean 72°·5. Min. below 52° on 21 days, below 42° on 3 (1st to 3rd); max. above 62° every day but two (1st and 11th), above 72° on 10 days, above 82° on 5 (15th to 19th). The mean temperature of the six days 14th to 19th was 71°·8 (9 a.m. 71°·5, min. 56°·8, max. 87°·2), being at least 12° above the average for the time of the year. Rain fell only on 4th, 6th, 21st to 24th, 26th, and 27th. A partial drought of 32 days, with an aggregate rainfall of 0·27 in., ended on the 21st.

July.—Very warm, with an average daily range of temperature, a very dry atmosphere of average pressure, a bright sky, and a considerable rainfall on a large number of days. Coldest day 15th, mean 55°·3; warmest day 8th, mean 74°·3. Min. below 52° on 4 days; max. above 62° every day but one (13th), above 72° on 8 days (1st to 8th), above 82° on 4 (2nd, 6th, 7th, and 8th). The first eight days were the warmest, having a mean temperature of 67°·7 (9 a.m. 68°·2, min. 54°·5, max. 80°·4). Most of the rain fell between 8th and 26th, only three days out of these nineteen being without rain. On several days during this period there were thunderstorms (on 8th, 9th, 12th, and 26th).

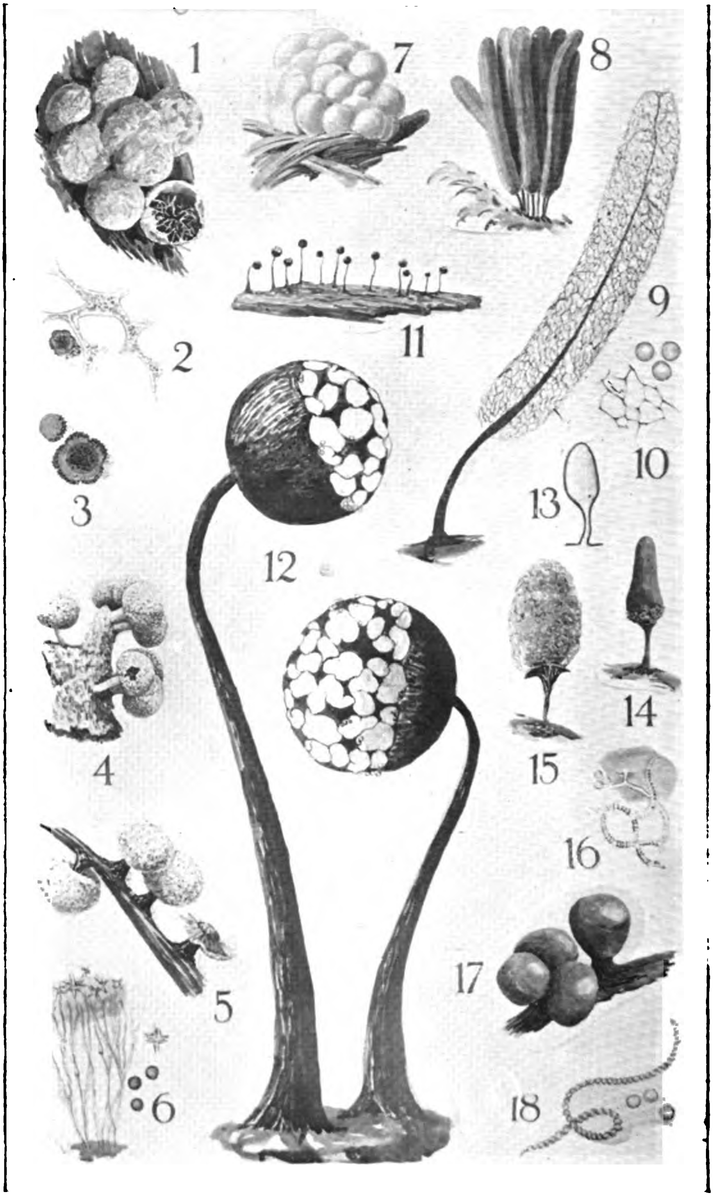
August.—Excessively warm, with a large daily range of temperature, a very dry atmosphere of rather high pressure, a rather bright sky, and a rather small rainfall on an average number of days. The eleven days 8th to 18th were the warmest, having a mean temperature of 72°·0 (9 a.m. 72°·8, min. 59°·8, max. 83°·4), being about 12° above the average for the time of the year. Coldest day 29th, mean 54°·9; warmest day 18th, mean 79°·6. Min. below 52° on 9 days; max. above 62° every day but one (27th), above 72° on 17 days, above 82° on 6 (9th, 10th, and 15th to 18th). No rain fell during the eight days 12th to 19th, and only 0·03 in. on one day during the 7 days 24th to 30th, but one inch fell on the 4 days 20th to 23rd, being nearly half the fall in the month. There were thunderstorms on 4th and 10th.

September.—Of average temperature, with a rather large daily range of temperature, a dry atmosphere of average pressure, a bright sky, and a very small rainfall on about the average number of days. Coldest day 21st, mean 45°·8; warmest day 7th, mean 65°·5. Min. below 42° on 6 days; max. above 62° on 20 days, above 72° on 4 (5th, 6th, 14th, and 15th). The first half of the month, during which only 0·20 in. of rain fell in two days, was exactly 5° warmer than the second half, which had 0·88 in. of rain on nine days, the mean temperature for the first 15 days being 58°·6 (9 a.m. 58°·3, min. 49°·0, max. 68°·6), and for the last 15 days being 53°·6 (9 a.m. 53°·2, min. 46°·1, max. 61°·5). Thus, while the weather from the first to the 15th was warm and dry, from the 16th to the 30th it was cold, with nearly an average rainfall. In fact our very warm, bright, and dry summer may be said to have come to a close in the middle of September. There was a thunderstorm on the 8th.

October.—Rather warm, with a considerable daily range of temperature, an atmosphere of average humidity and pressure, a very bright sky, and a very heavy rainfall, but on about the average number of days. Coldest day 31st, mean 36°·8; warmest day 15th, mean 60°·8. Min. below 42° on 10 days, below 32° on 1 (31st); max. above 52° on 27, above 62° on 5 (1st, 14th, 15th, 16th, and 21st). The temperature was very variable, and the weather became cold towards the end of the month, especially on the last two days (mean temp. 38°·9). Most of the rain fell during the first half of the month, the fall after the 14th being less than an inch, and the excess in the rainfall was almost entirely due to the fall of 2·02 ins. on the 9th. There was a violent thunderstorm on the 7th, at its height here between 6·35 and 6·48 p.m., during which time the rain came down in torrents, nearly half an inch falling in the thirteen minutes; the lightning appeared like balls of fire falling every minute or two, and for part of the time the thunder was heard whilst the lightning was still visible. The prevailing colour of the lightning-balls was blue, sometimes with a rather reddish tinge. A gale of wind blew, and uprooted several trees in the neighbourhood.

NOVEMBER. — Rather cold, with an average daily range of temperature, a rather humid atmosphere of considerable pressure, a cloudy sky, and an average rainfall on about the usual number of days. Coldest day 23rd, mean 32°·3; warmest day 4th, mean 59°·9. Min. below 42° on 26 days, below 32° on 13; max. above 52° on 5 (3rd, 4th, 16th, 17th, and 28th). The temperature was very variable. Rain or snow fell every day from 13th to 19th, the total for these seven days being over an inch and a half, or more than half the total for the month. Snow fell on 1st, 18th, 19th, and 30th. Barometric pressure was very low on 17th (3 p.m. 29·022 ins.), on the same day there was a gale, on 18th a very heavy snowstorm, on 19th a severe gale with snow, and snow also fell on 30th.

DECEMBER.—Warm, with a considerable daily range of temperature, an atmosphere of average humidity and pressure, a rather bright sky, and about an average rainfall on the usual number of days. Coldest day 2nd, mean 27°·2; warmest day 13th, mean 48°·3. Min. below 32 on 10 days, below 22° on 3 (2nd, 3rd, and 31st); max. above 42° on 23 days, above 52° on 1 day (13th). The first three and the last two days only were cold. Rain fell every day from 6th to 13th, the total for these eight days being 1·40 in., and every day but one from 19th to 25th, the total for these seven days being 0·89 in., thus leaving only 0·10 in. for the rest of the month. Snow fell on 1st, and there was a gale of wind on 20th, on which day barometric pressure was very low, being 28·985 ins. at 9 a.m. On 30th, when a very cold period commenced, it was the highest in the year, 30·750 ins.



MYCETOZOA

X.

FURTHER NOTES ON THE MYCETOZOA, WITH A LIST OF SPECIES FROM HERTS, BEDS, AND BUCKS.

By James Saunders.

A Lecture delivered at Watford, 19th December, 1893.

PLATES IV and V.

There is not a woodland, bosky dell, or more extended forest but teems with life. From the leafy canopy overhead, with its winged denizens, away down the rough stems of oak and ash, with their lichens and liverworts, to the spreading moss-covered roots, exists a multitude of living beings; and this not only in one spot, for such scenes might be multiplied indefinitely.

In any part of the world—from Canada to Ceylon, from England to New Zealand—would be found in such circumstances innumerable forms of life. These all agree in certain fundamental points. They start from a living cell, they are built up of cells, and every cell, when in activity, contains protoplasm. Do not these facts suggest that they form part of one organic whole?—that consequently there is no sharp line of demarcation between the animal and vegetable world?—that there are points at which these two kingdoms coalesce, and that all creatures have descended from a few primordial types, or possibly from but one?

On the border-land between the two realms of the natural world may be placed the creatures now under consideration. In what may be taken as the initial stage of their life, they exist as minute spores, many of which float in the air, and are distributed by the wind. When these fall on favourable situations, such as rotten wood or decayed leaves, the covering of the spore becomes moistened, and the protoplasm within bursts its way through. These amœbiform bodies are usually elongated or pear-shaped, with a minute cilium at the narrow end, and are known as "swarm cells." They have the power of locomotion, and, like the Amœbæ, frequently assume various shapes, their changes and movements being presumably effected in the search for food. They have been seen by careful observers, notably by Mr. A. Lister, to feed on Bacteria, which they surround by a digestive vacuole, these microbes being gradually absorbed until no trace of them can be seen. It is probable that the office of the Mycetozoa in the economy of nature is similar to that of the white blood-corpuscles of the human body, in that they destroy germs of disease.

After a brief period of independent existence they lose their cilia and unite to form what is known as plasmodium, which has the power of creeping, when favourably circumstanced, and exercises this power to obtain sustenance. During this stage there is considerable increase in size; the plasmodium grows upon what it absorbs, be this decayed vegetation or minute forms of life. During the mobile stage of existence, different genera and species exhibit diverse habits. Some pass their time in the interior of rotten wood, and apparently do not come to the surface until ready for the fruiting stage. Others, on the contrary, affect the exterior of decayed branches and logs, and are hence the most easily found.

The following observations, made in the South Midlands, will give some idea of the phenomena attending the plasmodium stage.

On one occasion, the writer was examining a decayed tree-root quite a foot in diameter, in a wood near Harpenden. In the very centre the woody fibres were saturated with plasmodium, which, when matured, proved to be that of *Hemiarcyria clavata*. Some of the Badhamias prefer the outside of rotten logs and branches. In a wood in Flamstead parish the plasmodium of *Badhamia utricularis* has been seen spread out on the upper side of a fallen tree, but this was in a very wet autumn. Quite recently, in the same place, this species was found creeping between the bark and the wood, but the season was much drier. During the year 1893 Mr. C. Crouch, of Kitchen End, near Luton, had two masses of plasmodium of *B. utricularis*, which were attached to an old log under some shrubs in his garden. These were under observation during the spring, summer, and early autumn. They repeatedly moved their position, and eventually, after seven or eight months existence in this condition, formed their sporangia.

Badhamia nitens is usually found, in the rare localities in which it occurs, on the under side of decayed branches, especially those of oak. It has the curious habit of concealing itself from view a day or two before its final emergence for fruiting, at least it has done so when it has been under our observation, and it repeated the habit when some of it was sent to Mr. A. Lister. The following extracts from his letters will illustrate this statement. "The plasmodium has, I fear, died."—12th Feb. 1893. "The plasmodium died and came to nothing."—15th Feb. 1893. "I am delighted to say that I was quite wrong in thinking that the last batch of plasmodium which you sent was dead; it had crept off and hidden itself for a day or two, leaving a good deal of refuse matter behind it. Yesterday we saw that it was turning into fruit, so exactly the usual shape of *B. utricularis* that we feared it was nothing but that species, but this morning the mature condition and yellow colour have been obtained, and it forms the most magnificent example of *B. nitens* which we have ever seen."—19th Feb. 1893. Subsequently to this some plasmodium of the same species was sent to Mr. H. Groves, of London, who, under date 11th Jan. 1894, writes: "Thank you very much for the plasmodium which you so kindly sent to me. It showed [circulation] beautifully with half-inch object-glass and dark-ground illumination, and it is really a most curious thing. I have put it in a fern-case, but I do not know where to look for it again." My impression is that as it is a winter-fruiting species, it had crept out of sight preparatory to assuming that stage. The two local stations for this species are Caddington, Beds, and Zouches Farm, near Kensworth, Herts, in both of which places the creeping stage has been observed on several occasions. These are the first British localities for which the plasmodium of this species has been recorded.

Some plasmodium of *B. nitens* was collected in a wood on Zouches Farm at Christmas, 1892. It was attached to a fungus (*Irpex*) that was on a decayed branch of oak. The whole thing—wood, fungus, and mycetozoon—was frozen hard when obtained. It rapidly thawed after reaching home, and exhibited movements for several days. A portion of it was given to a gentleman at Luton who took a casual interest in the subject. A short time afterwards he allowed the plasmodium to dry up into the condition of sclerotium. In this state it existed, looking like a piece of sealing-wax, until the early spring of 1894. It was then placed one evening in tepid water, which was kept warm, and during the succeeding night it exhibited unusual activity. It continued in a more or less mobile state for several weeks, when it matured and formed its fruit.

Whilst the foregoing species are usually found on decayed wood, as oak and fir, others most frequently occur on dead leaves. *Craterium vulgare* affects such situations, and may be seen throwing out its fan-shaped processes formed of a dense network of veins, but creeping from leaf to leaf, or insinuating itself between the compacted layers of dead damp foliage. Its dull greenish-yellow hue renders it inconspicuous and somewhat difficult to detect. Nor is it so satisfactory for microscopic work as are the Badhamias, for its circulation is obscured by its partial opacity. It would seem that it ingests particles of the dead leaves amongst which it lives, as under a two-inch object-glass it appears to be crowded with particles of them. Under cultivation we find that it loses some of its green colour and becomes yellower, more like a *Badhamia*. This is confirmed by Mr. C. Crouch, who states that he has "developed *Craterium vulgare* from very ochreaceous plasmodium, so that there seems to be no limit to variation of plasmodium-colour in the species."

In *Stemonitis fusca*, which is a wood-haunting species, we have never succeeded in finding the plasmodium except just prior to fruiting. It then appears as a white frothy substance, which rapidly assumes a densely-packed, columnar structure. When mature it appears like a miniature forest of pines, with dark stems and intricate branching. *Stemonitis ferruginea* is of similar habit, and is distinguished by lemon-yellow plasmodium.

The genus *Reticularia* is also a wood-haunting group, and so far as our experience goes is invisible till maturity is approaching. The largest specimen that has come under our notice was one of *R. lycoperdon*, which was attached to a decayed root on the north-east side of Lilley Hoo. It measured more than four inches long and three wide. It was intended to secure it for the Museum of this Society, but it proved to be infested with beetles, which ruined it as a specimen.

Another species of similar habit is *Lycogala epidendrum*. Its plasmodium is sometimes found to have stained crimson the wood on which it grows. Quite recently Mr. C. Crouch observed in Silsoe Park, Beds, a mass of it, several inches square, which was visible more than fifty yards away. The sporangia are compacted into masses which vary in size from that of a pea to that of a hazel-nut, and they may often be seen in groups on fallen logs in early spring. The species is not uncommon in such places as Sherrards Wood, near Welwyn, and in the valley of the Ver, near Redbourn.

A rare species, which has a deep crimson plasmodium, is *Clathroptychium rugulosum*. This is less reserved in its habits than is *Lycogala epidendrum*, and it creeps about on the surface of decayed willow logs which are shaded by vegetation.

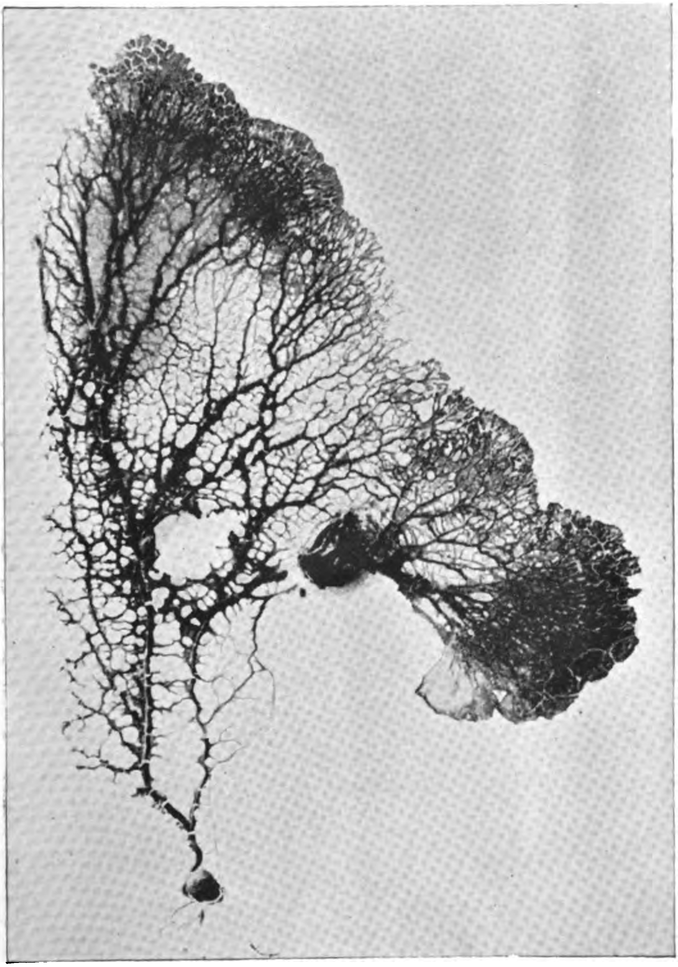
Brefeldia maxima should be sought for in moist hollows near streams and springs where decayed logs are to be found. The plasmodium is opaque white, and about the thickness of cream. It creeps about in the decayed vegetation near a rotten log for some time, and then spreads itself over the wood in a beautiful creamy-looking mass. When matured the aggregated sporangia (æthalium) become of a purplish black colour.

Cribraria argillacea has plasmodium of a dull leaden hue when rising to maturity, and is usually found on decayed conifers.

Didymium squamulosum is a very abundant species, growing in such places as damp ditches where leaves have accumulated, and in boggy spots under the shade of trees. Its plasmodium is of a dirty white colour, and in creeping over dead foliage it leaves a number of vein-like tracks behind. One is enabled sometimes to assume its proximity from the traces it has left. It is plentiful in the valley of the Ver, near Redbourn. *Didymium farinaceum* occurs amongst dead leaves and twigs which have accumulated in moist situations. The plasmodium is grey, its dusky hue being probably partly due to the ingested particles of decayed foliage on which it feeds. At least we find that some species with a similar habit, such as *Craterium vulgare*, have this peculiarity, and also have the power of cleansing themselves from the refuse material, becoming lighter and clearer in colour just prior to the fruiting stage.

Most of the Physareæ have a greyish-white or dirty grey plasmodium. That of *Physarum leucophæum* is with difficulty distinguished when attached to the bark of oak. That of *P. leucopus* is dirty grey in a natural state, but under cultivation it becomes lighter, and sometimes shows a beautiful network of veins, appearing almost white when on a dark background. The plasmodia of *Physarum*, *Craterium*, and *Badhamia* agree in the habit of progressing by throwing out fan-shaped processes or veins, often of the most intricate patterns. (See Plate V.) If they do not find food, or if their surroundings are not favourable to further progress, they have the power of retracting and condensing themselves into a small compass, thus assuming a resting stage until the recurrence of congenial conditions.

Physarum citrinum, a handsome species very rarely found in Britain, has recently been detected in considerable quantity in a



Plasmodium of Badhamia utricularis.

shady dell near Welwyn. There were three patches of it on a decayed root and the adjoining soil. One portion had mature sporangia, the second was forming them, and the third consisted of yellow plasmodium, still in its creeping stage, but which attained maturity in a day or two. The gathering exhibited many forms of sporangia, ranging from those with a fully-developed stalk to others which consisted of a sessile plasmodiocarp.

One of the handsomest and also one of the most frequent of the Mycetozoa is *Arcyria punicea*. The plasmodium stage is passed in rotten wood, and so far as our experience extends it is only observable when rising to form sporangia. When immature these are milky white, and in ripening they become a rich crimson. In the progressive stages the upper part of the sporangium wall is thrown off, the capillitium extends to several times its former size, and the spores disperse. Eventually all the contents of the peridia may be blown away, leaving the cup-shaped base of its wall supported by its short stalk.

The Trichias usually conceal themselves till near the fruiting time, and are therefore but rarely seen in the creeping stage. The only occasion on which we have observed the plasmodium of this genus was once in Luton Hoo Park. A number of white veins were noticed creeping among the interstices of some bark, over a surface of several square inches, but even in this instance it was near maturity, as some portion of the mass was already forming its sporangia. The white veins and immature peridia showing so well on the dark background of bark, a photograph of the group was taken. The species proved to be *Trichia varia*, which agrees with most of this genus in that it has white plasmodium, a notable exception being *T. fallax*, in which it may be either white or red. *Trichia Jackii* when fruiting generally leaves a quantity of slimy refuse, which the beginner might easily mistake for plasmodium. The sporangia appear as a mass of closely-compacted small white beads, which, on maturing, assume a rusty brown colour. Another species with a gregarious habit is *Trichia scabra*, which can readily be distinguished from the preceding by the slight metallic lustre of the walls of the sporangia. *Trichia affinis* is somewhat uncommon, and may be recognized in the field by its bright yellow hue.

Before leaving this interesting group, it will be well to observe that in maturing the sporangia great care should be taken not to dry them too quickly, as interesting gatherings may be spoilt in this way.

The incident that has had the most interest for those to whom it befel—my son and myself—was the discovery of *Cribraria violacea*. We had one day travelled a long distance over parts of Beds and Herts, and then traversed an extensive wood on Ivinghoe Hills, near the borders of Bucks. When nearing the edge of the wood, which had proved almost barren for our special objects of search, we noticed some very old logs of beech which looked promising. We separated, each intent on the portion under examination. Presently my juvenile companion called my attention to a group of immature sporangia which he did not understand. Examination with a lens showed that we had undoubtedly before us the sporangia of a Mycetozoon, appearing as minute white heads on black stalks. A good supply was secured, and allowed to mature under the best possible conditions. As no species with similar sporangia appeared to be described in our text-book, specimens were forwarded to Mr. A. Lister for identification. His reply was to the effect that it was a species that had been found before only in the United States, in the primeval forests of several mountain-ranges, and was therefore a new European record. A few weeks afterwards we revisited the spot, and again found the sporangia in fair quantity in a fully-matured condition. It was certainly an interesting discovery, forming as it does another connecting-link between the life-forms of the two hemispheres. There can be no suspicion either that it had been imported by human agency, for it is one of those obscure forms that can only be detected by persistent search.

Anyone who might take up this subject for investigation would find himself traversing a comparatively unexplored territory, where there is abundant room for original research. It would lead him into the very arcana of nature's mysteries, and at times it would seem as though the secret of organic life was to be unfolded to him. Yet, like a "Will o' the Wisp," it evades his grasp, and he finds himself still on the threshold of, and not within, the great "Temple of Truth." Baffled truly, but not discouraged!

[At the close of the lecture several lantern-slides were shown, illustrating the structure of the organisms under consideration. One of these was a preparation of the living plasmodium, or creeping stage. It was mounted in a moistened glass cell of the usual size for exhibition by a lantern, and it had been kept on the person of the lecturer, in the hope that the warmth of the body would cause the contents to develop movements, which fortunately was the case. When placed in the lantern, and its shadow projected upon the screen, it was seen to have thrown out a fan-shaped, intricate network of veins, showing also the rich yellow colour of the genus (*Badhamia*) to which it belongs. Whilst a brief description of it was being given, the audience and the lecturer alike were surprised to observe that the creature was receding towards the piece of decayed wood from which it had crept. "It moves," was the comment of the lecturer; "evidently the intense light and heat are too much for it." And to the gratified surprise of all present, the organism gradually receded towards the fragment of wood in which it had been found. The object was then put on one side until the other slides had been duly examined. After an interval of about ten minutes it was replaced in the lantern, when no trace of the plasmodium could be discerned, it having collected itself into a compact mass under the shade of the piece of wood. Subsequent observation showed that it took three or four days of careful treatment to enable it to partially recover from the shock it had received, but it never regained its full vigour, and gradually dwindled away.]

Mycetozoa of Herts, Beds, and Bucks.

The species included in the following lists have all been found by myself or my son Edgar, except those marked *C. C.*, which were collected by Mr. C. Crouch. An asterisk is prefixed to the species now first recorded for Hertfordshire and Bedfordshire.* All the species from Buckinghamshire were collected in Ivinghoe Woods, and all are new county records. They include one species new to Europe—*Cribraria violacea*—which is figured on Plate IV.

Hertfordshire.

**Physarum sinuosum* (Bull) Rost. Colne.—Caddington.
**P. citrinum*, Schum. Lea.—Welwyn.
P. compressum, A. & S. Lea.—Knebworth; *C. C.*
Craterium vulgare, Ditm. Colne.—Redbourn.
Leocarpus fragilis (Dicks.) Rost. Lea.—Sherrards Wood, Welwyn.
**Fuligo septica* (Link) Gmel. Colne.—Kensworth. Lea.—Sherrards Wood, Welwyn.
Badhamia panicea (Fr.) Rost. Colne.—Kensworth.
Didymium squamulosum (A. & S.) Fr. Colne.—Redbourn.
**D. clavus* (A. & S.) Rost. Lea.—Welwyn.
Chondrioderma difforme (Pers.) Rost. Colne.—Zouches Farm, near Kensworth. Gibraltar, near Redbourn.
Comatricha Friesiana (De Bary) Rost. Colne.—Pepperstock.
**C. pulchella* (Bab.) Rost. Colne.—Ashridge.
**Spumaria alba* (Bull) DC. Lea.—Near the Fulling Mills, Welwyn (on nettles).
Stemonitis fusca, Roth., *forma *rufescens*. Colne.—Redbourn.
Enerthenema papillatum (Pers.) Rost. Colne.—Caddington.
**Reticularia lycoperdon*, Bull. Ouse.—Lilley Hoo.
Trichia fragilis (Sow.) Rost. Colne.—Bricket Wood.
T. varia, Pers. Lea.—Sherrards Wood, Welwyn.
T. contorta (Ditm.) Rost, var. *inconspicua*. Colne.—Ashridge.
T. affinis, De Bary. Lea.—Wheathampstead. Sherrards Wood.
T. Jackii, Rost. Colne.—Flamstead.
Hemiarcyria clavata (Pers.) Rost. Lea.—Sherrards Wood.
Arcyria cinerea (Bull) Schum. Colne.—Caddington. Lea.—Sherrards Wood, Welwyn.
A. incarnata, Pers. Lea.—Sherrards Wood. Ashridge.
**Lycogala epidendrum* (Buxb.) Fr. Lea.—Sherrards Wood.

Bedfordshire.

**Physarum cinereum* (Batsch) Pers.—Kitchen End; *C. C.* Flitwick.
P. viride, Pers. (=*Tilmadoche mutabilis*, Rost).—Mead Hook; *C. C.* Limbury. Luton Hoo.
**P. contextum*, Pers.—Flitwick; *C. C.*
**P. sinuosum* (Bull) Rost.—Flitwick. Caddington.
**P. citrinum*, Schum.—Caddington.

* For previous lists for these counties see 'Trans. Herts Nat. Hist. Soc.,' Vol. VII, pp. 144–146.

Physarum compressum, A. & S.—Kitchen End; *C. C.*
**Craterium aureum* (Schum.) Rost.—Flitwick.
**Badhamia macrocarpa* (Ces.) Rost.—Kitchen End; *C. C.*
**Chondrioderma reticulatum*, Rost.—Flitwick. (From milky-white plasmodium.)
C. radiatum (Linn.) Rost.—Clophill; *C. C.* Flitwick. (From milky-white plasmodium.)
Didymium microcarpum (Fr.) Rost. Kitchen End; *C. C.* (Sept. 1892). Luton Hoo. Forma *pertusum*.—Mead Hook Wood; *C. C.*
**D. serpula*, Fr.—Flitwick; *C. C.*
**D. clavus* (A. & S.) Rost.—Flitwick; *C. C.*
D. farinaceum, Schrad.—Kitchen End; *C. C.* *Var. *minus*.—Luton Hoo.
**Diachæa leucopoda* (Bull) Rost.—Flitwick.
Enerthenema papillatum (Pers.) Rost.—Silsoe; *C. C.* (Sept. 1892).
**Stemonitis microspora*, Lister (= *S. Smithii*, Macbride).—Luton Hoo.
**Comatricha pulchella* (Bull) Rost.—Flitwick.
**C. rubens*, Lister.—Flitwick.
**Lamproderma physaroides* (A. & S.) Rost.—Flitwick.
**L. violaceum* (Fr.) Rost.—Luton Hoo.
Trichia scabra, Rost.—Streatley. Luton Hoo.
Prototrichia flagellifer (B. & Br.) Rost.—Flitwick; *C. C.*
Perichæna depressa, Lib.—Upbury; *C. C.*
**P. corticalis* (Batsch) Rost.—Luton Hoo; *C. C.*

Buckinghamshire.

(Ivinghoe Woods.)

Physarum leucophæum, Fr.
P. leucopus (Link) Rost. (From white plasmodium.)
Craterium vulgare, Ditm.
C. leucocephalum (Pers.) Rost.
Fuligo septica (Link) Gmel.
Badhamia panicea (Fr.) Rost.
B. utricularis (Bull) Berk.
B. hyalina (Pers.) Berk.
Didymium squamulosum (A. and S.) Fr.
Spumaria alba (Bull) DC.
Stemonitis fusca, Roth.
S. microspora, Lister (= *S. Smithii*, Macbride).
S. ferruginea, Ehrh.
Comatricha Friesiana, De Bary.
C. typhina (Roth) Rost.
Tubulina cylindrica (Bull) DC.
Clathroptychium rugulosum (Wallr.) Rost.
Dictydium cernuum (Pers.) Nees.
Cribraria violacea, Rex.
C. argillacea, Pers.

Reticularia lycoperdon, Bull.
Trichia fallax, Pers.
T. varia, Pers.
T. scabra, Rost.
T. affinis, De Bary.
T. Jackii, Rost.
Hemiarcyria clavata (Pers.) Rost.
H. rubiformis (Pers.) Rost.
Arcyria punicea, Pers.
A. cinerea (Bull) Schum.
A. incarnata, Pers.
A. nutans (Bull) Grev.
Lycogala epidendrum, Buxb.

EXPLANATION OF THE PLATES.

PLATE IV.

(Photographed from drawings in colour by Miss Lister.)

FIG.
1. *Badhamia nitens*. Group of sporangia; one showing capillitium. × 9.
2. ,, ,, Cluster of five spores and portion of capillitium. × 150.
3. ,, ,, Cluster of five spores and one spore separated. × 300.
4. *Physarum citrinum*. Group of sporangia. × 9.
5. *Didymium farinaceum*. Group of sporangia. × 10.
6. ,, ,, Capillitium, crystals, and spores. × 140.
7. *Stemonitis ferruginea*. Group of immature sporangia. × 5.
8. ,, ,, Group of mature sporangia. × 5.
9. ,, ,, Columella and capillitium after dispersion of spores. × 12.
10. ,, ,, Capillitium and spores. × 300.
11. *Cribraria violacea*. Group of sporangia. × 6.
12. ,, ,, Sporangia. × 80.
13. *Arcyria punicea*. Immature sporangium. × 7.
14. ,, ,, Sporangium more advanced. × 7.
15. ,, ,, Mature sporangium; outer wall fallen off. × 7.
16. ,, ,, Capillitium and spores. × 140.
17. *Trichia varia*. Group of sporangia. × 8.
18. ,, ,, Capillitium and spores. × 140.

PLATE V.

Plasmodium of *Badhamia utricularis*. × 2. (Photographed from nature.) The whole of the network of veins here shown was formed in one night between 11 p.m. and 7 a.m. It was developed from a small mass of plasmodium about half an inch in diameter which occupied a position a little to the right of the bulb at the base of the illustration. The material was placed in a moistened cell, when, in its search for food, it rapidly developed pseudopodia connected by anastomosing veins. It formed two centres of development of the branch systems, which united at the points of contact, as seen in the illustration. The transverse cracks in the principal veins are due to shrinkage from the effects of alcohol, with which the organism was killed.

XI.

NOTES ON LEPIDOPTERA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1893.

By A. E. Gibbs, F.L.S., F.E.S.

Read at Watford, 17th April, 1894.

The unusual meteorological conditions prevailing during 1893 had, as might have been expected, considerable influence on insect life, the dry warm spring causing many species to emerge a full month before their usual time.

I did not find that the sallows in March and April were very prolific, repeated visits to Bricket Wood for sallow-beating yielding only the common Tæniocampæ and a few hybernated moths. A female twin-spot quaker (*Tæniocampa munda*), however, taken at sallow, gave me some eggs from which I reared a good series of that moth. Sugaring during the summer was a failure, a fact which is emphasized by several of my correspondents. I spread the tempting bait in more than one locality near St. Albans, but it did not attract any of the rarer Lepidoptera. Mr. C. F. Pilbrow, of Colney Heath, writes: "I scarcely missed sugaring for a single evening, though the area was generally very limited—about half-a-dozen apple trees and plum trees of good size in my garden. The results were unusually unsatisfactory." Mr. R. W. Bowyer, of Haileybury, says: "Sugaring and light were almost failures in the summer. In the autumn I did better. I took at sugar five *Noctua rhomboidea*, an insect which I consider rare in this neighbourhood." These opinions as to the failure of sugar in the spring and summer are confirmed by the statements in the entomological magazines of observers in various parts of the country. Mr. R. Dymond, of Ferney House, East Barnet, however, appears to have been more fortunate. He says: "So far as I am concerned the season has been very good, for at sugar in the garden here insects have been very plentiful." Mr. Bowyer's experience as to the failure of light as an attraction for insects is not shared by Mr. Pilbrow, for with regard to the Colney Heath district he writes: "Light, speaking generally, proved the most productive source of attraction this year." The same gentleman reports that "old sacks, boxes, etc., placed about the garden proved fertile traps, several good things being taken by these means." Larvæ-beating had unusually prolific results, at least in the number, if not in the rarity, of the insects taken, while for pupæ-digging the season is generally pronounced to have been a most unproductive one.

The great abundance of larvæ in the early months of 1893 is a matter of common repute. Those of us who took part in the field meeting at Symond's Hyde, in May, will remember the enormous quantity of caterpillars, mostly "loopers," which were feeding on the hazel and hornbeam. I could have collected thousands of the commoner sorts in a few hours. I think I never saw the oaks at

Bricket Wood present such an appearance of devastation as they did in June, the larvæ of that destructive little green moth, *Tortrix viridana*, literally eating up every green leaf on some of the trees. A shake brought down quite a shower of both larvæ and pupæ of this species. Mr. Arthur Lewis and I took a considerable number of larvæ of the feathered thorn moth (*Himera pennaria*), and also of the curious-looking larvæ of the purple hairstreak (*Thecla quercus*). In June Mr. W. H. Shaw, who was then living in Clifton Street, St. Albans, brought me a number of small larvæ, which turned out to be those of *Cerostoma xylostella*, one of the Tineæ. It was a pale yellowish-green creature, with a broad brownish-red stripe all along the back; it fed on honeysuckle, and proved a great pest. It crept into the house to pupate, seeking such convenient places as the hollows in the mouldings of the doors and window-frames wherein to spin its boat-shaped cocoon. The moth is a pretty one. On May 15th I found the larva of the large emerald moth feeding on birch at Bricket Wood. Unfortunately the moth emerged a hopeless cripple. Mr. Arthur Lewis obtained the larvæ of *Pterostoma palpina* on a sallow in his garden. A curious instance of the power which certain species have to change their colour in order to adapt themselves to their surroundings, came under my notice. A number of larvæ of the peppered moth (*Amphidasys betularia*) were reared from the egg, separated into two lots, and placed in large-mouthed glass bottles. One lot was fed on birch, which has a brown shining stem, and the other on the false acacia (*Robinia pseudo-acacia*), which has green petioles. Those which fed on birch became of a dark shining brown colour, while the others were a bright green, the larvæ assuming in each case the tint of the stem or leaf-stalk of the plant on which they were feeding.

I am pleased to be able to report that I have received communications from several fresh correspondents this year. Lists of captures in their several localities have been sent by Colonel Gillum, East Barnet; Mr. S. H. Spencer, jun., Gladstone Road, Watford; and Mr. Noel Heaton, Sans Souci, Watford.

Mr. S. H. Spencer's list of captures includes *Notodonta dictæa* (larva), *Asteroscopus sphinx*, *Dasychira pudibunda*, *Selenia illustraria* (*tetralunaria*), *Pseudoterpna pruinata*, *Phorodesma pustulata*, *Ligdia adustata*, *Cheimatobia boreata*, *Emmelesia affinitata*, *Eupethecia minutata*, *Phibalapteryx tersata*, *P. vitalbata*, *Scotosia rhamnata*, *Cidaria silaceata*, *Acronycta rumicis*, *Calamia lutosa*, *Cerigo matura*, *Luperina cespitis*, *Apamea ophiogramma*, *Agrotis puta*, *Dianthœcia carpophaga*, *Hadena dissimilis*, *H. genistæ*, and *Habrostola triplasia*. *Nyssia hispidaria* he took several specimens of, on oak trees in Cassiobury Park, but unfortunately it was not found again this year, at least Mr. Cutts and I searched for it in vain, and Mr. Spencer tells me that he was equally unsuccessful. Several rare moths were taken by Mr. Spencer at the electric light at Messrs. André and Sleigh's Works at Bushey, and also on the street lamps. He has reared *Lophopteryx camelina* from ova from Bricket Wood, *Dicranura bifida* from ova found on aspen, *Leucoma salicis* from larvæ from poplars, and of *Acronycta leporina* he found twelve larvæ on birch. Altogether Mr. Spencer has been very successful, and his list includes five species which so far as our record goes are new to the county. They are, *Agrotis puta*, *Hadena dissimilis*, *Selenia illustraria* (*tetralunaria*), *Cheimatobia boreata*, and *Euphithecia minutata*. Mr. Spencer is to be congratulated on this result of his labours.

In Mr. Heaton's list, which includes many species taken by Mr. Wiggs, I find *Dicranura furcula*, *D. bifida*, *Notodonta ziczac*, *Peclura monacha*, *Demas coryli*, *Acronycta aceris*, *A. megacephala*, *Apamea ophiogramma*, *Agrotis saucia*, *Panolis piniperda*, *Nyssia hispidaria*, and *Geometra papilionaria*. His list contains 252 species.

Last year I briefly reported the capture of the beautiful footman moth (*Deiopeia pulchella*) at East Barnet. Being a rare insect and a species new to Hertfordshire, I took an opportunity of going to East Barnet to see it. The moth is in the small collection belonging to the Boys' Farm Home, and it was very courteously shown to me by Mr. John Bowden, the master. It is undoubtedly a specimen of *Deiopeia pulchella*, but is unfortunately rather badly set. Mr. Rühl, the schoolmaster, captured it, in 1892, on the railway-bank near Oakleigh Park Station, and just within the county boundary. Although a search has been made, no other specimens have been seen. My visit to East Barnet enabled me to inspect two small but interesting collections, one at the Home above referred to, and the other in the possession of Colonel Gillum, of Church Hill House. Through the kindness of Colonel Gillum I have been able to make a list of his insects, captured at East Barnet, and shall enter them in our Record Book. They include specimens of *Lycæna argiolus*, *Bombyx castrensis*, *Ellopia prosapiaria* (*fasciaria*) taken by Colonel Gillum in one of the hedges on Church Farm, *Chærocampa porcellus*, *Spilosoma fuliginosa*, *Arctia villica*, *Chesias spartiata*, and other rare insects. The collection at the Boys' Farm Home also contains some uncommon species, such as *Psilura monacha*, bred from larvæ taken locally, *Sphinx convolvuli*, and *Notodonta dictæoides*. Many of the insects were captured by the boys, who are wisely encouraged to spend their leisure in pursuits of this kind.

BUTTERFLIES.

The species of butterflies generally reputed to be natives of Britain number 65, of which no less than 46 have been recorded by different observers as occurring in Hertfordshire. The remaining 19 are extinct, rare, or local species, the majority of which, it may safely be predicted, will never be seen flying within our borders, though there are one or two species which we may hope will some day be entered in our County list. Twenty-six species have been taken by Colonel Gillum, at East Barnet; by Mr. S. H. Spencer, jun., at Watford; by Mr. N. Heaton in the same neighbourhood; and by your Recorder; but though the number happens to be the same in each case, the lists of species are not exactly identical.

The early summer months of last year were marked by an abundance of butterfly life. Mr. J. J. Willis, of Harpenden, writes: "The large white cabbage-butterfly (*Pieris brassicæ*) and the small white cabbage-butterfly (*Pieris rapæ*) were exceedingly numerous throughout the season, although in this neighbourhood the damage done by their caterpillars appeared to be much less than usual. This was also the fact with regard to the magpie-moth (*Abraxas grossulariata*), which, although most abundant, produced fewer larvæ than in some former years. Was this due to their destruction by birds?" On the other hand, Mr. Pilbrow, of Colney Heath, points out that with regard to the Vanessidæ, a diametrically opposite state of things occurred. "Almost every bunch of nettles," he says, "contained larvæ of *Vanessa io*, *V. atalanta*, or *V. urticæ*, yet only the second of the trio was at all common in the perfect state."

Among the butterflies there are some very early appearances to record. The pretty little grizzled skipper (*Syrichthus malvæ*) was taken by me on the Harpenden Road, St. Albans, near the Rifle Butts, on April 9th, or about a month before it usually appears. It is a very bold and familiar insect. It likes to bask on the sunny road, and when disturbed returns to the same spot time after time, like some of the Vanessidæ. Having no net with me I tried to capture this one with my hat, which I succeeded in placing over it four or five times before I could fairly bag my game. Another rather early record is Mr. Dymond's note of the capture of the pearl-bordered fritillary (*Argynnis euphrosyne*) on April 26th.

It will be remembered that one of the great entomological features of the year 1892 was the remarkable abundance of the beautiful clouded-yellow butterfly (*Colias edusa*). I referred to this at some length in my last annual report. I have only one record of its re-appearance in Hertfordshire in 1893, and that is by Mr. J. J. Willis, who says that a few specimens were seen at Harpenden. Mr. N. Heaton, of Sans Souci, Watford, records the capture of one specimen of this insect on August 29th, 1889. Mr. Heaton says: "I should be glad of an explanation of the statement, found in all the text-books I have seen, that *C. edusa* haunts clover-fields. I was at Deal in 1892, when this species was abundant, and never caught a single specimen in a clover-field, but found them in plenty around such plants as dandelion, ragwort, or whatever yellow flowers were then out; situations where I should have expected to find it had it not been for the statement in the text-books. *C. hyale* I noticed was partial to corn-fields." That *C. edusa* does haunt clover-fields is a fact to which most entomologists can testify, but I have noticed that it is very partial to railway-banks and waste ground. It must not be forgotten that the larva is a clover-feeder.

The orange-tip butterfly appeared to be more plentiful than usual, a fact which was also noticed by Mr. Willis. Messrs. Latchmore and Gatward, of Hitchin, who have sent me a joint report, speak of it as coming out unusually early and flying in clouds. Mr. Heaton tells me that the specimens he took last year were all of a small size, one of them only measuring 1¼ inches across the wings.

An insect which appears to be getting scarcer with us is the large tortoise-shell butterfly (*Vanessa polychloros*). Some years ago I used to take this plentifully near St. Albans, and it even used to venture into the garden at The Hollies, but of late it seems to have almost entirely disappeared. Mr. F. Latchmore, of Hitchin, writing on this subject, says: "Formerly this insect was common at Ickleford. The chrysalises were to be seen hanging from the coping of the walls near the church opposite some lime-trees. I have not seen a pupa-case at that spot for some years." Mr. Spencer records the capture of one specimen at Bricket Wood in 1892, and he saw another in Cassiobury Park in 1893. It is several years since I saw this insect on the wing.

In speaking of the Fritillaries, reference need only be made to two insects. The pearl-bordered fritillary (*Argynnis euphrosyne*) was unusually common. Mr. Dymond mentions its occurrence at Ayot on April 26th, and when the Society visited that place on May 13th it was still to be seen sporting over the green outside the gates of Brocket Hall Park. Messrs. Latchmore and Gatward, of Hitchin, inform me that at Hitch Wood it was taken in some numbers. The same recorders mention the fact that later on the high brown fritillary (*A. adippe*) appeared in the same locality. A careful examination of the plants of the dog-violet round the outside of the wood did not lead to the discovery of the larvæ.

Last year the capture at Broxbourne of a single specimen of the chalk-hill blue (*Lycæna corydon*) was placed on record, and I then expressed the opinion that though this insect had not hitherto been recorded for Hertfordshire, it ought to occur on the hills in the north and west of the county. I am glad to be able to mention that Messrs. Latchmore and Gatward state that it abounds at Lilley Hoo. The same two careful observers report that in the cutting of the Cambridge and Hitchin line they saw some specimens of the little blue (*Lycæna minima*) at rest on some rushes in a wet spot on the bank side. This insect has appeared before in our county lists.

At a recent meeting of the Entomological Society, some interesting varieties of the small copper butterfly (*Polyommatus phlœas*) captured in Middlesex were shown. This pretty little insect was observed in unusual quantities everywhere, and my Hitchin correspondents especially call attention to its abundance. I should be glad to learn if any aberrations in markings were noticed in this butterfly in our own county. Mr. A. Lewis and I again took a fair number of larvæ of the purple hairstreak, both at Bricket Wood and at Symonds Hyde. They are oak-feeders and not difficult to rear. Mr. Heaton reports the capture of the white-letter hairstreak at Bricket Wood in August, 1891, and tells me that Mr. T. M. Goadby caught three specimens in Cassiobury Park in the same year.

HAWK-MOTHS.

I have pleasure in recording the capture in St. Albans of two full-grown larvæ of the death's-head moth (*Acherontia atropos*). On July 12th Mrs. Ashdown kindly sent me a larva which had been found in the grounds of Mr. A. McIlwraith, at Campbellfield. It was a well-marked dark variety, and went to earth almost immediately. At about the same date one of Mr. Arthur Lewis's gardeners rescued another caterpillar of this moth from the tender mercies of a small boy. It was crawling across the road in Grange Street, St. Albans, evidently seeking a convenient spot for pupation, when it attracted the attention of an urchin, who was on the point of smashing it with a large stone. Both these specimens went through the pupa state successfully, and the perfect insects emerged at the end of September or the beginning of October, but as I was from home I cannot give the exact dates.

Mr. Latchmore sends me an interesting note about the death's-head moth. He tells me that an old Bedfordshire farmer has been interested in his men finding a lot of the larvæ in potato-digging. "He put a number in a pot and placed them in his garden, thinking to hatch them naturally, as he said. One of his men put seven or eight into a jar filled with earth, and the result was that the farmer's, which were out of doors, were all mouldy and dead in the spring, whilst the labourer's, which were in the warm chimney corner, all came out and flew about the cottage." Mr. Latchmore says that no specimens of either this moth or *Sphinx convolvuli* were taken last year at Hitchin, though nearly all the hawk-moths noticed last season have been equally common again.

Miss Ormerod informs me that a full-grown larva of the eyed hawk-moth (*Smerinthus ocellatus*) was found at Torrington House, St. Albans, about the middle of August. Mr. Arthur Lewis has in his collection an interesting moth which appears to be a hybrid between the poplar hawk-moth (*S. populi*) and the eyed hawk-moth (*S. ocellatus*). Mr. Cutts took the larvæ of the latter moth off his apple-trees again last year, and those of *S. populi* at the end of Nascot Wood Road. Mr. Charles Rothschild figures and describes a very curious aberrant form of the lime hawk-moth (*S. tiliæ*) in the 'Entomologist' for February.

Mr. C. F. Pilbrow, of Colney Heath, reports that the larvæ of the elephant hawk-moth (*Chœrocampa elpenor*) were very scarce. He only took five, all being, strange to say, green. In other years he has taken dozens, but had only found about two per cent. green. Mr. Pilbrow had formed the theory that the unusually bright weather had affected the colour, but this was upset by finding another batch in Hampshire, all of which were very dark. They were full fed quite a month earlier than usual. Of the five green specimens four were perceptibly "stung," and Mr. Pilbrow suggests that this may possibly affect the colour. These larvæ are to be looked for along the streams, feeding on water-betony and other plants. Mr. Heaton has several times found the larvæ of this species on the banks of the canal, feeding on *Impatiens fulva*, but he says that he has not succeeded in rearing them, as he could not get the food home without withering, and they would not eat a substitute.

One of the most remarkable features of the past season has been the great abundance of the humming-bird hawk-moth (*Macroglossa stellatarum*). One bright day, I think in July, I noticed a number of people assembled in front of Mr. F. Beal's office in St. Peter's Street, St. Albans, and I found that their attention had been attracted by these insects flying about the jasmine in front of the house. Mr. Beal's clerk told me that he had seen a great many of them hovering round the flowers. Mr. Henry Lewis had a remarkable experience with this insect. He was standing in Sparrowswick Wood, wearing some honeysuckle in his coat, when one of these moths hovered before it and extracted the honey. It flew away, but with remarkable persistency came back again to suck the sweet nectar from the flower. This was in September. Mr. Pilbrow says that at the harvest festival held in the Church at Colney Heath, dozens of these insects were attracted by the floral decorations, and their humming was very noticeable. Mr. Latchmore reports that this moth "has been seen everywhere right through the summer until the cold weather." He took several at the windows inside his house, and "observed them in numbers in the garden in the hot sunshine, resting on a brick wall or wooden fence." Miss Ormerod noticed the moth flying at Torrington House up to October 14th. In the autumn Mr. Dymond observed single specimens of this insect flying swiftly over the geranium beds in his garden at Ferney House, East Barnet. Mr. Bowyer writes from Haileybury: "*Macroglóssa stellatarum* was common, though not strikingly so. I have never seen the larvæ here. On the cliffs near Dover it occurs on both *Galium verum* and *G. mollugo*, preferring the former." Mr. E. Hartert, curator of the Zoological Museum, Tring, says that *M. stellatarum* was not rare in that district. Several were taken on the flowers in the yard behind the Museum, and he saw a few in his own garden. Mr. Hartert informs me that in Germany it is nowhere rare, although never common. Mr. Heaton reports the capture of several specimens this year, and also in 1888.

Mr. Pilbrow netted a fine specimen of the hornet clear-wing moth (*Trochilium apiforme*) at Colney Heath. Messrs. Latchmore and Gatward inform me that this moth is common at Hitchin, but exceedingly difficult to capture in the larva state. They noticed on some aspen-trees perforated by this larva places where some birds (probably nuthatches) had dug several pupæ out of the bark. The chrysalis may be found in the spring near the outside of its burrow.

OTHER MOTHS.

Messrs. Latchmore and Gatward record the occurrence of the green forester (*Ino statices*) at Lilley Hoo. Mr. Heaton failed to find it in a field near Rouse Barn Lane, Watford, where it is generally plentiful. Mr. Spencer had a somewhat similar experience. I have taken it flying with the common burnet-moth in a field between Green Street and Theobald Street, near Elstree.

In the summer Mr. Cutts found the larvæ of the cinnabar-moth (*Euchelia jacobææ*) in great abundance near his house. He sent some to Mr. A. Lewis, which were nearly all "stung," but those I got from the same place are now in the chrysalis state and appear to be free from this infestation. Mr. Heaton says that he finds the moth in only one field of small area, and has only taken one specimen elsewhere. I do not find this species to be very common at St. Albans, but I heard of several specimens being seen last year.

In my last year's report I alluded to the discovery of a large number of the larvæ of the goat-moth (*Cossus ligniperda*) at Hitchin by Mr. Latchmore. He was good enough to send me some of them, which duly pupated, and, in June last, emerged.

A larva of *Acronycta alni* was taken by Mr. Pilbrow, of Colney Heath, upon "acacia" on the lawn at Oaklands in July. He searched very closely, but failed to find another. Being unable to find the proper food for it, it died. Mr. Bowyer, of Haileybury, reports with reference to this moth: "A larva of *A. alni* was brought to me and at once entered a thistle stem. On looking at it to-day (7th Feb., 1894) I find that it died without pupating. This was new to our Haileybury list." I was last year able to report two other records of the occurrence in Hertfordshire of this rare moth. Mr. Bowyer was also fortunate in securing another rarity in the great prominent (*Notodonta trepida*), which has only been recorded for one other Hertfordshire locality, viz. Sandridge, where it was taken by Mr. A. F. Griffith. Mr. Bowyer says: "I bred from the egg a fine series of *N. trepida.* The female was caught in one of our dormitories in 1892."

Mr. Pilbrow tells me that though he has not found the puss-moth (*Dicranura vinula*) at Colney Heath, he has seen traces of it. I get it occasionally at St. Albans. Mr. Cutts, of Silverdell, Nascot Wood Road, Watford, says: "Judging from the way in which the foliage was eaten, *D. vinula* must have been fairly common on my poplars. I did not notice them until just upon full-fed, but I have three pupæ from the larvæ I took, and have since found two others in the garden." Messrs. Latchmore and Gatward tell me that the larvæ were found on some weeping-willow trees at the Hitchin Town Cemetery. The same recorders also report that several prominents were taken last season on the same trees. In hunting for kitten cocoons on the bark of willows and poplars Mr. Latchmore met with no success until February 8th of this year, when after infinite labour he dug out two specimens, which, he says, "may after all be ichneumoned," and he continues: "You disturb some queer creatures in tearing off the bark of these trees with a 'jemmy.' The other day I exposed beetles in great numbers and of brilliant colours, ladybirds, a queen wasp, and some luminous centipedes, which I at once recognized as the little creature I have often taken on a footpath on a humid evening in summer."

Mr. Pilbrow has failed to take the centre-barred sallow (*Cirrhædia xerampelina*) this year. The specimens he has secured hitherto were taken on or near ash-trees, and had not long emerged. He finds that the best time to look for them is between noon and early evening. The fact that they were taken on ash-trees seems to indicate that the larva might be worth searching for. It is an ash-feeder. This is not a common insect with us, though I have taken it at light at St. Albans, and Mr. Griffith records it from Sandridge.

The shark-moth (*Cucullia umbratica*) is recorded from East Barnet by Colonel Gillum, and Mr. Pilbrow reports its capture on a fence at Colney Heath in the bright sunshine.

A specimen of the emperor-moth (*Saturnia pavonia*) was also taken in daylight on a fence by Mr. Pilbrow, it apparently having just emerged, and he has taken *Acronycta ligustri* (?), *Cossus ligniperda*, and *Smeranthus tiliæ* in the same way. *S. pavonia* is one of the moths of which the males may be taken by what is known as "assembling." The female should be put in a muslin-covered box, and if there are any males in the neighbourhood they are attracted to the spot. Mr. Lewis took a moth in that way last spring.

Mr. A. Sainsbury Verey, of Heronsgate, Rickmansworth, writes that he took a specimen of the bird's-wing moth (*Dipterygia scabriuscula*) at that place. He has favoured me with the following notes with regard to the larvæ of this moth: "Some years ago, when residing at Barnes, I was one day in August collecting the caterpillars of *Chærocampa porcellus*, when I found some brownish larvæ, with somewhat darker and also white stripes running along their bodies, feeding upon a species of coarse rank grass, which was growing with the *Galium saxatile*, upon which, together with *G. verum*, *C. porcellus* feeds. These I took home, when they quickly span-up in loose cocoons under some dead leaves on the surface of the earth in the rearing-cage, and, emerging in the following June, proved to be the *Dipterygia pinastri* of Newman. I see that Newman gives 'various species of docks' as the food-plants, but all the caterpillars I found were on the coarse grass, although, as they so very soon changed to pupæ, I cannot actually say that they were feeding upon it."

Among the insects in Colonel Gillum's collection may be mentioned the lappet-moth (*Lasiocampa quercifolia*), which was taken at East Barnet. It was caught by one of the boys in the Farm Home and given to Colonel Gillum. There are four other Hertfordshire records for this moth. A full account of *L. quercifolia* and its habits, together with life-like figures of the larva and perfect insect, appear in Miss Ormerod's 'Report of Observations of Injurious Insects for 1893.'

Mr. Cutts reports that *Leucania comma* and *L. pallens* were plentiful in the autumn, but he did not see any earlier in the year, when sugar was a complete failure. There was a very fine second brood of *Agrotis segetum* in the autumn, when he secured a nice series, and also took one specimen of *A. saucia*. *Noctua C-nigrum* was plentiful, and of that also he took a good series. He also captured specimens of *Anchocelis litura*, but *A. lunosa* he did not see at all. *Cerastis vaccinii* and *Scopelosoma satellitia* were very abundant, the latter being especially plentiful and fine. He took a long series of *Xanthia fulvago* (*cerago*) and several specimens of the variety *flavescens*. He also secured *X. flavago* (*silago*) and a few specimens of *X. gilvago*. *Phlogophora meticulosa* has been fairly common, and he was so fortunate as to take one specimen of *Colocampa vetusta*. A friend of Mr. Cutts also took *Euclidia mi* and *Heliaca tenebrata* near by. My correspondent has done very little with the geometers. *Himera pennaria* was common in the larval form, and Mr. Cutts took many caterpillars of *Hybernia defoliaria*, which did not succeed with him. He let them go down into peat-moss, which was probably too dry for them. From some self-sown mullein plants in the garden Mr. Cutts took a good many larvæ of *Cucullia verbasci*, which are now emerging.

Mr. Dymond reports the chimney-sweeper moth (*Atrata chærophyllata*) to be common at East Barnet, and that last year it was unusually abundant. Of this insect Mr. Dymond finds it difficult to capture specimens which are in any degree perfect, for after it has been flying about for a day or two it loses the sooty blackness of its wings. Mr. Pilbrow takes this moth annually, but only finds it in one corner of a large field, which corner, about two acres, is laid down with permanent grass.

Mr. Dymond found the larvæ of the figure-of-eight moth (*Dilopa cæruleocephala*) to be particularly abundant in the early part of the year, but did not observe a corresponding increase in the number of imagos in the autumn. He attributes this to the fact that a large number of the larvæ were "stung" by ichneumons, for out of about fifty larvæ which he took for breeding, only about thirty resulted in imagos, the rest being the prey of the parasite. Mr. Pilbrow also comments on the large number of the larvæ both of this insect and of *Eriogaster lanestris*, the hedges in many places being nearly ruined by them.

On April 23rd I took a number of larvæ of *Xanthia citrago* at Gorhambury. They were concealed in rolled or united leaves of lime. They emerged in August, and proved to be rather light-coloured varieties. Mr. Dymond took a few specimens of this moth at sugar, and also about two dozen specimens of *X. flavago*. This appears to have been a *flavago* year, that moth being commoner than usual in most localities. Mr. Cutts also reports taking *X. flavago*, and Mr. Bowyer writes: "*Flavago* was common both last year and the year before: we do not as a rule take many here." Mr. Dymond captured about a dozen specimens of *Calymnia diffinis* at sugar, and found *C. affinis* to be common. Other insects which Mr. Dymond reports to be commoner than usual last year are: *Euclidia mi*, *Agrotis segetum*, *Noctua augur*, *Anchocelis litura*, *Xanthia circellaris*, *Calymnia trapezina*, *Hadena protea*, and *Miana strigilis*.

Miss Selby, of Battler's Green, Aldenham, tells me that her bee-hives are a great deal infested by the wax-moths. In December she sent me a number of specimens of *Galleria mellonella*, which were flying about the kitchen. Some old wax from the hives had been brought into the house, and the warmth caused the moths to emerge from their chrysalises at this unusual date. I have sometimes found the smaller wax-moth (*Achrœa grisella*) very troublesome in my hives. These insects are wax-feeders, the larvæ eating their way through the honey-comb, and sometimes causing a great deal of damage. Mr. T. B. Blow, of Welwyn, thinks that if the bees are kept strong they will turn the grubs of the wax-moth out of the hives. He says that he rarely hears of a case of really serious injury caused by them.

In conclusion, I must thank my correspondents who have rendered such valuable help. I would like to again emphasize the necessity of our county entomologists keeping a record of the appearances of rare insects, and informing me of the same. During the year several friends have sent me moths which they have found, and although in some cases they were only very common insects, occasionally a rare one came to hand, and I welcome all help of this kind. As a rule a moth will travel safely if sent alive in a pill-box, packed inside a tin to keep it from being smashed in the post. Moths sent in this way often deposit eggs and enable one to study the insect from the ova to the imago.

XII.

ANNIVERSARY ADDRESS.

A WONDERFUL ANIMAL.

By the President, ARTHUR STRADLING, M.R.C.S., F.Z.S.

Delivered at the Annual Meeting, 27th February, 1894, *at Watford.*

LADIES AND GENTLEMEN,—

I purpose to take as my text to-night the dictum that the "proper study of mankind is man," but in a literal and more prosaic sense than that intended by the poet. Indeed, the line which I shall pursue is the very converse of that implied by the quotation; for, with the higher attributes of man—mental, moral, intellectual, or spiritual—I shall, of course, not attempt to deal. I am going to say a few words about man the animal, in relation to, and in comparison and contrast with, the rest of the animal world; and I have presumed to select this subject on the grounds that, in the first place, my past life in the wilds has afforded me exceptionally advantageous opportunities of studying this noble animal in his natural and noblest condition, so far as bodily characteristics go; and secondly, because it is my lot to follow as a profession that branch of Natural History—for it is nothing else—known as medicine.

Let me say at the outset that, although I am going to speak, and to speak with intense admiration, of man viewed as an animal and nothing more, I am not taking the materialistic platform too commonly adopted in science nowadays, that man *is* an animal and nothing more. It is true that the gulf between him and beast is not to be found in structure, but is an intellectual one only—and that not one of character but of degree, utterly valueless for the purposes of classification. Nevertheless, that gulf remains so wide, so immeasurably profound, that man must always occupy a place apart in creation. But of course it is patent to all that we are built up on the same general plan and design as the creatures which come immediately below us in the scale of life; we have similar eyes, ears, tongues, similar senses and corresponding likes and dislikes arising out of the exercise of those senses, pleasures of appetite, susceptibility to pain, and so forth. And therefore it is perfectly justifiable, as it seems to me, for us, as a Society avowedly devoted to the investigation of the whole phenomena of Nature, to take man and study him for the time being on precisely the same principle that we might a cat or frog; and indeed he is well worth it, for no more wonderful animal has ever trodden this earth. And I venture here to enter a protest against the tendency to underrate this remarkable animal which appears to prevail at the present day. In popular acceptation the proper study of mankind seems now to be any other animal, from a microbe to a mammoth, rather than our own species. So far is this really the case, that the British Association has recently sent round memoranda, begging societies of this sort not to neglect among their observations to record facts relating to ethnology and other topics pertaining to humanity. We have in consequence just added that word to our schedule of subjects for consideration. Then, again, we constantly hear injurious comparisons instituted between ourselves and the lower animals. Probably we have all suffered much in our youth from those hateful insects, the industrious ant and the busy bee; but even now we frequently get the exclamation, "Ah, which of *us* could do that?" from people of cheap, second-hand, philosophical proclivities, when they see anything on the part of an animal which strikes them as clever or ingenious,—the very people who, as a rule, scornfully repudiate the idea that we are of one flesh and blood with the rest of creation. No one can delight in the marvels of animated nature more than I do, for I have lived in close and constant companionship with animals of various species all my life; but I confess that it *does* make me indignant when I hear them lauded at the expense of that crown and miracle of evolution, myself. For, as I shall hope to point out presently, man is far and away the best all-round animal, even from a purely physical aspect.

Now, where shall we put man in the zoological scale? Man, to whom the question is necessarily addressed, usually replies: At the top, as high up as possible; not like the little boy at school, who, on being asked which was the highest animal, answered that it was a giraffe! It is very doubtful, though, whether there are any structural grounds sufficiently valid to justify this position. If we agree with one of the schools of systematists of the present day, that specialization of structure should be taken as the criterion of altitude of type, then man, though undoubtedly ranking very high in this respect, must yield precedence to the bat and the whale, both of whom have become more modified than he in adaptation to their environment. On the other hand, if we throw in our lot with another school who hold that specialization should be regarded rather as evidence of degradation, as evincing departure from perfection of type, then, although not quite at the bottom, man would have to take a very low seat indeed. I have attempted to demonstrate in a previous lecture that there is no absolute zoological specialty which serves to distinguish man from the rest of the animal world. He is lord of creation by virtue of his intellectual supremacy alone; and though it is impossible to deny that the intellectual quality is shared in some degree by the brutes—for in many of them we see evidence, not only of cerebration, but of ideation, of classification and judgment, with a very obvious and definite concept of the *ego*—yet this supremacy is so great as to leave it little matter for wonder that in time past man should have semi-deified his mind as the immortal part of him, and regarded it as synonymous with the soul. Later knowledge has shown this to be untenable, since the mind may be destroyed at will by a simple surgical operation, and is in fact not seldom so destroyed by accident, while it is subject to decay and death from disease quite independently of the body. Mind is merely the function of a tissue, the secretion of the brain-substance; but the utter disproportion between the increase of this tissue and its developed action is perhaps the most marvellous and least explicable of all human phenomena. Our brain is only about three times as large as that of a gorilla or chimpanzee, and very little more elaborate in its elemental complexity; yet no one would dream of stating its resultant function, the mind, as equivalent to thrice or three hundred times that of the ape. And then look at the enormous progression that goes on, century after century. Everywhere outside man we find psychical fixity; but if the increment of mind during no more than the last fifty years could receive material expression in anatomical factors, bone, muscle, and artery, it would yield basis enough to found a new species. For this stupendous evolution, practically unaccompanied by corresponding structural development, there is, so far as I know, only one parallel throughout nature; but there *is* a parallel, in the venom-gland of a poisonous serpent. This gland is to all appearance simply a common parotid, the exact analogue of those which swell up so uncomfortably and ridiculously when we have mumps. All snakes have them; but how or why the secretion, an ordinary saliva, should acquire so remarkable a property in the lethal species is a mystery as little to be solved as the origin of the human mind.

Not only in our anatomy and physiology, but, as it seems to me, in our acts and deeds, if we analyse them, do we present as much theme for wonder as any creature outside the genus *Homo*. May I give an illustration of what I mean? We are lost in admiration, and with good reason too, at the exquisite instinctive nicety and calculation of distance displayed by the squirrel or gibbon in leaping from one slender bough to another, springing without hesitation and alighting with unfailing accuracy on the desired point, the impetus employed being no fraction more or less than that demanded by the exact requirements of the interval. Very beautiful is this to contemplate, but to my mind not half so marvellous as the spot stroke at billiards, as played by an expert—the precision, the almost microscopic delicacy, the judgment, the correct apportioning of force; above all, the command of nerve involved to make stroke after stroke with so unerring an aim. Still further, we have to reflect that this aptitude, which has become well-nigh an instinct with the player, has been acquired by him during a portion only of one life-time—heredity is no factor in the case; while with the squirrel the faculty has been gained by the accumulated experience of thousands and tens of thousands of generations. So, too, when we catch a ball thrown up in the air, we calculate the trajectory and place our hand almost intuitively in the line of its descent. Witness also the dexterity attained by jugglers after a few years' practice, enabling them to toss about and manipulate half-a-dozen different objects while reading aloud from a book or paper, or to throw a ball high above them whilst blindfolded, and to so adjust the impulse and the distance which it shall traverse that it shall fall into their outstretched hand. I doubt, moreover, whether the whole creation of animals, living or extinct, has ever produced such a marvel of semi-instinctive performance as that offered by the musician who executes a rapid movement on an instrument like the piano, where thousands of muscular actions, each distinct, independent, co-ordinate, and purposeful, take place within a minute; and the marvel is multiplied ten-fold when to this is superadded the process of reading and translating each note coincidently. So again with the subtlety, neatness, and delicacy of manipulation acquired in many trades and industries, instances of which might be adduced by the hundred; but what I would rather lay stress on is the fact that equal theme for astonishment may be found in countless acts of our every-day life, complex movements which we perform almost unconsciously (certainly without conscious thought), very little to be distinguished in their results from what we call instinct, yet all learnt and accumulated by obvious methods of attainment; such acts as running up stairs, balancing the body, the umbrella, or the hat against a high wind, putting on a pair of gloves, shortening our steps mechanically in crossing a road so that the foot is exactly timed to reach the edge of the pavement, and the numberless examples of instinctive memory and localization.

The last is seen no doubt in its highest development amongst savages—it is said that the aboriginal inhabitants of the West Indies, now nearly extinct, could foretell the advent of a hurricane a week or more in advance, which the most delicate meteorological instruments fail to do. One may point out here, as somewhat remarkable, that although the principles of almost all man's great mechanical inventions have been anticipated by the lower animals, he does not seem to have copied directly from Nature in this respect in any instance, but to have evolved his discoveries independently. And although he does not possess the power of scent of the chamois, the hearing of the bat, the sight of a hawk, the muscular strength of the tiger, or speed of the cheetah, in the aggregate the sum total of his senses and faculties far exceeds that of any, while in endurance and adaptability he is second to none—this wonderful creature, whom Bremser has declared to occupy a sad middle state between the animal and the angel.

Take, for instance, his sense of sight. Very few creatures can compare with us in acuteness or comprehensiveness of vision—some few birds, perhaps, such as the hawk and the gull. The compliment "lynx-eyed" is a very doubtful one, since neither the lynx nor any other cat is gifted with sight equal to that of man. In fact, the excellence of this faculty is quite extraordinary in comparison with its condition in the rest of the animal world; snakes see nothing distinctly at a distance equivalent to twice their own length, while even the possessors of multiple eyes—insects and spiders—cannot boast a power of perception even relatively as good. A spider with its eight eyes may be observed to feel along the threads of its web in order to discover the precise whereabouts of a captured fly. It is very doubtful whether any animal but man sees the stars.

And, speaking of seeing the stars, it is curious how little we know what we *do* see. All our senses befool us to some extent, but none so much as that of sight—seeing is *not* believing. How big does the moon appear to us? A thousand persons, of all ages, were tested with this question, and invited to draw on a black-board the image of the moon of the actual size which it presented to the mind of each. The result was a series of circles ranging in diameter from that of a shilling to that of a soup-plate; so great was the diversity that it was impossible to arrive at any trustworthy average amongst them. In respect of the moon, too, occurs the singular sense-deception that we see it apparently larger on the horizon than when we view it directly overhead. We know, of course, that it is the same body; but our reason revolts at the assertion that the image and presentment which fall upon the retina are of precisely the same dimensions whether the satellite be at the zenith or upon the horizon. Nevertheless, this may be demonstrated to be the case by placing a disc of cardboard the size of a shilling at the extremity of a straight stick, forty inches long, at which distance such a disc will exactly extinguish that of the moon, whatever its situation may be. The explanation of the anomaly lies in the circumstance that we can never get rid of the impression that the vault of the heavens assumes the form of a flattened dome, that the horizon is farther away from us than the vertex, and that consequently a body ought to appear smaller to us at the greater distance; we therefore intuitively magnify the moon's image in our receptivity to compensate for the discrepancy of its equality of diameter in both positions. In a somewhat similar manner, the gas-lamps in the street, which we know to be close at hand, convey when looming through a fog an irresistible impression of distance to our easily-deluded ocular appreciation. In fact, the eye can never be depended upon to give a correct perception of distance unless there be something to mark the interval; a light in the air may be an expiring candle a few feet off, or a planet at millions of miles. A curious illusion of a small character affects myself in connection with the constant use of spectacles. (If I quote myself and the phenomena of my own life-history from time to time in the course of the evening, please do not set it down to inordinate vanity on my part, or misjudge me as offering myself as a remarkably fine example of the Wonderful Animal we have under consideration. I do so simply because I happen to be the specimen which comes most immediately within the sphere of my personal observation. If I were lecturing on cats or dogs or serpents, you would naturally expect that I should select for illustration those in my own collection as most familiar to me, and it is on precisely the same principle that I allude to myself in the present instance. However, other people wear spectacles, and may perhaps have noticed a similar deception.) For me of course the world is framed in a somewhat narrow oval; I don't employ the whole capacity of my extent of vision, that being bounded by the rim of my glasses. The result is that pictures of landscapes always seem unnatural to me—they all have too much sky, more, that is to say, than I am accustomed to see in proportion to the amount of ground. This shows that it does not do to accept everything as viewed through one's own spectacles.

No other animal probably depends so much on the sense of sight as we do, yet the eye is remarkably defective, not only in respect of distance, but in its power of quantitative estimate. If we are accustomed to take sugar in our tea or coffee, our sense of taste will inform us at once whether our cup has been sweetened with one, two, or three lumps. So, when the conductor of an omnibus gives us change out of sixpence, we can guess pretty correctly without looking whether he has made a mistake of a penny (especially if it should be a penny short), simply by the weight of the coppers. Yet it is exceedingly difficult to say whether a room is lighted by one, two, or three candles, if the candles themselves be not seen; moreover, the illumination of twenty candles is scarcely to be differentiated from that of ten, when they are hidden from view, and even the sudden addition of ten candles to a like number already lighted fails to produce an impression of the increase of more than two or three. It would be quite possible to lower the lights in this room to one half of the volume which they are now yielding without any perceptible alteration to the majority of those present, provided the diminution were effected gradually. Even the tactile perception is more delicate and acute than this: in selecting one from a number of instruments of the same shape but of different sizes (different in calibre, that is to say), I find that my sense of touch is a much more trustworthy guide than is the eye where the gradations are very fine. The sight of savages, about which so much nonsense has been talked, is by no means exceptionally acute, though specialized in certain directions by habitude; they may pick out, for instance, a motionless animal which is invisible to the unpractised eye, but my fellows in Nicaragua had the greatest difficulty in seeing any distinction between an *n* and an *m* printed in small type, and even between a full stop and a comma, things that strike us like a blow when one is misplaced for the other. A child's vision appears to be deficient in comprehension rather than intensity, though whether this is due to immaturity of the organs involved or to defective receptivity of the centrum I am unable to say. I was much impressed with this fact on one occasion some few years ago, in taking a child of five and his nurse—specimens again from my own vivarium—to the Crystal Palace. Neither of them had been there before; and when we emerged from the Low Level Station into the grounds, the nurse, a girl of eighteen or twenty, was rapt in amazement at the panorama which suddenly burst upon her, the enormous gardens, the fountains, the wide terraces, and, behind all, the huge building and towers. The child, on the other hand, saw nothing and heeded nothing but the flowers and shrubs in the immediate vicinity—he was capable of perceiving all the rest when his attention was especially directed to it, and it aroused equal wonder in him, but he at once reverted to neighbouring objects when left to himself.

The first colour which a child recognizes is invariably red, and children are singularly attracted by anything of a golden hue or sheen; babies just able to crawl will stretch out their hands towards gilt balls in the midst of other objects equally bright, and will pick out gold coins from amongst silver or any others—a predilection which certainly persists into later life with the majority of our species. At the age of ten the colour of the eyes is fixed; and it is said that blue-eyed people are never colour-blind. We probably see more colours than the rest of the higher animals; at any rate, apes seem to be colour-blind.

That human sight is deteriorating, our children afford most melancholy proof. I have been told on very competent authority that the reason why the stereoscope has fallen so much into disuse is because few people now can see with both eyes alike. Nevertheless, it is pleasant to know that total blindness is steadily diminishing. In the year 1871, the proportion of blind folks per million of the whole population of England and Wales was 951; in 1881 it was 879; and ten years later still, it had fallen to 809. This decrease is no doubt largely due to the improvement in remedial appliances and operations which have been devised by oculists in the last quarter of a century; I think those medical men who are present will agree with me when I say that the progress of ophthalmic surgery during recent years offers the most satisfactory aspect of our profession. There is one little operation known as iridectomy, the object of which is to restore the pupil when it has been obliterated by inflammation, concerning which it is said that it has actually exercised an appreciable effect on the poor-rates of every civilized country in the world! Young and able-bodied people who had become blind from inflammation of the iris were formerly regarded as incurably so, and had in consequence to be maintained by the state, the parish, or charity for the remainder of their natural lives, or had to take up occupations for which the power of sight can be dispensed with, such as basket-making. Now, by a snip of the scissors the blessing of sight can be restored to many, enabling them to set to work and earn their bread. The number of the totally blind in England and Wales was returned at the last general census, that of 1891, at 23,467. Amongst these the male sex predominated greatly up to the age of 65, but blind old women far outnumbered the blind old men. The occupation of the majority of these blind persons was basket-making, but music was the vocation of many of them, either teaching or actually performing. Six blind doctors appear in the list, and two blind veterinary surgeons; three blind dentists are gruesomely suggestive of new horrors added to a terrible craft; and, most extraordinary of all, there are two sightless photographers. The blind pianoforte-tuners, who are very numerous, appear to have been included in the census returns under the head of musicians.

As an example of the wonderful perfection of functional specialization to which the eye can attain, I may state that it is credibly affirmed that signalmen in their cabins on the railway are able to detect and recognize the inspectors for whom they watch as they pass in the trains at full speed. But, indeed, the most casual phenomena of the vision are altogether marvellous when we think of the tiny pinhole, the pupil, through which we look out and survey the world, through which our sense not only embraces many miles of landscape, but perceives such trifles as the minute deflection of the globe of another person's eye in "meeting a glance."

It is very difficult to deceive the eye, though the eye may deceive us; of this striking instances might be given.

It is possible that sight is somewhat complementary to hearing, as smell is to taste, for, when we are listening, we turn our eyes, although the face is averted to bring the ear round. We also have some power of hearing through the open mouth.

But hearing does not present so many curiosities as does the sense of sight. Our external ears are not of much use; people get on very well without them.

The dullest and most neglected sense is that of smell; we practically make scarcely any use of it. It is the only sense that does not sleep, and it is said to be more acute when we are asleep than when we are awake, odours then being very distinctly perceived by the olfactory nerves.

In no animal is the sense of taste so much developed by education as it is in man. People experienced in tasting wine can recognize different vintages without any hesitation. Many animals can taste their food very little, if at all. Birds with their horny tongues, and reptiles which swallow their prey whole, can have no palatal refinement, and yet they are discriminative to a great extent.

The sense of taste is shared by the tongue with the rest of the mouth, but the tongue is also a tactile organ. Mr. Herbert

Wailes, in his recent lecture on "Crystals and Precious Stones," told us how the tongue was applied to test diamonds. The way in which the food is balanced by means of the muscles is very wonderful, and so also is the way in which we detect a grain of sand in the food and steady it against the teeth; while the whistling of the chromatic scale by a boy is an achievement probably unsurpassed in the animal world. On the other hand, the movement involved in putting out the tongue is probably the easiest of all bodily actions.

With regard to speech, we are told on the authority of Mr. Edison that very few persons recognize their own voices, but probably they would not recognize themselves if they could meet. It is said that stammering is not known amongst savages, but is a product of civilization. No savage makes the noise of clearing the throat, and it is very doubtful whether a savage ever laughs aloud. But savages soon learn to do so, as the wild dog learns to bark on hearing the bark of the domestic dog. Gesture-language is pretty much the same amongst savages as amongst the rest of mankind; although it may seem remarkable at first, it is descriptive and imitative in its origin. Language will have to be modified very much in that toothless future of which dentists give us the prediction. Cooked food has probably very much to do with the loss of teeth, but the great expanse of the brain may take up so much of the skull that there is not sufficient space for powerful muscles to work a heavy jaw.

The average weight of the brain of males is 49½ ounces; that of females is said to be about 6 ounces less, which shows what capital stuff it must be made of, the smaller quantity doing so much. These are, of course, the absolute weights; if we take the relative weight to the weight of the body, we shall probably find that the female brain is proportionately equal in weight to the male brain. Some very clever and intelligent men had very large brains. Thackeray's brain weighed 58½ ounces; a celebrated French surgeon's 62½ ounces; Abercrombie's an ounce heavier; and Cuvier's, the heaviest on record, 64 ounces. Napoleon's was a very heavy brain. But there is no rule: the brain of some very intelligent people is not much above the average; the brain of John Stuart Mill was a very small one indeed. Only two animals in the world have a brain heavier than that of man, the elephant and the whale, both intensely stupid creatures; in fact, no animal comes near to man in intellect in comparison with weight of brain. Some of the giant brutes of bygone days were remarkably scanty in this respect, some allied to the rhinoceros having smaller brains than that of the cat. The brain of some of the extinct reptiles would scarcely fill a wine-glass. But the intelligence of an animal generally bears some relation to the complexity, if not to the size, of its brain. There has been an effort lately made to associate both crime and genius with insanity, but with regard to genius I think it would be very remarkable if perversion of tissue were correlated with the highest development of the function thereof.

Turning from the consideration of the brain to that of the limbs, it is scarcely necessary to say that the primary object of locomotion is to enable the organism to seek food over a larger area than was possible with a fixed position. It has been reserved for man alone to differentiate his limbs and use his legs and feet, and not his arms and hands, for locomotion, and in this respect he is higher in the scale of creation, in his purely animal nature, than any of the other animals. It is thought that the erect position preceded the development of mind. The hand, also, plays an important part in the superiority of man over the other animals.

Man the animal, irrespective of his mind, progresses; the lower animals do not progress; but he, even in his animal characteristics alone, is always going forward. We see this fact brought out in nothing more clearly than in the way in which records are broken in athletics and sports every year. Bicycling statistics prove this as much as anything. But the limits of human performance are very narrow without the aid of machinery, and are probably nearly reached now. That we shall never fly is certain; for it has been mathematically calculated that our muscles can never be employed to lift our weight from the ground.

I regret that I have not time enough to speak of the development of races, but there is one point in connection with descent which is sufficiently remarkable to notice. We find a great many instances of survival and reversion, especially in watching the habits of our children; all their games are mimic war, and they like "bluggy" stories. There is also amongst us one direct graft from barbarism, and that is the practice of smoking.

There are several other points involving curiosities of human life-phenomena to which I had intended to allude, but I find that I have miscalculated my time at the outset in dwelling on the nerves of special sense. Now, is it allowable to speculate for a few minutes, by way of conclusion, as to the future of this wonderful animal?

That our race is no longer in the heyday of its youth, that it is in fact long past its prime, admits of no dispute whatever.

There are many points of positive evidence of this, too technically anatomical to be brought forward here; but one may say briefly that races present their signs of growth, maturity, senility, and decay, just as do individuals. Indeed, an American statistician has recently published a computation that, at the present ratio of increase, the extreme limit of population of the globe will be reached in the year 2072—no more than 178 years hence—by which time the earth's inhabitants will number 5994 millions, more than which it will not hold or support. I believe that the average proportion, taking the world over, so far as can be ascertained, is seventeen births for sixteen deaths, but this proportion varies greatly in different lands; in France, for instance, according to the census recently issued, there were in 1892 more than 20,000 deaths in excess of the number of births. It is extremely unlikely, however, that man will persist to the limits of possible population of the earth—which is not by any means the same thing as saying that he will become extinct before the suggested 178 years have elapsed, but rather the reverse, as no doubt unknown and at present unknowable factors of determination will arise in the meantime. We must not forget that there are tracts of land, even in Canada and the United States, Alaska and Labrador, which are less known at this period than equal areas in the moon; and that the future colonization of air and water may not be altogether chimerical. We must remember, too, in connection with this part of the question, that man, though encompassed by an infinitely greater variety and complexity of conditions than any other animal, has infinitely greater control over those conditions, by his employment of engines, his choice of food and clothing, and other modifications of his environment at will. As to his antiquity, we have but uncertain data, so far as years are concerned. We know of course that he is a very baby amongst the Mammalia, quite their latest product, just as the serpent is amongst reptiles; that in fact he did not appear until long after the wane of mammalian life had set in; and that he can be but a very transient phenomenon on the face of the globe, even though his existence be reckoned by thousands of centuries, when we compare him with such creatures as the catfish of the Missouri, which has persisted in its present form unchanged since the Silurian epoch. Sir Charles Lyell predicates the presence of man in the valley of the Mississippi for at least 100,000 years, and the traces upon which this estimate is founded would demand a period quite three times as long to admit of his perfect evolution and differentiation into races. But extinction is vastly quicker in its operation in all cases than evolution, and it is certain that we shall not see another 300,000 years, or anything like it.

The fatal disease to which we shall owe our extermination is civilization—that civilization which is as recent a feature in our racial history as any event of yesterday in the lifetime of the individual; and by civilization I do not mean the missionary process of clapping a naked savage into a top hat and frock coat and making him a member of a County Council—imposed civilization of that sort kills at once, witness the sudden extinction of the aboriginal Tasmanians. It is that gradual and self-evolved civilization, which comes inevitably to every nation sooner or later, and which is no less surely destructive, though immeasurably slower than the other. The Apahuai Indians, with whom I sojourned in Central America, offer an excellent illustration of this contemporaneously. Their tribes, nomadic by nature and habit from time immemorial, are now just beginning to split up into sections, whereof one goes on wandering through the forests and prairies, while the other settles down into *pueblos* or villages and evinces a tendency to form agricultural communities; and every year these communities receive an accession from the nomads—the first step on the downward path! And this deadly symptom, civilization, is of course the direct product and outcome of man's fatal advantage, his aggrandization of brain—that which has made him is wreaking his undoing. It is curious to note the frequency with which this fatality of advantage occurs in the animal world. The development of the hood of the cobra must at the outset have been of use to it in the struggle for existence, yet its weight and expanse now prove often a positive bane, and cause it to fall a prey to creatures from which it might otherwise escape; and the enormous dimensions to which the tusks of some of the old mammoths attained must certainly have conduced ultimately to their extinction. The sabre-toothed tiger, again, the most specialized carnivore that ever existed, could not at last close its mouth on the teeth to which it owed its initial superiority over the rest of its kind. So, too, one might adduce as parallel instances the brilliancy of certain birds, the plumes of the bird of paradise, the neck of the giraffe, and many other examples of the disadvantageous exaggeration of a development originally and within moderate limits of the greatest utility to the possessor. And so it will be with that awful and ever-increasing high pressure and tension under which we live, owing to the ceaseless and insatiable goading of this hypertrophied brain of ours. That the pace at which we now live kills is simply a truism and requires no demonstration; but perhaps no more conclusive proof of the increase of pressure could be given than the fact that it is not so very long ago that watches were made with the hour hand only; old writings do not speak of minutes—there was no 9.47 train to catch then, or anything of that sort—they allude comfortably to noon, midnight, and so on as a rule. Minor divisions of time, in relation to daily life, are sequent upon the requirements of this terrible civilization. And look at the awful results to the race which spring from the education that it entails. Look at our children, cramped in body and mind through the best years of their existence—what a lamentable contrast is theirs to the grand young savages brought up in the school of Nature! Children—there are no children nowadays; the young playful human animal is a thing of the past; they are like the kangaroos which have been kept in captivity generation after generation—they are beginning to walk, not hop or jump—the saddest spectacle to my mind which civilization affords. Read what our learned and valued member, Dr. Shelly, said on this head in his lecture to the National Health Society last week. There is no need to multiply instances; the demand for rational dress shows that the pinch on vitality is making itself felt, and there is no clearer evidence of our decay than the constant and increasing quest of peptomised and other foods which shall lighten the labour of digestion. The very existence of a medical profession shows that there must be something wrong—a race of undeteriorated animals would not want doctors. And that leads me to remark that doctors are after all the greatest and chiefest enemies of the human race. It is not too much to say that nine-tenths of the effort of medical science is directed towards the extinction of the race, by preservation of the unfit. It is a law of nature that, under ordinary conditions, not one per cent. of the animals of any species born shall survive—not one in a thousand, not one in ten thousand of some species. Mysterious as it seems, Nature is always taking repressive measures to keep the pot from boiling over, to neutralize the exuberance of vitality; if it were not so, the world would not support any single species for a single year. Man in a state of nature offers no exception to this rule, and even under civilization it is said that two-thirds of the race perish in infancy; but this is not enough for its conservation. Now, medical science, and especially sanitary science, prevents that beneficial waste of immature and weakly life in explicit defiance of this law; and in using the word "beneficial" I of course adopt the seeming paradox—no paradox at all, however—that that which is beneficial to the individual is commonly, though not necessarily or invariably, prejudicial to the race, and *vice versâ*. The passive survival of the fittest can only be compassed by the destruction of the less fit by independent forces; though I do not suppose that any new Herod is likely to arise, to prescribe *euthanasia* or compulsory infanticide in lieu of our perniciously-preservative vaccination.

Then, again, man has scarcely any enemies amongst other animals—the tiger, the shark, and the venomous serpent are all inconsiderable; and although it may seem like another paradox to speak of this as an element of disfavour in his racial prospects, yet it is a fact that the presence of enemies, beasts of prey and such like, within certain limits, *does* conduce to the well-being of a race, by weeding out the weaklings and superfluous young, keeping up the food-supply, and stimulating speed, alertness, and other qualities serviceable in the battle of life among the rest. Man, moreover, is unquestionably the terminal twig of his branch. He will leave no descendants, and there is no ancestral ape-like form from which more will be evolved. In a very short time man will be gone—New Guinea and Central Africa are the last homes of the savage in his furious state, uninfluenced by contact with white civilization; and we, the posterity of such, already hopelessly on the road to extermination, will be all that are left. And what shall we leave behind us? Practically nothing. It is very humiliating to think of, but if a future race of intelligent beings should inhabit the earth, they will find the only evidence of that development of brain and its results, which we consider so wonderful as to ascribe it peculiarly God-gifted to ourselves, in the vestiges of a mere constructive power, exactly comparable in kind or degree to that of the bee, the nest-building bird, or the beaver. In another hundred thousand years there will probably be more evidence of the past existence of the ichthyosaurus than of that of man.

What will the last man be like? It is possible to predict, with a tolerable approach to certainty. A creature with a big head, big hands, and shrunken legs; with a thin weak jaw and thickened upper lip; bald, purblind, and with few or no teeth; a creature with swollen projecting ribs, flat hips, and small ill-developed feet; deficient in the power of locomotion, yet still procuring food and preserving vitality by his marvellous mastery over the forces of nature through the resourcefulness of science. But the stage will be reached at length when the enfeebled stomach can no longer minister to the unbounded exigency of the horrible, parasitic, all-devouring demon of a brain; the secretion of intellect will fail from inanition; and man must succumb, wholesale and rapidly, in the precise order and precedence of his boasted civilization. Science, which has prolonged his existence far and remarkably beyond the span of any other creature, can do no more for him; science will speak the last word uttered upon earth, and that word will be one of sheer negation and despair. Many centuries, however, have yet to elapse before that word shall be spoken, and it may be that man is destined to spend the declining years of his racial career under happier physical conditions than those which have hitherto obtained. Already signs are apparent of what is probably an impending universal migration towards those regions where, and where only, the delight and majesty of life can be fully developed and appreciated, the tropics. Probably the same thought has occurred to everyone who has lived in those regions which was expressed by the late H. W. Bates, though it may not be given to all to clothe it with such grace of diction as he does when he says that "although humanity can reach an advanced degree of culture in high latitudes by battling with the inclemencies of Nature, it is under the equator alone that the race of the future will attain to complete fruition of man's glorious and beautiful heritage, the earth."

XIII.

THE RELATIVE ADVANTAGES OF HARD AND SOFT WATER, WITH SPECIAL REFERENCE TO THE SUPPLY OF WATFORD.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 29th January, 1895.

The question of the relative advantages of hard and soft water is a very wide one. Considered in an economic light it cannot be denied that the advantages are decidedly in favour of soft water; considered from a sanitary point of view it must first be resolved into two distinct questions,—the one as to the external application of water (for ablution); the other as to its internal use (for imbibition). That soft water has great sanitary advantages over hard water in our ablutions is no more likely to be disputed than that it is decidedly more economical in domestic use,—for washing ourselves as well as for washing our clothes and cooking our food,—and the only sanitary question which is really open to debate is whether soft water or hard water is best for us to drink. But this should not be the only point discussed, for the amount of water which we drink is but a very small portion of that which we use in other ways. It is therefore to the purpose to show that if hard water and soft water were equally beneficial in this respect, the advantages on the whole would be greatly in favour of soft water; and of this I think there cannot be the slightest doubt.

The hardness of water may be expressed in two different ways, in parts per 100,000 by weight, and in grains per gallon. In general analyses of water the former scale is usually adopted, for the sake of uniformity, the amount of organic and mineral ingredients in water being most clearly and advantageously expressed on this scale; but the latter, which is known as Clark's scale, is more familiar to us, and I will here adopt it. A grain of carbonate of lime being the 1–70,000th part by weight of a gallon of water, parts per 100,000 can be converted into grains per gallon by multiplying by seven and dividing by ten, and *vice versâ*.

The water with which Watford is supplied derives its hardness mainly from the presence of bicarbonate of lime; not from that of sulphates or chlorides which are much more difficult to deal with. It is usually about 20 degrees of hardness, about 16° of which are temporary, that is can be removed by boiling, and 4° are permanent, that is cannot be so removed. The mean of two analyses of water from the well at the Watford Waterworks made in 1870 and 1873 for the Rivers Pollution Commission, gave 20°·0, 16°·3 being temporary and 3°·7 being permanent. Several other analyses of water from wells in the neighbourhood of Watford, made about the same time (1870 to 1873), gave from 18° to 22°; and the mean of 16 analyses of water from wells and springs in Hertfordshire, made from 1868 to 1874, gave a total hardness of 19°·2, 15°·6 being temporary and 3°·6 being permanent. (See Table I, p. 113.) The hardness of the water supplied to London throughout the year 1873, by the seven Companies drawing a portion or the whole of their supply from rivers, averaged nearly 15°. In the year 1892 it averaged 15°·3, ranging from 13° in the autumn to 18° in the winter. (See Table II, p. 114.) The slightly-increased hardness of the London water in recent years is due to the supply derived from deep wells in the Chalk having increased to a greater proportionate extent than that derived from rivers. There is no reason to believe that the degree of hardness of the Watford water, or the proportion of temporary and permanent hardness, has materially altered since the analyses were made for the Rivers Pollution Commission, and we may accept it as a fact that the Watford water is about 5° harder than the London water. This difference is due to the greater part of the London water being derived from rivers, while the whole of the Watford water comes from the Chalk. In the classification of hardness the water supplied to Watford would be considered to be between "hard" and "very hard," and that supplied to London between "moderately hard" and "hard," and it is important to bear this distinction in mind, for, whatever objection may be urged against the London water on account of its hardness, applies with greater force to the Watford water.

Hard water, as already stated, may be partially softened by boiling, and is so softened in steam-boilers and to a less extent in our kitchen boilers, to their great detriment and that of any iron pipes through which the water flows, for a deposit called "scale" or "fur" is formed on the iron, uniting with it and caking over it. This, being a bad conductor of heat, renders an increased consumption of fuel necessary to raise the temperature of the water in the boiler; the "scale" has occasionally to be removed at considerable expense; and as it cannot be chipped off without bringing with it some of the iron, boilers wear out much faster when supplied with hard water than they do with a soft-water supply. The "scale" also gradually chokes up the iron pipes through which the water flows, sometimes with disastrous results. The water must boil for at least half-an-hour to be materially softened. The so-called bicarbonate of lime (calcium-bicarbonate) is then decomposed, half of its carbonic acid (carbon-dioxide) being driven off as gas, leaving it a monocarbonate (calcium-carbonate), which falls to the bottom of the water as a fine powder, and cakes on the iron. There can be no question, therefore, as to the great economical advantage of soft water over hard water for any purpose for which it has to be boiled.

The difference between hard water and soft water is most pertinently perceived by us in washing. Soap, in hard water, does not at first cleanse; some of it must be wasted in decomposing the bicarbonate of lime in the water before it can act as a detergent; in fact, the water must first be softened to a considerable extent at the expense of the soap. In soft water there is no such waste. In washing there is, therefore, a very decided economical advantage in using soft water.

But this is by no means the only advantage. However much soap we may use with hard water, the pores of the skin cannot be thoroughly cleansed and thus left open as they are with soft water. The lather which is obtained with either, after much waste of soap in hard water, with no such waste in soft water, should be removed from the skin in order to leave the cuticle in a healthy state. Rinsing with soft water at once removes it and leaves the skin soft and with open pores, in the most healthy state possible; rinsing with hard water clogs the pores of the skin with insoluble, greasy, curdy matter, the combination of the lime in the water with the fatty acids in the soap, and leaves the skin in an unhealthy and uncomfortable state. Moreover, to habitually wash the face with hard water ruins the complexion, and the excessive use of soap which hard water renders necessary is also bad for it, facts of which most ladies are probably well aware. In our personal ablutions soft water has, therefore, a sanitary and æsthetic as well as an economical advantage over hard water.

In washing clothes with hard water it is necessary to soften the water before the soap can have the requisite detergent effect. Soap is too expensive to be used as the softening agent in this operation. Carbonate of soda (the so-called "washing soda") answers the purpose well, and is not only much less expensive than soap, but a smaller quantity is required to produce the same effect. It is therefore generally used. Its action is to combine with a portion of the carbonic acid gas in the soluble bicarbonate of lime, to the presence of which the hardness of the water is due, converting this bicarbonate of lime into the insoluble monocarbonate of lime, and also producing a bicarbonate of soda, which remains in solution, adding to the detergent effect of the softened water. This action may be thus expressed:—calcium-bicarbonate + sodium-carbonate = calcium-carbonate + sodium-bicarbonate. In using soft water for washing clothes, not only is the expense of the carbonate of soda saved, but the wear and tear on the linen is also greatly reduced.

Soft water is far more economical than hard water in cooking our food. There is considerable waste with hard water, for not only is it longer in producing the required effect, whether upon meat or vegetables, but the calcareous hardening matter damages the quality of the food. The saving effected in making tea with soft water is almost too well known to require mentioning.

The great economical advantage of soft water over hard water is not, it must be admitted, a question open to dispute.

The amount of soap which water can destroy is the test of its degree of hardness, which is measured by shaking up a standard soap-solution in a given quantity of water. The soap-solution is added to the water until on shaking it a permanent lather (one which will remain for about five minutes) is obtained. Thus a water is said to possess one degree of hardness when its soap-destroying power is equal to that exerted by one grain of carbonate of lime (existing as bicarbonate) in one imperial gallon of water (weighing 70,000 grains).

It is well known that lime is made by driving off from chalk, by means of heat, the carbonic acid which it contains. Chalk, or calcium-carbonate, is thus converted into lime, or calcium-oxide, and carbonic acid gas, or carbon-dioxide, which escapes into the air. The lime has then a great affinity for its former partner, carbonic acid gas, and it is in virtue of this affinity that slaked lime softens water which is hard owing to the presence of bicarbonate of lime, or calcium-bicarbonate, for it combines with half its carbonic acid gas, thus forming chalk, and by this deprivation the rest of the bicarbonate is also left as chalk. The bicarbonate is soluble in water, but the carbonate (chalk) is not, or is only so to a very slight extent; and therefore the chalk thus formed is deposited as a fine powder, or may be removed from the water by filtration, thus rendering it soft.

The hardening of water by bicarbonate of lime and its softening by lime may be thus expressed quantitatively. A gallon of rain-water charged with 7 grains of carbonic acid gas, which it may take up from the air or from decaying vegetable matter, passing through chalk, will carry with it in solution about 17½ grains of the chalk, of which 16 grains will be in chemical combination with the carbonic acid gas, forming 23 grains of bicarbonate of lime, and the water will be said to be of 17½ degrees of hardness. If now 9 grains of lime be added, they will combine with the 23 grains of bicarbonate of lime and form 32 grains of chalk, for 7 grains of carbonic acid gas will have abandoned the bicarbonate of lime, and have formed, with the 9 grains of lime, 16 grains of chalk. The whole of these 32 grains of chalk can now be removed from the water by settlement or filtration, leaving it with only a grain and a half of chalk dissolved in it, and thus reducing it from 17½° of hardness to 1½°.

This is the reaction which takes place in the now well-known and extensively-adopted method of softening water called Clark's process, though it is by no means a complete explanation of the process. For instance, in practice the lime is added in the form of lime-water in the proportion of about one gallon of lime-water to every ten gallons of hard water to be softened. In Clark's original process, as adopted at the Colne Valley Waterworks, the chalk is allowed to subside to the bottom of a settling-tank; in the modification of it known as the Porter-Clark process, as adopted at the Southampton Waterworks (and many others), it is mechanically filtered away.

We cannot boil hard water, wash in it, wash our clothes in it, or cook our food in it, without softening it, and at considerable expense; we boil it in a closed boiler, such as is used for heating water for baths, at the risk of an explosion from a choked-up pipe; we cannot effectually cleanse our skin with it; and our clothes are sometimes rather washed away than cleansed by its use.

For every purpose but drinking, washing our streets and flushing our drains, and perhaps for a few manufacturing processes, such as paper-making and brewing pale ale, hard water must be softened, and we are therefore naturally led to consider in what way it can be most economically softened.

The Rivers Pollution Commission of 1868 stated the relative cost of softening water by lime, soda, and soap, to be as follows:—

	£	*s.*	*d.*
1 cwt. of quick-lime	0	0	8
4¾ cwt. of carbonate of soda at 12*s.* 2*d.* .	2	17	9
20¼ cwt. of hard yellow soap at £2 6*s.* 6*d.* .	47	1	8

The cost of the coal required to soften the same quantity of water by boiling in an ordinary kitchen boiler they estimated to be at the rate of 7*s.* 6*d.* for every 9*s.* expended in soap, or £39 4*s.* 8*d.* (See 'Report of the Commission,' pp. 204, 205.)

These figures do not, however, quite tally with some other statements in the Commissioners' Report, and the cost of coal, soda, and soap is now much less than it was at the time this enquiry was being made. A fairer estimate, for the present time, of the quantities and cost of these different materials required to reduce 100,000 gallons of water from 20° of hardness to 6°, or by 14°, which is the extent of softening which would probably be deemed adequate for the Watford water, would be as follows:—

	£	*s.*	*d.*
1½ cwt. of quick-lime at 8*d.* per cwt. . .	0	1	0
5 cwt. of carbonate of soda at 3*s.* 8*d.* per cwt.	0	18	4
21½ cwt. of soap at 21*s.* per cwt. . . .	22	11	6
25 tons of coal at 16*s.* per ton . . .	20	0	0

Even at these much-reduced prices of soda, soap, and coal (the Commissioners estimated the cost of coal at 1*s.* 6*d.* per cwt. or 30*s.* per ton), it will be seen that the cost of softening water by carbonate of soda is 18 times that by lime, that the cost of softening it by boiling is 400 times that by lime, and that the cost of softening it by soap is 450 times that by lime.

Lime, therefore, completely puts out of court the other three agents by which water is usually softened.

There is yet another, and a very effectual, method of softening water to be mentioned, and that is by distillation, but this is a very expensive process, distilled water requiring for its production the consumption of about one-tenth its weight of coal. This is equivalent to the consumption of a pound of coal for every gallon of softened water. Distilled water is the softest that can be obtained, and if aërated is perfectly wholesome and pleasant to the taste.

While soft water is undoubtedly the best for every purpose we have yet considered, whether soft water or hard water is best for drinking is not easily determined. Statistics of the death-rate in towns have frequently been brought forward as bearing upon this point, and the result is almost invariably that the rate is a little higher in towns supplied with soft water than it is in towns supplied with hard water. For instance, in his evidence before the recent Royal Commission on the Metropolitan Water Supply, Mr. Thomas Hawksley put in a table showing a death-rate for the ten years 1882–91 nearly 3 °/₀ higher in thirteen towns supplied with soft water than in fifteen towns supplied with hard water; but no one would consider that the death-rate of Preston (27·3 per 1000) and of Manchester (27·2) is higher than that of Derby (17·9) and of Brighton (17·7) because the former towns are supplied with soft water and the latter with hard water. On the other hand, Newcastle, with a death-rate of 24·1 per 1000, is supplied with hard water; Bradford, with a death-rate of only 19·5, with soft water. It is just as reasonable to infer that the higher death-rate of Newcastle is due to the hard water with which it is supplied. (See Table III, p. 114.) Again, in the 'Sixth Report of the Rivers Pollution Commission' (pp. 196–199) are tables which show that the average death-rate in a number of seaport towns and inland non-manufacturing towns supplied with moderately hard water is higher than it is in such towns supplied with either hard water or soft water. Surely this is a *reductio ad absurdum*, for if the death-rate in these towns depends upon the water with which they are supplied, we should drink either very soft or very hard water, and carefully avoid a water which is only moderately hard!

It is possible that there may be an indirect connection between the death-rate of a town and its water-supply in this way. Other things being equal, the healthiest towns will be those which are situated on permeable formations, such as Watford and St. Albans, owing to the dry subsoil and good drainage resulting from their location. Not only is the ground drier on such formations than it is on impermeable formations, but the air is also, which is of even more importance for health, for it tends to a comparative absence of fogs, and therefore to a clearer and more healthy atmosphere. But it is just such towns which are supplied with hard water, for it is accessible underground, and if obtained from neighbouring rivers it is almost equally hard, for they, on such formations, are chiefly fed from springs. Towns on impervious formations must get their water from rivers near, and they are fed from surface-waters which usually are soft; or they must procure it from a long distance, and in that case the water is always soft, for no town has ever yet sought or obtained a hard-water supply from a long distance. A soft-water supply, again, encourages manufactures by which the air is polluted.

Experiments have recently been made which tend to prove that the death-rate in our towns is directly dependent upon the degree of purity of the air; that the purity of the air and the amount of light are directly interdependent; and that by merely determining the amount of sulphur-compounds in the air we may form a very good idea of its purity, of the amount of light which passes through it, and of the healthiness of a town or of different parts of a large city, such as London or Manchester. These and other considerations seem to show that it is air, not water, which mainly determines the death-rate of a town; that so long as a water sufficiently free from organic impurities is provided, it makes very little difference whether the water be hard or soft. (See 'Report Brit. Assoc. for 1894,' p. 37.)

It is generally admitted that when a change has been made in any town from a hard-water to a soft-water supply, beneficial results have followed, and it has been argued that this proves that soft water is the most wholesome; but this does not necessarily follow. In the first place the soft water is usually more plentiful, and purer irrespective of hardness, than the water previously supplied, the change not as a rule being made merely to obtain soft water, but owing also to the scarcity or contamination of the old supply; and in the second place with an improved or increased supply of water other sanitary improvements have usually been introduced. One of these is the substitution of a constant for an intermittent supply of water, a change which is always conducive to health, and which, if properly carried out, by lessening the waste, reduces the consumption. To be wasteful with almost anything is bad for our health as well as for our morals; and there can be no doubt but that a plentiful and constant supply of water, whether hard or soft, with provisions for using it to the best advantage generally understood and appreciated, largely conduces to health of body and morality of mind.

The general opinion of experts appears to be in favour of soft water for drinking purposes. Of thirty witnesses who gave evidence before the Duke of Richmond's Commission on Water Supply, twenty-eight expressed an opinion in favour of soft water, some of them very strongly, one was decidedly in favour of hard water, and one expressed a qualified opinion in favour of it. The question was also fully discussed before the Rivers Pollution Commission, and the Commissioners state that the general result of the attention given to it by the highest medical and chemical authorities is that "whilst, on the one hand, opinions have differed considerably as to the wholesomeness of hard water, on the other there has been, and now is, an almost complete unanimity as to the wholesomeness of soft water." ('Report,' p. 184.) A still more decided opinion in favour of soft water was expressed by the Metropolitan Sanitary Commission of 1850. "On the whole," the Commissioners say, "we cannot doubt that the presence of lime and other mineral matter deteriorates the wholesomeness and value of water for the purposes of drinking." ('Report of the General Board of Health on the Water Supply of the Metropolis,' pp. 59, 60.)

The statement of the Duke of Richmond's Commission, that there is "a great want of exact evidence on the subject of the dietetic value of soft and hard waters," is still true; we know very little of their physiological action upon the human system. Even so recently as the year 1892, Mr. Hawksley, who appears to be almost alone in his advocacy of hard water, in his evidence before the Royal Commission on the Water Supply of the Metropolis, said that the hard-water towns showing a lower death-rate than that of the soft-water towns "is very much in accordance with reason; because hard water contains a certain quantity of lime, and lime is very beneficial to the human system, both as an ant-acid and as forming the base of all our bones." ('Minutes of Evidence,' p. 263.)

We all know the value of bicarbonate of soda as an ant-acid, but I think we should with as much reason put bicarbonate of lime into our teapot to soften the water as we should take it medicinally to correct acidity; and it is well known that it is phosphate of lime, and not carbonate or bicarbonate, that enters largely into the composition of our bones.

The fallacy of such reasoning as Mr. Hawksley's has been shown, moreover, long ago. The Right Hon. Lyon Playfair (now Lord Playfair), when giving evidence before the Duke of Richmond's Commission, was asked: "Do not some medical men consider that the presence of carbonate of lime in drinking-water is rather desirable than otherwise for health?" And he replied: "I have seen evidence given in cases of water-supply, not only that it was desirable for health, but that it was absolutely necessary for the formation of the bones. But that showed a lamentable want of chemical knowledge, because the lime required in food does not come from the water, but from the solid articles of food taken, and I do not think that the lime taken in water has any influence on the processes of bodily nutrition." This opinion he supported by referring to the men of Westmoreland and Cumberland, and of the Highlands of Scotland, who drink soft water from the hills. "Our Highlanders," he said, "are not generally supposed to be deficient in bone or muscle." Such a fact as this, which is incontestable, is worth much theory, even though it might be suggested that the Highlanders sometimes pollute the pure water from their hills with whisky!

Hard water has been credited with causing rheumatism, calculus, and dyspepsia. Calculous complaints have certainly been traced to its use, but it appears that it is water rendered hard by the presence of sulphates of lime and magnesia, rather than carbonates, which has been found to have caused such diseases. The Metropolitan Sanitary Commission of 1850 investigated this question, and came to the conclusion that although "stone" was more often caused by errors in solid than in liquid diet, it was "undoubted that the number of calculous complaints in the hospitals, as at Paisley, has greatly diminished, and that in the same ratio as the consumption of soft water has increased. At Bolton, also," the Commissioners add, "the most experienced practitioners independently attest the fact of the diminution of calculous complaints since soft water was introduced." ('Report,' p. 57.) Evidence in the same direction has been furnished by the introduction of a soft-water supply to Glasgow, and the following important statement as to the Gorbals soft water has been made by Dr. Leach, of Glasgow: "The comparative value of the new soft supply over the old hard supply has been a matter of discussion at the Glasgow Medical Society, of which I was President for two years. It was the unanimous opinion of the medical profession that great benefits of a sanitary kind had followed in the substitution of the soft water on the principle of constant supply. It has been observed that since this change urinary diseases have become less frequent, especially those attended by the deposition of gravel. So far as [my] experience has gone, my own opinion is that dyspeptic complaints have diminished in number." The Medical Society also attributed diminution in the number of fever cases and comparative immunity from cholera, in the one district of Glasgow which was then supplied with soft water, to the same cause—the substitution of a soft-water for a hard-water supply. This was before the introduction of the Loch Katrine water to the whole of Glasgow. (See the above 'Report,' p. 55.)

To quote another instance. The hard water formerly supplied to Liverpool has been credited with having the tendency to produce visceral obstructions; and Dr. Sutherland, a physician of that city, found that such complaints vanished on his patients leaving Liverpool, and reappeared immediately on their returning to it, but the water which did the mischief there was a hard selenitic water from the New Red Sandstone.

While the presence of bicarbonate of lime in water cannot, I think, be proved to be a cause of such complaints as these, dyspepsia can undoubtedly be traced to it, and I know persons who cannot drink the hard water supplied to Watford without it having a bad effect upon their digestive organs. It is my own impression that, although I do not suffer in this way from drinking the hard chalk water of St. Albans, some of the beneficial effects which I and others experience from a visit to a mountainous country such as North Wales, are due to our drinking the soft water from the hills, which I do largely and with much greater relish than the hard water to which I am accustomed. We should not, however, be too ready to rely upon our own tastes and feelings; we are very much the creatures of prejudice as well as of habit. The lower animals are less so, and we cannot credit them with having unjustifiable prejudices with regard to the water they drink. It is well known that hard water is injurious to horses, making their coats rough and rendering them liable to gripes, and they seem to know it as well as we do, for they will not drink it if they can get soft water. Dogs, also, will rather drink rain-water from a rut in the road, even if slightly muddy, than the clearest hard water which may be provided for them; at least, this is a trait of my own dog, and I have noticed it in others. I have been informed that the same is the case with birds, and that fancy pigeons should always have soft water provided for them.

This part of my subject has already extended to too great a length, and I will only add, in view of the possible objection that I have not been quoting recent authorities, that the view maintained more than a quarter of a century ago by Lord Playfair and other authorities, that water of the same degree of hardness as that of Watford (about 20°) is too hard for drinking purposes, has much more recently been expressed by the following foreign authorities:—Fischer, who places the limit of hardness of a water suitable for drinking at 12 degrees; Reichardt, who places it at 12½ degrees; and Wibel, and Kubel and Tiemann, who place it at from 12½ to 14 degrees. I have altered their expression, which is in parts per 100,000, to grains per gallon. (See Prof. W. R. Nichols' 'Water Supply,' New York, 1883.)

Although it may not admit of proof, in the present state of our knowledge, that water of 20 degrees of hardness due to the presence of bicarbonate of lime, as supplied to Watford, is unsuitable for dietetic purposes, that such water is so is the opinion of the highest medical and chemical authorities in this country and abroad, and it is an undoubted fact, universally admitted, that it is much too hard for all other domestic purposes, both on economical and sanitary grounds. The real question at issue, therefore, seems to be whether it is worth while to go to the expense of softening the Watford water. Before this question can be answered it is necessary to consider what the expense of softening it would probably be. The lime-process is the only one which is practically available for this purpose, whether the original Clark process, the Porter-Clark, or any other modification, need not here be considered.

The expense of this process, and the suitability for any particular place of one or other modification of it, depend upon various circumstances—the cost of lime, labour, machinery, site, etc., and, perhaps chiefly, upon the hardness of the water to be softened and the degree to which this is required to be done. At the Otterbourne Waterworks at Southampton the expense of the process employed is under a farthing—really about one-fifth of a penny—per thousand gallons, with a farthing per thousand gallons for interest and depreciation of plant. The water is there reduced from 18 to 6 degrees of hardness. At Henley-on-Thames, with water of 21½ degrees of hardness, the cost of softening is one-third of a penny per thousand gallons; and at Wellingborough, with water of 37 degrees of hardness, the cost of softening is four-fifths of a penny per thousand gallons, but this hardness is exceptional. The Porter-Clark process is the one employed at these places, the water after its admixture with lime-water being mechanically filtered through cloth, instead of being run into settling-tanks, as in the original Clark process employed at the Colne Valley Waterworks, where the cost is about the same as at the Southampton Waterworks. It has been calculated that if settling-tanks had been constructed at Southampton, the first cost of the plant would have been £3,000 more than it was with mechanical filters, exclusive of the cost of the extra land required for tanks. Against this, however, must be placed the increased cost of working with the filters. The cost of these processes is therefore much about the same, but at the Watford Waterworks the Porter-Clark process would probably have to be employed owing to the small extent of space available, unless the waterworks were removed from their present situation.

We may fairly presume that in such a town as Watford, where no appreciable quantity of water is required for manufacturing purposes (except by brewers, who have their own wells), 30 gallons per head per diem, with a constant supply, which it ought to be made compulsory for all towns to be provided with, would be ample. This is about 11,000 gallons per head per annum, the cost of softening which, at ½*d.* per 1,000 gallons, including materials, labour, depreciation of plant, and interest on outlay, would be 5½*d.*, or we may say, in order to leave a margin for contingencies, 6*d.* It is a difficult matter to estimate the saving which the use of the softened water would occasion. The estimated saving at the Darenth Asylum and Schools, due to the introduction, in 1887, of softening-plant, is stated to have been, up to December, 1892, at the rate of nearly 10*s.* per head per annum, the number of inmates being about 1,800. Interest on plant does not, however, appear to have been allowed for. In his Report to the Metropolitan Asylums Board, after the first twelve months of working the process, the Steward pointed out that in addition to this saving the wear and tear on the linen had been greatly reduced by its being washed in softened water. A large proportion of the saving here is due to reduced wear and tear of steam-boilers, and of steam and hot-water pipes, which are not used in an ordinary household, and therefore the average saving throughout a town is not likely to be so great as it is in such a public institution as this. Even if about half as much, say 5*s.* per head per annum, it would represent at least £4,200 per annum for the town of Watford.

The advantages so far considered have all been in favour of soft water, or of softened water; and there is one other advantage in the softening of water by the lime-process. Organic and other impurities are thrown down with the chalk, and thus the water is purified as well as softened. (See Table IV, p. 115.)

And not only is this the case, but the softening of the water appears to render it less liable to become contaminated by confervoid growths. In a Report to the Canterbury Gas and Water Company, Mr. S. C. Homersham said: "Spring water, when softened, may be kept in open reservoirs exposed to the air, light, and sun, without becoming covered on its surface with vegetation as the hard water does which issues from a chalk spring; for such water, though naturally free from organic matter, has a source of contamination within itself. When exposed to air, light, and sun, more especially in warm weather, the duplicate dose of carbonic acid that keeps the chalk dissolved gives rise to masses of vegetation that float in the water. Such masses (Confervæ) soon grow, soon become corrupt, soon give forth an offensive marshy odour, and become the habitat of animalcules and other living organisms that permeate and contaminate the water." (Quoted in 'Sixth Report of the Rivers Pollution Commission,' p. 210.) Whether or not Mr. Homersham may be correct as to the cause of the immunity of softened water from such organic vitiation, its beautiful light blue tint, as seen in the softening-tanks at the Colne Valley Waterworks, bears witness to its extreme purity.

The only advantages which I can find in a hard-water supply are the certain immunity from lead-poisoning, and the sparkling nature of the water, which renders it, to some, more pleasant to the taste than is a softened water, or a naturally soft water.

The action of soft water upon lead has been fully investigated, especially in the exhaustive enquiry which was made preparatory to the introduction into Glasgow of the soft water of Loch Katrine, when the only cases of lead-poisoning which were found to have occurred in any town supplied with soft water were traced to the action of the lead contained in paint upon plumbers and house-painters. It was also elicited that the water of Loch Katrine, which is about as soft as it is possible for any natural water to be, having a hardness of less than one degree, although having a decided action upon bright lead when taken direct from the lake, after it has run some distance has no action whatever upon leaden pipes, and this was found to be the case upon its introduction into Glasgow. Cases of lead-poisoning from very soft water of a slightly acidulous composition, have, however, occurred in the North of England, but as it is only proposed to reduce the hardness of the Watford water to about 6 degrees, there need be no fear of lead-poisoning when it does not occur with the very pure water of less than one degree of hardness obtained from Loch Katrine.

The taste of the water is a matter upon which opinions differ. From habit we usually prefer the water to which we are accustomed, but I think that to make softened water palatable to all it is only necessary to ensure its thorough aëration.

The title of this paper may appear to be somewhat misleading in view of the conclusion at which I have arrived that the advantages are all in favour of soft water, with the reservation that although the balance of evidence and the consensus of opinion of those best qualified to judge are in favour of the dietetic superiority of soft water over hard water, such superiority cannot be absolutely proved. I prefer, however, to leave the first part of the title as announced in our circular before the writing of the paper was commenced, when I thought that something might be said in favour of hard water and that there would not be so much to say in favour of soft water. In the case of Watford the only possible objection to softening the water that could be urged is the cost, and although that would probably be saved ten times over in the use of the water, most people would rather incur an indirect expenditure of half a sovereign, if not very patent to them, than be directly taxed a shilling. The poorer classes would benefit the most, for their water-rate is very much less in proportion to the quantity of water they use than is the rate charged to those who live in highly-rented houses.

TABLE I.—ANALYSES OF WATER FROM CHALK WELLS AND SPRINGS IN HERTFORDSHIRE.

(*Compiled from Tables in the 'Sixth Report of the Rivers Pollution Commission,' pp.* 100, 101, 123, *and* 127.)

LOCALITY AND SOURCE.	DISSOLVED MATTERS, IN PARTS PER 100,000.								HARDNESS, IN GRAINS PER GALLON.		
	Total Solid Impurity.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Previous Sewage contamination.	Chlorine.	Temporary.	Permanent.	Total.
Watford—Well at Waterworks, 1870	38·20	·030	·015	·001	·752	·768	7,210	1·60	16 94	3·22	20·16
,, Well at Waterworks, 1873	37·26	·042	·011	·001	·774	·786	7,430	1·80	15·54	4·20	19·74
,, Well at Sedgwick's Brewery, 1870	35·16	0	0	0	·635	·635	6,030	1·50	15·33	4·20	19·53
,, Spring at Otterspool, 1868	32·36	·026	·012	·002	·422	·436	3,920	1·26	14·70	2·59	17·29
Bushey—Well at Station, 1870	36·08	·034	·018	0	·174	·192	1,420	1·90	13·79	4·20	17·99
,, Bore-hole in Bushey Meadows, 1870	33·88	·027	·006	·006	·314	·325	2,870	1·35	16·66	2·66	19·32
,, Bore-hole in Bushey Meadows, 1873	33·16	·071	·026	·029	·343	·393	3,350	1·40	16·24	3·01	19·25
,, Well at Mr. Majoribank's, 1873	38·20	·038	·017	·003	·605	·624	5,750	1·80	15·33	4·83	20·10
Rickmansworth—Well by Moor Park, 1871	36 12	033	·014	0	trace	·014	0	1·68	19·11	3·22	22·33
Tring—Well at Chiltern Water Works, 1868	28·60	·036	·010	·001	·094	·105	630	1·39	16 10	2·31	18·41
Wheathampstead—Well at Blackmore End, 1874	38·32	·029	·007	0	·303	·310	2,710	3·00	18·90	2·80	21·70
,, Well at Farm, Blackmore End, 1874	54·60	·035	·030	0	·890	·920	8,580	6·30	22·19	5·18	27·37
Hertford—Well at Waterworks, 1873	37·06	·026	·008	0	·497	·505	4,650	1·90	14·98	3·22	18·20
,, Chadwell Spring, 1873	29·80	·420	·084	·001	·299	·384	2,680	1·80	9·38	4·62	14·00
Ware—New River Co.'s well at Amwell, 1868	31·88	·076	·009	0	·406	·415	3,740	1·39	11·55	4·13	15·68
,, Amwell Spring, 1873	33·32	·149	·034	0	·327	·361	2,950	1·80	12·88	3·43	16·31
Average	35·87	·067	·019	·003	·427	·448	3,995	1·99	15·60	3 61	19·21

TABLE II.—HARDNESS OF THE WATER SUPPLIED TO LONDON THROUGHOUT THE YEAR 1892, IN GRAINS PER GALLON.

(*Compiled from the Official Reports 'On the Composition and Quality of Daily Samples of Water supplied to London.'*)

MONTH.	New River Company.	East London Company.	Chelsea Company.	W. Middlesex Company.	Lambeth Company.	Grand Junction Co.	Southwark & Vauxhall Co.	Average.
January	17·32	18·63	16·03	16·73	17·63	17·10	17·03	17·21
February	16·38	17·43	16·57	16·73	16·41	16·40	16·73	16·66
March	16·73	17·89	16·10	16·26	16·38	16·31	16·68	16·62
April	14·94	15·94	14·53	14·94	15·05	15·05	14·84	15·04
May	15·00	15·78	14·98	15·52	15·05	14·84	15·00	15·17
June	14·28	14·42	13·35	13·55	14·48	14·21	13·73	14·00
July	13·77	13·50	13·65	13·14	13·79	13·50	13·39	13·53
August	14·26	14·05	14·11	12 79	13·00	13·17	13·50	13·55
September	14·07	13·26	13·49	12·04	13·00	12·49	13·05	13·06
October	15·10	14·01	14·89	12·84	13 09	12·59	13·06	13·65
November	17·42	18·63	17·74	15·47	16·25	15 94	16·05	16·80
December	18·58	19 84	18·00	17·16	17 79	17·69	17·84	18·13
Year	15·65	16·11	15·29	14·76	15·16	14·94	15·07	15·28

TABLE III.—MEAN ANNUAL DEATH-RATE PER 1,000 IN 1882–91, IN 26 LARGE TOWNS IN ENGLAND, WITH THE POPULATION IN 1891.

(*Compiled in part from Tables in the Appendices to the 'Report of the Royal Commission on Metropolitan Water Supply,' p.* 347.)

TOWNS SUPPLIED WITH HARD WATER.			TOWNS SUPPLIED WITH SOFT WATER.		
Municipal Borough.	Population.	Death-rate.	Municipal Borough.	Population.	Death-rate.
Birkenhead	99,857	19·5	Blackburn	120,064	24·5
Birmingham	478,113	20·2	Bolton	115,002	22·5
Bristol	221,578	18·9	Bradford	216,361	19·5
Cardiff	128,915	21·8	Halifax	89,832	21·3
Derby	94,146	17·9	Huddersfield	95,420	20·5
Hull	200,044	19·9	Leeds	367,505	22·2
Leicester	174,624	19·6	Liverpool	517,980	24·2
Newcastle	186,300	24·1	Manchester	505,368	27·2
Norwich	100,970	20·4	Oldham	131,463	22·7
Nottingham	213,877	19·7	Plymouth	84,248	22·4
Portsmouth	159,251	19·8	Preston	107,573	27·3
Sunderland	131,015	22·6	Salford	198,139	22·3
Wolverhampton	82,662	21·8	Sheffield	324,243	21·9
Mean	174,720	20·5	Mean	221,015	23·0

London ("Greater London"), with a population of 5,633,806 and a death-rate of 19·9, and Brighton, with a population of 115,873 and a death-rate of 17·7, are supplied with hard water.

TABLE IV.—IMPURITY AND HARDNESS OF WATER FROM CHALK WELLS AND RIVERS BEFORE AND AFTER SOFTENING WITH LIME BY CLARK'S PROCESS.

(*Compiled from Tables in the 'Sixth Report of the Rivers Pollution Commission,' pp.* 209 *and* 215.)

SOURCE.	BEFORE SOFTENING.				AFTER SOFTENING.			
	Total Solid Impurity.	Organic Carbon.	Organic Nitrogen.	Hardness.	Total Solid Impurity.	Organic Carbon.	Organic Nitrogen.	Hardness.
	Parts per 100,000	Parts per 100,000	Parts per 100,000	Grains per Gallon	Parts per 100 000	Parts per 100,000	Parts per 100,000	Grains per Gallon
From Chalk Wells.								
Tring Water-supply	28·60	·036	·010	18·41	8·18	·041	·008	2 24
Caterham Water-supply	27·68	·028	·009	14·84	8·80	·015	·003	3·08
Canterbury Water-supply.....	33·60	·012	·012	18·41	11·94	0	0	3·43
Kent Company's Water	40·42	·045	·014	20·37	19·00	·044	·016	4·90
From the Thames.								
Grand Junction Co.'s Water*	27·46	·159	·026	14·40	12·49	·110	·019	3·51
From the Lea.								
New River Co.'s Water	30·60	·135	·018	15·68	13·76	·100	·011	4·20
Average	31·39	·069	·015	17·02	12·36	·051	·009	3·56

* Mean of ten analyses given in the 'Report.'

XIV.

ON THE ADVANTAGES OF A SUPPLY OF SOFT WATER FOR THE TOWN OF WATFORD.

By Arthur King, M.B., C.M., D.P.H.

Read at Watford, 29th January, 1895.

Absolutely pure water is a very rare if not an unknown substance in nature, and has only been prepared by very careful distillation in vessels constructed of silver. In this condition, as is well known, it is composed of two elementary gases—oxygen and hydrogen—in the proportion by volume of one of the former to two of the latter. If we passed a current of electricity through some water we should see the bubbles of gas come off at the two poles of the battery, and if over each pole we placed an inverted glass tube we should find that at all stages of the process we should have double the volume of hydrogen to that of oxygen. Hydrogen is an inflammable gas, and oxygen is what is called a supporter of combustion; that is, it unites with bodies of the nature of hydrogen to give out light and heat, a new body being formed. Coal gas is largely composed of hydrogen and carbon or charcoal, and we know that when we heat it to a certain temperature it bursts into a flame, uniting with the oxygen of the air, two new bodies being formed, namely, water and carbonic acid gas. Perhaps some people do not quite appreciate the full importance of water to living beings, especially human beings. It forms about three-quarters by weight of the body of animals, a large percentage of all our drinks, and from about 10 to 80 per cent. of the different food-stuffs. It occurs largely dissolved in the atmosphere in the form of vapour. In this way it moderates the direct heat of the sun, and, still more important, it prevents the earth from losing heat by radiation; indeed, if it were not for this watery vapour the earth would not be a fit place for us to live on, for its whole surface would be frozen in a single night. I mention this presence of water in the air because it is of the utmost importance in connection with the question of water-supply.

Our main reservoir for water is the ocean, covering as it does nearly three-quarters of the surface of the earth. Unfortunately we do not all live near the sea, and, if we did, the large quantity of salts dissolved in sea-water would prevent our using it for drinking or domestic purposes. Nature, however, comes to our rescue, and by distillation and evaporation the sea gives up a large quantity of its water to the atmosphere in a very pure condition, retaining the salts itself. The warmer the air the more water it will absorb, and when this heated air comes to colder portions of the earth it cannot hold so much water; clouds are formed, and eventually the surplus water falls in the form of rain. In this country we are chiefly supplied with water distilled from the seas which lie between the tropics, and we owe in great measure the mildness of our climate to the latent heat conveyed by this watery vapour, which is again set free when it becomes condensed and falls to the earth as rain or snow. This rain falling on the different soils gets disposed of in various ways: some runs off the surface at once, forming streams, lakes, and rivers; a part again evaporates and goes back into the air; and a third portion sinks into the ground until it comes to some impervious stratum, when it accumulates in underground reservoirs or forms streams that break out at a lower level on the surface as springs.

Although the water when in the form of clouds is nearly pure, when it falls as rain it dissolves and takes up various matters which it meets with in the air, and various mineral and organic matters from the soils it falls upon. Near manufacturing towns it often contains sulphuric acid from the combustion of the sulphur in the coal consumed, and in all localities it dissolves a considerable quantity of the carbonic acid gas existing in the air. This carbonic acid, as I have mentioned before, is the result of the burning or combustion of carbonaceous materials, and is produced in large quantities from any ordinary wood or coal fire, and is also given off by the lungs of animals as the result of the burning or oxidation which goes on in them. I want especially to draw attention to this fact, because this gas in rain-water falling upon chalk is an important agent in the production of hard water. Hardness of water merely means that the water contains certain mineral substances which decompose soap, and render it a difficult matter to get any undecomposed soap dissolved in the water. The chief hardening ingredients are salts of lime and magnesia, but in the case of the Watford water we are principally dealing with carbonate of lime or chalk. To obtain a numerical expression for this quality of hardness, a sample containing 1 lb. of carbonate of lime in 10,000 gallons of water is said to possess one degree of hardness. The hardness of water is divided into permanent and temporary; the former is uninfluenced by boiling, the latter is removed by boiling for half-an-hour. As we cannot get rid of the former by the different softening methods, we will only consider the latter, which is principally due to the carbonates of lime and magnesia. The temporary hardness of the Watford water appears to vary somewhat between 15 degrees and 20 degrees.

The next question to consider is where the water obtains this considerable quantity of chalk. As there are extensive beds of chalk beneath the surface both around Watford and at a great many other localities in England, and as chalk is a porous medium, it stands to reason that the water from wells, springs, and streams in such situations should contain a great deal of dissolved chalk. But carbonate of lime or chalk is insoluble in pure water, so we must have some additional information as to the method of its solution. I have drawn attention to the fact that rain-water when it arrives on the ground has a good deal of carbonic acid gas in it, and it is the presence of this gas that enables the water soaking into the chalk to dissolve some of the carbonate of lime on its way. With regard to water from deep wells in the chalk, the Duke of Richmond's Commission on the Pollution of Rivers made the following report in 1874:—"The unpolluted deep well waters from the Chalk rank amongst the best and most wholesome with which we have become acquainted. They are almost invariably colourless, palatable, and brilliantly clear. . . . The Chalk constitutes magnificent underground reservoirs in which vast volumes of water are not only rendered and kept pure, but stored and preserved at a uniform temperature of about 50° F., so as to be cool and refreshing in summer and far removed from the freezing point in winter. It would probably be impossible to devise, even regardless of expense, any artificial arrangement for the storage of water that could secure more favourable conditions than those naturally and gratuitously afforded by the Chalk; and there is reason to believe that the more this stratum is drawn upon for its abundant and excellent water, the better will its qualities as a storage medium become. Every 1,000,000 gallons of water abstracted from the Chalk carries with it in solution on an average 1¼ ton of the chalk through which it has percolated, and thus makes room for an additional volume of about 110 gallons of water. The porosity or sponginess of the chalk must therefore go on augmenting, and the yield from wells judiciously sunk, ought, within certain limits, to increase with age. The only drawback to these waters is their hardness, but this disadvantage is greatly reduced by the circumstances that it is chiefly of the 'temporary' kind, and can be therefore easily and cheaply removed by the application of Clark's process."

Let us consider next more fully the meaning of hardness as applied to the action of the chalk on soap. In chemistry we recognize two distinct classes of compounds, acids and bases: these, having the property of uniting, together forming a third class called salts. Carbonate of lime is a salt formed of the base, quick-lime, and the acid, carbonic acid gas. Soap in the same way is a salt formed of the base or alkali, soda, and some rather complex organic acids called fatty acids. It often happens that when the two salts are brought together in solution the acid of the one goes to the base of the other and *vice versâ*, two new salts being formed as a consequence; and although both the original salts might be soluble in water, it does not follow that these new salts formed are soluble also. This is the case when chalk and soap come together in solution. The chalk which is soluble by virtue of the carbonic acid gas in the water reacts on the soap and the base of the gas, and quick-lime unites with the fatty acids of the soap, giving rise to the white, curdy, insoluble salts that we see floating on the top of hard water when we try to wash in it, the soda of the soap or base uniting with the acid of the chalk to form carbonate of soda; so that instead of chalk and soap we get carbonate of soda and lime salts of the fatty acids.

If we want to do away with this property of hardness, how are we to manage it? The simplest answer is by getting rid of the chalk. We have already seen that were it not for the carbonic acid gas in the water there would be no chalk, so we may go a step further and say, Get rid of the carbonic acid and the chalk will become insoluble. Of course, if we add sufficient soap we may in time get the water softened, but this is an expensive method, and there are always the nasty curdy compounds formed which get into the pores of the skin in our personal ablutions and clog them up. One well-known method of softening, which I have mentioned before, is by boiling the water for some time. This drives the carbonic acid gas off and liberates the chalk from solution, but to be effective the boiling must last for at least twenty minutes to half-an-hour; and there is another objection mentioned by the Chemical Commission of 1851, as follows:—"It is in the more careful washing for the upper and middle classes that the advantages of soft water become fully sensible; for where a hard water is heated the carbonate of calcium is precipitated on the linen, carrying down with it the colouring matter of the dirty water, and producing stains which there is the greatest difficulty in afterwards removing from the linen. The colouring matter from the water is thus, indeed, fixed upon the cloth by the precipitated calcium salt with the tenacity of a mordant." When, however, the chalk is precipitated by the lime-process which I am now about to mention, this carrying down of organic impurities is a distinct advantage, and I show here a specimen of precipitate derived from hard water, which has taken down with it a considerable quantity of dirty matter much better than any filter would have done. Compared with others the easiest and most economical way of getting rid of the chalk is by the lime-method.

It may seem somewhat paradoxical to add lime to get rid of chalk, but what we add is quick-lime (the base), which unites with the carbonic acid gas in the water and forms more chalk. By thus giving the gas something else to do it can no longer dissolve the chalk originally held in solution, and both the newly-formed chalk and the chalk in solution fall down to the bottom of the water, leaving it comparatively free from hardness. How shall we tell when we have added enough lime? If while we are mixing the lime with the hard water we add it till we get a pale yellow colour with a solution of nitrate of silver, this shows a very slight excess of lime which will quite disappear after the water is allowed to remain half-an-hour longer before being again tested.

I should like to point out one fact with regard to washing and laundry purposes, and that is that we cannot use hard water at all till it has been softened. It must be softened either by boiling, soda carbonate, lime, or soap, and the question that we have to ask ourselves is, Which is the most economical and convenient? Boiling is neither of these, as it requires time and gives trouble; soda is expensive; and soap is both expensive and unpleasant. The lime-method is both economical and gives us a most pleasant water to use.

It may have been observed that I have not yet touched upon the medical aspects of the question. In this case, as in some others, I may say that "doctors differ." I have no doubt in my own mind that in some cases hard water produces indigestion, constipation, and other troubles resulting from these conditions, and I am inclined to think that possibly the continual drinking of even small quantities of lime-salts may promote calcareous degeneration of the arteries and valves of the heart. With regard to the skin there can be no two opinions that softened water is better than hard, and I believe that Dr. Adams Clarke has found at the Leavesden School a great improvement in the condition of the children's skins since the introduction of softened water there. One point I cannot help touching on, and that is the question of rickets; I have heard it stated that hard water is a beneficial thing in the prevention of this disease. I wish rickets were only a question of chalk, as it might easily be dealt with then. Rickets, however, is a disease of improper feeding and bad hygienic surroundings. It is not water containing chalk that the children want, but good food containing phosphate of lime. If children had good pure air, plenty of light, and genuine new milk instead of so much of those starchy foods, they would not suffer from rickets. In this connection I may quote the evidence of the Right Hon. Lyon Playfair (now Lord Playfair) before the Royal Commission of 1869:—

(*Questioned by Mr. Prestwich*): "Do not some medical men consider that the presence of carbonate of lime in drinking-water is rather desirable than otherwise for health?—I have seen evidence given in cases of water-supply, not only that it was desirable for health, but that it was absolutely necessary for the formation of the bones. But that showed a lamentable want of chemical knowledge, because the lime required in food does not come from the water, but from the solid articles of food taken, and I do not think that the lime taken in water has any influence on the processes of bodily nutrition."

With regard to the other advantages of softened water I may quote the evidence of the same witness:—

(*Questioned by the Duke of Richmond*): "I gather from your statement that the mass of the population would be likely to be more cleanly, and therefore more healthy, if the water were soft, and less soap were used, than if the water were hard, causing a great difficulty in producing lather?—Yes, it is a curious thing that one never washes one's hands *in* a basin with hard water; where the water is hard you take a small quantity of it in the hand itself, and rub the soap until it forms a lather in the small quantity of water that is in the hand, and you merely use the water in the basin to rinse off that which you have employed in cleaning the hands; but with soft water you use the whole mass of water for detergence, and therefore it is more effective.

"And it is therefore more conducive to health?—Yes, a more thorough cleansing takes place.

"So that if it were a question of obtaining either hard or soft water for a population at the same price, you would give the preference largely to soft water, taking all the purposes into consideration?—At a very great difference in price I would give the preference to soft water, because the economy in manufactures is so enormously great with soft water."

(*Questioned by Mr. Harrison*): "Supposing that you had a choice between a hard water, such as is now supplied from the basin of the Thames, supposing it to be free from the impurities of sewage and otherwise, and a pure soft water, which should you give the preference to, with regard to the question of drinking or its use for culinary purposes?—Undoubtedly to the soft water. In all cases I strongly recommend towns not to accept hard water. Within the last three or four weeks I have been consulted with regard to supporting a Bill in Parliament for a water-supply to a town, and I refused to support it because it had a water with 20 degrees of hardness.

"You do not consider that hardness is positively injurious to health, do you?—In some cases hard water might prove injurious, as in calculous affections and in dyspepsia; still, generally a tolerably hard water may be taken without much inconvenience; but water of 20 degrees of hardness is very hard water, and I should much prefer even for purposes of health that it should be softer.

"And you think that it [soft water] is decidedly conducive to the health of a town, especially amongst the lower orders of the people?—I think it is of very great importance indeed."

Another point worth a moment's consideration is the furring of kettles and hot-water apparatus by hard water. The iron of an ordinary kettle is usually less than 1–16 in. thick and is a good conductor of heat, but the fur round the inside where hard water is used is at least 1–8 in. thick, and this fur is a bad conductor of heat. Consequently, when we want to boil water the heat has to pass through three times the thickness of material, two-thirds of which is a bad conductor. It has been found by experience that a kettle boils in a little more than one-third the time when soft water is used in place of hard water. Again, kitchen boilers average about ¼ in. thick, the fur in this case is about ½ in. to 1 in. thick, and the pipes being more or less furred, the proper circulation of the hot water is interfered with. To obtain hot water the fire must be very fierce, and the boiler then gets burnt away in about one-half or one-quarter the time it otherwise would be. The pipes also have to be repaired and cleaned, and there is the risk of explosion.

With reference to the matter of cooking, not having had much personal experience of culinary operations, I think it will be better if I let a cook speak for himself. Monsieur Soyer, the head cook at the Reform Club, was examined before the Royal Commission on Water Supply, and gave some very interesting evidence. I may mention, by the way, that after the completion of this Commission, the chairman, the Duke of Richmond, was so convinced of the advantages of softened water that he had all his water at Goodwood treated by Clark's process.

To return to Monsieur Soyer's evidence. It is as follows:—

"You are known to the Commissioners from your writings on cookery; and you have doubtless had occasion to try the qualities of different waters for culinary purposes; you have probably used Thames water?—Yes, I have; when I first became cook to the Reform Club we occupied Gwydyr House, which was then supplied with Thames water.

"What was your experience of it?—That it was very hard and inconvenient. . . .

"What was the effect of the hardness in cooking?—That we were in many processes obliged to use potass or soda for the water, to soften it.

"What were the processes?—First, in boiling cabbage, greens, spinach, asparagus, [and] especially French beans, hard water gives them a yellow tinge. Hard water shrivels greens and peas, [this] will be more particularly noticed in French beans. The process of boiling is also longer.

"That requires more fuel?—Certainly.

"What would be the difference in time?—With dry vegetables certainly one-fourth more.

"How is it with potatoes?—I do not think it acts so much upon potatoes, but still it has an influence upon all sorts of vegetables. I do not see the same effects, however, upon roots generally, as upon leaves generally; the effects are very powerful.

"What do you find to be the effect of hard water upon the animal foods?—Upon salt beef the hard water is not so good; it does not open the pores of the meat so freely as soft water. On fresh meat it likewise has a prejudicial effect, but not equal to that on vegetables. It has the effect of making very white meat whiter than [does] the soft water. Upon all delicate things it has, however, a more marked effect; for example, in making beef-tea, chicken or veal broth, or upon lamb; and the more delicate a substance is, the greater is the influence of a hard water upon it. A hard water as it were compresses the pores, whilst a soft water dilates them and the succulent matter which they contain, [and] it makes them more nutritious. The evil of hard water is more visible in small quantities, such as [of] broth or beef-tea.

"Then it will be the more prejudicial or expensive in domestic cookery, which must be in small quantities?—Exactly so; in the larger operations, where there is much boiling, the boiling itself, and for a long time, reduces the hardness. In the small quantities requisite for invalids and delicate persons the disadvantages are the most experienced. When I used Thames water at Gwydyr House, I have had quantities boiled in order to soften it, and have then let it get cool and kept it ready for use for the smaller operations.

"What is the effect of hard water upon bread?—I have not had practical experience in bread-making; but there is not the least doubt that soft water is of the greatest importance as making the best bread. This is exemplified in Paris, where the water is hard, and where that bread which is made in imitation of Gonesse bread, though made with the same flour and by the same bakers, never equals that made at the place itself, where the water is soft. I am informed that part of the water at Glasgow is very soft, and that the Scotch bakers [who have used it], when they first come to London, cannot understand why the bread does not rise so well as in Glasgow, even though they make use of the same yeast and flour. . . .

"What is your experience in respect to tea?—The hard water is injurious in deteriorating the flavour; it also requires more tea to give an equal strength. There can be no doubt that the softer water is of great importance; we have found it so with the water used at the Reform Club, which is Artesian well water.

"In respect to coffee, what is your experience?—Hard water produces a similar effect, but not quite so powerful.

"From these experiments and your extensive knowledge, will you state the general results as to the relative power of the hardest and the softest water in making tea?—I should say that whilst with the hard water three cups might be made, with the soft water about five might be made.

"What extra expenditure of tea, then, would the use of the Thames water incur in making tea?—Nearly one-third.

"That is on all the tea consumed in the Metropolis?—Yes, I have no doubt of it.

"Do you consider that the action of water on tea is a fair test and representative of its action on meat and vegetables in general, in all the delicate processes of cookery?—Yes, I do, and I have proved it in the following way. I have taken the solution of 16°, and compared it with the water from the well of the Reform Club. First, with vegetables, that is carrots, turnips, and onions, cut into small pieces of about one inch long and an eighth of an inch square, such as are used in Julienne soup, placed in two saucepans, with the same quantities of water and on the same gas-stove: those cooked in the Reform water were quickly done, and the flavour of the vegetables [was] in the water; whilst those cooked in the solution never became tender, nor did the flavour go into the water. Secondly, with potatoes, I cut a peeled potato into two, and boiled them at the same time in the above waters: the difference was easily distinguishable, that which was boiled in the hard water being harder but at the same time whiter. Thirdly, in extracting the juice or gravy from meat: the soft water does so quickly and well; but the hard water, instead of opening the meat, seems to draw it closer together, and to solidify the gluten; and I believe that the true flavour of the meat cannot be extracted by hard water. In [the] boiling of salt meat less salt is extracted when boiled in hard water, and at the same time the meat is not so tender as when boiled in soft water. Soft water evaporates one-third faster than hard water. I should in every way give the preference to soft water." . . .

I think we are in a position now to summarize the advantages of softened water under three heads—Health, Convenience, and Economy.

Health.—As to the wholesomeness of water with a hardness of 15° before boiling and 5° afterwards, the evidence given before the Royal Commission on Water Supply, 1869, is somewhat conflicting; for while Dr. Letheby considered a moderately hard water, such as Thames water, best suited for drinking purposes and the supply of cities, Dr. Parkes maintained that the amount of hardness should not exceed 10 or 12 degrees if possible. Mr. Simon and Dr. Lyon Playfair, on the other hand, although they did not condemn the London water on account of its hardness, both expressed themselves in favour of a softer water for purposes of health. The inference that may be drawn from this and other evidence would, therefore, appear to be this, that the total hardness of a good water ought not to exceed 15 degrees nor the permanent hardness 5 degrees. The Watford water has much more than this amount of total hardness.

Convenience.—I think we must all acknowledge the greater convenience of softened water both in washing, laundry, and cooking operations.

Economy.—With regard to soap the General Board of Health in 1850 issued a report on the Thames water, and among other remarks occurs the following: "That the saving in soap from the use of soft water, in the operation of washing (the expense of washing linen and other clothes being estimated, at an average of 1*s.* per head per week, to be nearly £5,000,000 per annum on the population of the Metropolis), would be probably equivalent to the whole of the money expended at present in water-supply." Of course these figures would come out much larger at the present day. It has been calculated that a saving of 1*s.* 6*d.* in every private family of five persons, and of 6*d.* in every working man's family, is effected by the lessened consumption of soap, fuel, and tea, and that for this there would be an increase of ½*d.* per week for water-rate in one case, and ¼*d.* per week in the other.

I will not go further into the practical methods of softening, except to say that there are two systems in use. The first is to let the precipitated chalk subside in tanks as is done in the Colne Valley Waterworks, and in the second, the water is filtered through a continuous band of cloth, which is kept continually worked. The latter, I believe, would be found the most practical for Watford.

I must express my regret, in conclusion, that the lack of time at my disposal has prevented me from preparing a few simple experiments that might have relieved the monotony of the subject.

XV.

CLIMATOLOGICAL OBSERVATIONS TAKEN IN HERTFORDSHIRE IN THE YEAR 1894.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 23rd April, 1895.

This is the eighth annual report of observations made at our five Climatological Stations, and comprises the usual series of tables.

The mean temperature of Hertfordshire in 1894, deduced from these observations, was 1°·3 above that of the seven previous years, and 0°·2 above the mean of 1882–86, showing that the year was rather warm. The mean daily range was small, being 0°·6 below the mean of 1887–93, and 0°·8 below that of 1882–86. The extreme range was great, owing to the low temperature (4°·0) recorded at New Barnet in January. Humidity and cloud were about the average; the rainfall was heavy and on an unusually large number of days. The most northern station (Royston) was as usual the warmest, and our most southern station (New Barnet) had as usual much the greatest range of temperature.

The observations are made at 9 a.m., the maximum temperature and the rainfall being entered to the previous day.

ROYSTON.

(London Road.)

Latitude: 52° 2′ 34″ N. Longitude: 0° 1′ 8″ W. Altitude: 301 feet.

Observer: *Hale Wortham, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Amount	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·6	31·4	41·8	10·4	10·0	52·0	87	5·9	1·56	19
Feb.	40·2	33·8	46·7	12·9	19·8	56·0	85	5·3	1·53	15
March	45·7	34·7	54·6	19·9	28·7	67·8	79	3·8	0·93	10
April	51·8	40·7	62·9	22·2	32·3	75·6	76	4·5	0·76	9
May	50·1	40·2	60·0	19·8	27·6	69·3	71	6·6	1·50	15
June	58·8	48·9	68·8	19·9	41·2	83·9	82	6·7	1·97	13
July	63·4	52·7	74·2	21·5	47·7	84·9	82	6·7	2·70	17
August	60·6	52·1	69·0	16·9	43·8	79·1	80	7·5	2·90	17
Sept.	54·2	46·5	61·9	15·4	34·6	72·2	83	6·9	1·38	13
Oct.	49·6	43·1	56·1	13·0	29·8	68·9	86	7·0	2·65	19
Nov.	45·3	39·6	51·1	11·5	31·0	60·8	89	5·5	3·41	17
Dec.	40·4	35·3	45·4	10·1	25·3	51·0	88	7·4	1·48	16
Year	49·7	41·6	57·7	16·1	10·0	84·9	82	6·2	22·77	180

BERKHAMSTED.

(Rosebank.)

Latitude: 51° 45′ 40″ N. Longitude: 0° 33′ 30″ W. Altitude: 400 feet.

Observer: *Edward Mawley, F.R.Met.Soc.*

Months	Temperature of the Air: Means: Mean	Means: Min.	Means: Max.	Means: Range	Extremes: Min.	Extremes: Max.	Humidity	Cloud, 0–10	Rain: Amount	Rain: Days
	°	°	°	°	°	°	%		ins.	
Jan.	37·1	32·2	42·0	9·8	10·8	51·5	92	7·2	2·24	23
Feb.	40·9	34·7	47·0	12·3	20·4	54·0	90	6·8	1·89	16
March	44·1	34·9	53·4	18·5	26·8	63·6	81	4·9	1·86	11
April	49·1	39·4	58·7	19·3	32·7	70·2	79	7·0	1·67	14
May	48·9	40·5	57·4	16·9	30·1	66·2	74	7·0	2·05	16
June	56·9	48·4	65·4	17·0	39·8	81·1	79	6·4	1·88	13
July	61·1	52·3	69·9	17·6	45·6	83·2	75	7·5	2·48	19
August	58·7	51·2	66·1	14·9	41·5	76·3	80	7·2	3·28	18
Sept.	53·5	45·9	61·2	15·3	35·5	69·8	86	7·8	1·63	11
Oct.	49·1	43·0	55·1	12·1	29·6	63·2	89	8·6	3·50	21
Nov.	45·3	39·5	51·1	11·6	30·7	62·3	91	7·0	5·18	18
Dec.	40·5	35·6	45·5	9·9	25·8	51·2	92	7·4	2·32	19
Year	48·8	41·5	56·1	14·6	10·8	83·2	84	7·1	29·98	199

ST. ALBANS.

(The Grange.)

Latitude: 51° 45′ 9″ N. Longitude: 0° 20′ 7″ W. Altitude: 380 feet.

Observer: *John Hopkinson, F.R.Met.Soc.*

Months	Temperature of the Air: Means: Mean	Means: Min.	Means: Max.	Means: Range	Extremes: Min.	Extremes: Max.	Humidity	Cloud, 0–10	Rain: Amount	Rain: Days
	°	°	°	°	°	°	%		ins.	
Jan.	36·9	31·4	42·4	11·0	10·9	51·2	90	6·8	2·58	24
Feb.	40·4	34·4	46·5	12·1	23·0	54·5	89	6·6	1·86	16
March	44·2	35·7	52·7	17·0	30·2	64·0	80	5·4	2·36	12
April	49·8	41·0	58·6	17·6	35·3	69·9	79	7·2	2·19	16
May	49·1	41·2	57·0	15·8	32·8	67·3	74	6·5	2·41	16
June	56·9	49·0	64·8	15·8	42·9	79·8	75	6·2	1·94	14
July	61·0	53·2	68·9	15·7	46·3	81·6	75	7·0	2·78	20
August	58·6	51·7	65·6	13·9	44·5	75·7	78	6·5	3·78	21
Sept.	53·5	47·3	59·7	12·4	37·9	67·5	83	7·1	1·88	15
Oct.	49·1	44·0	54·2	10·2	34·6	60·5	88	7·7	3·52	21
Nov.	45·2	39·6	50·8	11·2	30·9	62·1	89	6·2	4·81	18
Dec.	40·5	35·5	45·5	10·0	25·8	50·6	90	7·5	2·09	19
Year	48·8	42·0	55·6	13·6	10·9	81·6	82	6·7	32·20	212

BENNINGTON.

(Bennington Lodge.)

Latitude: 51° 53′ 45″ N. Longitude: 0° 5′ 20″ W. Altitude: 407 feet.

Observer: *Rev. J. D. Parker, LL.D., F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Amount	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·3	31·3	41·2	9·9	10·7	50·7	89	7·5	2·11	21
Feb.	40·4	34·6	46·3	11·7	22·0	54·6	87	6·6	1·85	17
March	44·1	35·5	52·7	17·2	28·7	64·3	78	5·2	1·06	10
April	50·1	40·8	59·3	18·5	32·8	71·8	76	6·8	1·80	11
May	48·5	40·3	56·7	16·4	31·1	68·8	73	7·8	1·84	17
June	56·8	48·5	65·1	16·6	42·2	79·3	76	6·7	1·67	15
July	61·0	52·4	69·6	17·2	46·4	82·0	74	7·5	2·82	19
August	58·6	51·2	66·1	14·9	43·5	75·0	76	7·5	2·48	20
Sept.	53·4	46·7	60·1	13·4	37·0	68·6	84	7·3	1·64	14
Oct.	49·1	43·7	54·5	10·8	33·1	63·0	89	8·5	2·48	21
Nov.	45·1	39·7	50·5	10·8	30·1	61·9	90	7·5	3·49	19
Dec.	40·6	36·0	45·2	9·2	25·8	50·5	89	7·3	1·79	21
Year	48·7	41·7	55·6	13·9	10·7	82·0	82	7·2	25·03	205

NEW BARNET.

(Gas Works.)

Latitude: 51° 39′ 5″ N. Longitude: 0° 10′ 15″ W. Altitude: 212 feet.

Observer: *T. H. Martin, C.E.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Amount	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·7	31·1	42·3	11·2	4·0	52·5	87	7·0	2·75	21
Feb.	40·2	33·0	47·5	14·5	16·5	56·9	86	5·9	1·89	15
March	43·7	32·6	54·8	22·2	22·5	66·8	79	4·5	1·45	9
April	49·0	36·9	61·0	24·1	27·5	71·1	84	6·5	2·10	13
May	50·4	39·5	61·4	21·9	29·8	72·1	80	6·7	1·73	9
June	58·2	47·7	68·7	21·0	39·0	81·6	78	6·5	1·86	11
July	62·1	51·0	73·1	22·1	41·8	85·0	86	6·5	2·66	15
August	59·8	50·3	69·3	19·0	39·0	79·9	80	6·9	3·21	15
Sept.	54·1	45·3	62·9	17·6	31·5	72·5	88	6·6	1·07	10
Oct.	49·7	42·4	57·1	14·7	26·1	63·0	90	7·7	3·77	18
Nov.	44·9	37·6	52·1	14·5	24·8	64·0	85	5·4	3·17	13
Dec.	40·4	35·1	45·7	10·6	25·2	51·5	85	6·4	2·24	15
Year	49·1	40·2	58·0	17·8	4·0	85·0	84	6·4	27·90	164

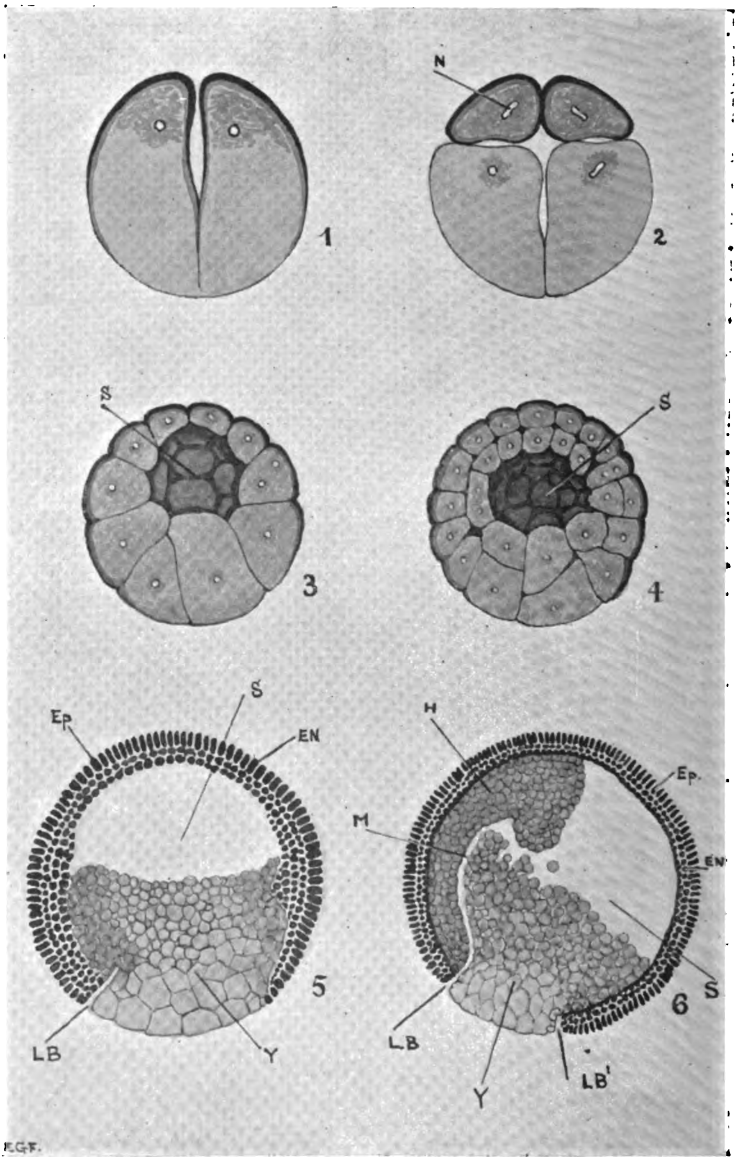
HERTFORDSHIRE.

Means of Climatological Observations (with extremes of temperature) in 1894, at Royston, Berkhamsted, St. Albans, Bennington, and New Barnet.

Months	Temperature of the Air						Humidity	Cloud, 1–10	Rain	
	Means				Extremes				Amount	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·7	31·5	41·9	10·4	4·0	52·5	89	6·9	2·25	22
Feb.	40·4	34·1	46·8	12·7	16·5	56·9	87	6·2	1·80	16
March	44·4	34·7	53·7	19·0	22·5	67·8	79	4·8	1·53	10
April	50·0	39·8	60·1	20·3	27·5	75·6	79	6·4	1·71	13
May	49·4	40·3	58·5	18·2	27·6	72·1	74	6·9	1·91	14
June..........	57·5	48·5	66·6	18·1	39·0	83·9	78	6·5	1·86	13
July	61·7	52·3	71·1	18·8	41·8	85·0	78	7·0	2·69	18
August.....	59·3	51·3	67·2	15·9	39·0	79·9	79	7·1	3·13	18
Sept..........	53·7	46·3	61·1	14·8	31·5	72·5	85	7·1	1·52	13
Oct.	49·3	43·2	55·4	12·2	26·1	68·9	88	7·9	3·19	20
Nov..........	45·2	39·2	51·1	11·9	24·8	64·0	89	6·3	4·01	17
Dec.	40·5	35·5	45·5	10·0	25·2	51·5	89	7·2	1·98	18
Year	49·0	41·4	56·6	15·2	4·0	85·0	83	6·7	27·58	192

Results of Climatological Observations, 1887–93.

Stations.	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Amount	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Royston	48·4	40·3	56·5	16·2	4·3	93·0	83	6·2	21·99	160
Berkhamsted	47·4	39·7	55·1	15·4	11·1	91·0	82	7·2	25·41	179
St. Albans.........	47·8	40·6	55·0	14·4	11·8	91·0	83	6·7	26·12	183
Bennington	47·5	40·2	54·7	14·5	14·4	90·9	81	7·3	24·31	187
New Barnet	47·6	38·3	56·8	18·5	8·0	94·5	82	6·2	23·31	141
County.........	47·7	39·8	55·6	15·8	4·3	94·5	82	6·7	24·23	170



Development of the Frog's Egg.

XVI.

THE BLASTOPORE OF THE FROG'S EGG IN RELATION TO THE HYPOBLAST.

By J. B. Russell, B.Sc.

Read at Watford, 23rd April, 1895.

PLATE VIII.

Before I refer to the special subject which I desire to bring before the Society with regard to the egg of the common frog (*Rana temporaria*), it is necessary to consider some of the earlier stages in its development.

The process of cell-division, or segmentation as it is called, of the frog's egg, is very similar to that which takes place in *Amphioxus*, but there are important differences which are due in great measure to the amount and distribution of the food-yolk.

This food-yolk, which is much more abundant in the lower hemisphere than in the upper, consists of nutritious matter embedded in the substance of the egg, and although this forms a ready store of nutriment for the developing embryo, yet it greatly impedes and interferes with the symmetrical segmentation of the egg, as will be seen from Figures 2, 3, and 4, in Plate VIII.

The egg, just before the completion of the first cleft, dividing it into two equal parts, is represented in Fig. 1. It will be observed that the cleft is at this stage incomplete below, in consequence of the presence of a large amount of food-yolk. A small cavity, also, has made its appearance in the interior: this is the segmentation-cavity (S). After this a second cleft is formed at right angles to the first; and Fig. 2 shows the third cleft, which is equatorial and much nearer the upper pole than the lower.

After this stage the division of the egg is continued according to no regular plan, but it will be seen from the figures that the upper cells are smaller than those at the lower pole. This is of course due to the absence of the hampering effect of yolk-cells. The ovum at the close of segmentation is represented in Fig. 4. At this stage we have a ball of cells—the upper ones, pigmented and devoid of yolk, forming the primary epiblastic layer; the lower ones large yolk-bearing cells, and unpigmented. These surround the segmentation-cavity.

In the succeeding stages of development the epiblast (Ep, Fig. 5) gradually encircles the egg until only a small circular patch remains at the lower pole (LB–LB′, Fig. 6). The growth of the epiblast in this way takes place by the division of yolk-cells into smaller pigmented ones at the surface.

The point to which I wish to direct special attention is that the alimentary cavity is formed as a narrow slit-like aperture opening at LB, Fig. 5. I have placed a section under the microscope showing this point. The slit rapidly grows inwards and spreads out beneath the surface of the egg near the future dorsal surface of the embryo (M, Fig. 6). A line of pigment appears in the yolk before the actual separation takes place, and the slit is at first very narrow, so that the two walls are almost in contact. At a later stage the floor of the segmentation-cavity (S, Fig. 6) is depressed, and a cavity is produced which forms part of the alimentary canal of the embryo.

The slit was formerly described as being formed by a process of invagination from the epiblast, but Professor Milnes Marshall has, I believe, clearly shown that this is incorrect, and that the alimentary tract is formed as has now been described. Thus it will be seen that the hypoblast which lines the embryonic canal is derived from yolk-cells.

The circular aperture, LB–LB′ (Fig. 6), is spoken of as the blastopore, and in the section under the microscope is shown the commencing formation of the hypoblast from its dorsal lip.

In conclusion, I desire to acknowledge my indebtedness to the works of Prof. Milnes Marshall, and to thank Mr. E. G. Farncombe for kindly preparing the drawings which illustrate this paper.

EXPLANATION OF PLATE VIII.

FIG.

1. The egg of the frog just before the completion of the first cleft.
2. The egg after the formation of the first equatorial cleft. N, one of the nuclei.
3. A later stage in the development. S, the segmentation-cavity.
4. The ovum at the close of segmentation. S, the segmentation-cavity.
5. A further stage, showing the epiblast (Ep) extending round the egg. EN, differentiated portion of the epiblast. LB, the point at which the slit-like aperture appears. S, the segmentation-cavity. Y, yolk-cells.
6. Showing the formation of the hypoblast (H) from the yolk-cells (Y). EN, differentiated portion of the epiblast (Ep). LB, the dorsal lip of the blastopore. LB′, the ventral lip of the blastopore. M, the mesenteron or alimentary canal. S, the segmentation-cavity.

The figures are highly magnified.

XVII.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN THE YEAR 1894.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 26th March, 1895.

There has been no change in the staff of our rainfall observers since the previous year. The records for the year 1894 entered in our principal table are therefore the same in number as before, namely 40. The number of daily records received is 35, which is two more than that for the previous year. We are still without observers in the districts of the Upper Ivel (Baldock), the Chess, the Upper Colne (North Mimms), the Brent, and the Stort (Bishop's Stortford and Sawbridgeworth). The places mentioned are those where rainfall observers are most required.

Particulars of the 40 rainfall stations, and the monthly and total rainfall and number of days on which at least 0·01 inch of rain fell, or, when the measurement is taken to thousandths of an inch, 0·005 inch, are given in Tables I and II, pp. 133–135.

The following supplementary table (Table III) gives eight other records of the rainfall in the year. Two of these are the records of additional gauges at Rothamsted, and six are taken from 'British Rainfall, 1894.'

Table III.—Supplementary to Tables I and II.

District.	Station.	Observer.	Gauge. Diameter.	Gauge. Height above Sea.	Rainfall.	Days.
			ins.	feet.	ins.	
6.	Northchurch	F. L. Sutton	5	400	29·67	182
8.	Harpenden—Rothamsted	Sir J. Lawes and Sir H. Gilbert	8	420	29·55	182
,,	,, ,,		72×87	420	31·22	201
9.	Elstree—Aldenham House	E. Beckett	10		27·48	166
10.	Watford—Kytes	Mrs. Horsman	5	239	30·06	173
11.	Barnet—Trent Park	W. H. Lees	5	254	27·42	
12.	Welwyn—Danesbury	A. M. Blake	5	405	28·28	189
18.	Hoddesdon—Feildes Weir	Major L. Flower	8	401	29·98	199

The mean rainfall in the county in the year 1894 was 27·82 inches. This is 1·08 inch above the average for the decade 1880–89, and 1·39 inch above that for the half-century 1840–89. The year was, therefore, rather a wet one. The number of wet days was very large, the average throughout the county being nearly 14 per cent. greater than the mean during the 20 years 1870–89.

The second half of the year was a little more than half as wet again as the first half, 11·04 ins. of rain falling in the first six months and 16·78 ins. in the last six months. The weather was dry in spring, and there was one long drought from about the middle of March to the middle of April; and it was wet in autumn, especially during the latter part of October and the first half of November, 22½ per cent., or two-ninths, of the year's rain falling in about one-sixteenth of the year.

Droughts in 1894. — Accepting as before the definitions of Mr. Symons (in 'British Rainfall') of an "absolute drought" as a period of *more than* 14 consecutive days without any rain, and a "partial drought" as a period of *more than* 28 consecutive days with an aggregate rainfall not exceeding 0·01 inch per day, there were three absolute droughts in 1894, and there was one partial drought.

The first absolute drought occurred at 33 out of the 35 stations for which I have the daily rainfall, lasting for

29	days,	March	16	to	April	13,	at	3	stations.
28	,,	,,	17	,,	,,	13	,,	1	,,
27	,,	,,	15	,,	,,	10	,,	1	,,
27	,,	,,	18	,,	,,	13	,,	1	,,
22	,,	,,	15	,,	,,	5	,,	1	,,
20	,,	,,	25	,,	,,	13	,,	1	,,
17	,,	,,	15	,,	March	31	,,	4	,,
17	,,	,,	16	,,	April	1	,,	3	,,
16	,,	,,	15	,,	March	30	,,	11	,,
16	,,	,,	16	,,	,,	31	,,	1	,,
15	,,	,,	15	,,	,,	29	,,	1	,,
15	,,	,,	16	,,	,,	30	,,	5	,,

The stations at which it did not occur were Elm House, Tring, where the longest period without rain was 14 days (March 16 to 29), and Moor Park, where it was only 13 days (March 17 to 29). The average duration of this drought was 18½ days.

The second absolute drought lasted for

15 days, June 21 to July 5, at 24 stations.

The third lasted for

19	days,	Nov.	18	to	Dec.	6	at	1	station.
16	,,	,,	21	,,	,,	6	,,	1	,,
15	,,	,,	21	,,	,,	5	,,	3	stations.

A partial drought lasted from about the middle of March to the middle of April, its average duration being 31 days. It prevailed at 30 stations, and lasted for at least

30	days,	March	15	to	April	13	at the	30	stations.
31	,,	,,	15	,,	,,	14	,,	21	of these.
32	,,	,,	13	,,	,,	13	,,	12	,, ,,
32	,,	,,	15	,,	,,	15	,,	9	,, ,,
33	,,	,,	13	,,	,,	14	,,	7	stations

of the 12 at which it lasted to at least the 13th of April.

Table I.—Hertfordshire Rainfall Stations, 1894.

District.	Station.	Observer.	Diameter of Gauge.	Height of Gauge above Ground.		Height of Gauge above Sea-level.
			ins.	ft.	ins.	ft.†
1.	*Royston	Hale Wortham	8	0	6	269
,,	*Odsey	H. George Fordham	5	1	0	260 T
3.	*Hitchin—The Firs	William Lucas	5	2	1	238
,,	* ,, Bancroft	Francis Ransom	5	0	9	212 T
,,	,, The Maples	William Hill	8	1	1	220
,,	* ,, High Down	Joseph Pollard	5	1	1	422
4.	*Tring—Elm House	E. J. Le Quesne	5	1	2	460
,,	,, Pendley Manor	J. G. Williams	5	2	0	500 ?
6.	*Cowroast	Rupert Thomas	5	4	2	345 L
,,	*Berkhamsted—Rosebank	Edward Mawley	8	1	0	401
,,	* ,, Fairhill	W. Bonner Hopkins	5	1	0	550 T
7.	*Great Gaddesden Vicarage	Rev. W. T. Drake	8	1	0	427
,,	*H. Hempstead—Apsley Mills	J. Dickinson & Co.	24	0	9	260
,,	* ,, Nash Mills	,,	12	3	9	237
8.	*Kensworth—The Grove	Miss S. Grace Jones	5	1	0	630 B
,,	Harpenden—Rothamsted	Lawes and Gilbert	5	0	9	420 T
,,	*St. Albans—Gorhambury	Hon. Wm. Grimston	5	1	0	425 T
,,	* ,, The Grange	John Hopkinson	5	1	0	380
10.	*Watford—Oaklands	Edward Harrison	5	5	6	273 T
,,	* ,, Frogmore	Arthur P. Blathwayt	5	1	0	182
,,	,, ColneVal.WaterW'ks	William Verini	5	1	0	220
,,	*Rickmansworth—Moor Park	Lord Ebury	5	2	0	340
12.	*Welwyn Rectory	Rev. Canon Wingfield	5	0	4	228 T
,,	*Hatfield—Brocket Hall	Lord Mount Stephen	8	1	0	250
,,	*Datchworth Rectory	Rev. J. Wardale	5	1	0	386 T
,,	Hertford—Marden Hill	Richard Hoare	5	0	6	257 T
13.	*Stevenage—Weston Park	M. R. Pryor	5	0	8	470 T
,,	* ,, Bennington House	Rev. Dr. Parker	5	1	0	408
14.	*Therfield Rectory	Rev. J. G. Hale	5	4	3	500
,,	*Throcking Rectory	Rev. C. W. Harvey	5	1	0	484 T
,,	*Buntingford—Hamels Park	E. Wallis	5	1	0	400 T
15.	*Much Hadham	T. Woodham Mott	5	1	0	222 B
17.	*Hertford—Bayfordbury	W. Clinton Baker	8	1	2	250
,,	*Ware—Red House	Joseph Francis	5	0	9	112 T
,,	* ,, Fanhams Hall	Miss Joyce Croft	8	1	0	253 T
18.	*Broxbourne—Stafford House	G. J. Newbery	5	1	0	118 T
,,	*Cheshunt—Old Nurseries	Paul and Son	5	1	0	92 T
,,	* ,, College	Rev. Dr. Reynolds	5	1	1	94 T
,,	*New Barnet—Gas Works	T. H. Martin	8	0	9	212
,,	*Southgate—The Lawns	George A. Church	5	0	6	240 T

* Daily fall received for these stations.
† For explanation of these symbols see Vol. VII, p. 53.

TABLE II.—RAINFALL IN

River District.			Station.	Jan.	Feb.	Mar.
				ins.	ins.	ins.
Ouse	Cam	1. Rhee	Royston	1·56	1·53	·93
			Odsey	1·35	1·59	·70
	Ivel	3. Hiz	Hitchin—The Firs	1·69	1·73	1·07
			,, Bancroft	1·80	1·43	·88
			,, The Maples	1·85	1·61	1·11
			,, High Down	1·64	1·69	1·11
Thames	Thame	4. Up. Thame	Tring—Elm House	1·78	1·62	1·53
			,, Pendley Manor	1·99	1·68	1·57
	Colne	6. Bulbourne	Cowroast	2·21	1·73	1·78
			Berkhamsted—Rosebank	2·24	1·89	1·86
			,, Fairhill	2·36	1·76	1·85
		7. Gade	Great Gaddesden Vicarage	2·24	1·68	2·03
			Hemel Hempstead—Apsley Mills	2·69	1·98	2·45
			,, Nash Mills	2·40	1·75	2·18
		8. Ver	Kensworth—The Grove	2·15	1·74	1·66
			Harpenden—Rothamsted	2·26	1·89	2·11
			St. Albans—Gorhambury	2·67	2·02	2·46
			,, The Grange	2·58	1·86	2·36
		10. Lo. Colne	Watford—Oaklands	3·52	2·13	2·22
			,, Frogmore	2·87	2·06	2·07
			,, Colne Valley Water Works	2·86	1·96	1·99
			Rickmansworth—Moor Park	3·21	2·52	2·24
	Lea	12. Mimram	Welwyn Rectory	2·19	1·62	1·39
			Hatfield—Brocket Hall	2·37	1·67	1·45
			Datchworth Rectory	2·18	1·80	1·17
			Hertford—Marden Hill	1·99	1·66	1·27
		13. Beane	Stevenage—Weston Park	2·09	1·82	1·12
			Bennington House	2·11	1·85	1·06
		14. Rib	Therfield Rectory	1·80	1·60	·99
			Throcking Rectory	1·85	1·70	1·07
			Buntingford—Hamels Park	2·08	1·72	1·03
		15. Ash	Much Hadham	2·56	1·98	1·10
		17. Upper Lea	Hertford—Bayfordbury	2·15	1·85	1·25
			Ware—Red House	2·23	1·69	1·05
			,, Fanhams Hall	2·71	1·72	1·20
		18. Lower Lea	Broxbourne—Stafford House	2·78	1·73	1·03
			Cheshunt—Old Nurseries	2·73	1·81	1·09
			,, College	2·64	1·54	1·07
			New Barnet—Gas Works	2·89	1·88	1·33
			Southgate—The Lawns	2·79	1·79	·99
Mean for the County				2·30	1·78	1·47

HERTFORDSHIRE IN 1894.

APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR.	DAYS.
ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	
.76	1.60	1.97	2.70	2.89	1.38	2.65	3.41	1.48	22.86	179
1.03	1.75	1.74	2.32	2.81	1.63	2.38	3.79	1.48	22.57	198
1.49	2.09	1.98	1.94	4.18	1.77	2.30	4.33	1.52	26.09	191
1.41	1.73	1.88	2.18	3.80	1.76	2.38	4.61	1.64	25.50	201
1.42	2.10	2.05	2.04	3.91	1.78	2.32	4.50	1.56	26.25	177
1.27	1.81	1.97	2.49	4.47	1.99	2.48	5.01	1.67	27.60	197
1.30	1.58	2.03	2.50	2.47	1.83	3.76	4.80	2.05	27.25	194
1.42	1.63	2.22	2.27	2.73	2.12	3.66	5.02	2.16	28.47	178
1.48	1.49	2.11	2.56	3.02	1.77	3.53	5.64	2.35	29.67	
1.67	2.05	1.88	2.48	3.28	1.63	3.50	5.18	2.32	29.98	199
1.71	2.02	1.88	2.38	3.56	1.61	3.46	5.27	2.22	30.08	212
1.49	1.97	1.93	2.72	3.02	2.00	3.31	4.99	2.40	29.78	192
1.92	2.01	1.99	1.99	3.01	2.02	3.63	5.30	2.37	31.36	186
1.67	2.15	2.01	2.94	3.35	1.98	3.59	5.19	2.01	31.22	181
1.66	1.82	2.27	2.58	2.97	2.28	3.49	5.75	2.06	30.43	187
1.67	1.98	1.96	2.35	3.50	2.10	3.33	4.82	2.07	30.04	196
2.06	2.47	2.03	3.01	3.95	2.47	3.73	5.30	2.36	34.53	203
2.19	2.41	1.94	2.78	3.78	1.88	3.52	4.81	2.09	32.20	212
2.08	1.80	2.29	2.78	4.32	1.72	4.08	4.88	2.20	34.02	197
2.02	1.75	2.16	2.95	4.59	1.35	3.87	4.42	1.90	32.01	187
1.96	1.77	1.98	2.59	3.50	1.21	3.68	4.23	1.91	29.64	169
1.80	1.80	2.42	2.92	4.23	2.18	4.57	5.53	2.18	35.60	203
1.60	2.13	2.01	2.08	3.31	1.66	2.86	4.49	1.60	26.94	164
1.37	1.89	1.77	2.53	3.34	1.45	2.90	4.47	1.75	26.96	193
2.04	1.66	1.69	2.22	2.49	1.33	2.47	3.96	1.71	24.72	180
1.61	1.79	1.79	2.66	2.56	1.30	2.70	3.40	1.52	24.25	174
1.32	2.04	2.03	2.51	3.26	1.65	2.48	4.30	1.84	26.46	193
1.80	1.84	1.67	2.82	2.48	1.64	2.48	3.49	1.79	25.03	205
1.02	1.81	1.94	2.60	3.17	1.61	2.95	3.60	1.71	24.80	199
1.08	2.13	1.69	1.94	2.58	1.47	2.42	3.59	1.74	23.26	203
1.45	1.80	1.66	2.53	2.36	1.62	2.60	3.10	1.91	23.86	185
1.74	2.28	2.01	3.21	2.81	1.50	2.85	3.46	2.24	27.74	193
1.46	2.14	1.86	2.22	2.66	1.21	3.15	3.45	1.82	25.22	195
1.24	1.75	1.82	2.57	2.29	1.32	2.96	3.30	1.82	24.04	180
1.36	2.18	1.90	2.59	2.44	1.36	2.84	3.52	1.89	25.71	193
1.82	1.80	2.11	3.30	2.76	1.13	3.73	3.24	1.77	27.20	199
1.85	1.93	1.96	3.42	2.64	.91	3.82	2.80	1.90	26.86	174
1.68	1.98	2.00	2.91	2.73	.99	3.64	3.05	1.88	26.11	166
2.08	1.84	1.74	2.66	3.22	1.07	3.78	3.16	2.24	27.89	164
2.44	2.07	1.99	2.96	3.09	.93	3.92	3.23	2.28	28.48	227
1.61	1.92	1.96	2.58	3.19	1.62	3.19	4.26	1.94	27.82	191

The rainfall at the 7 stations at which this partial drought lasted for 33 days averaged 0·008 in. per diem; at the 30 stations at which it lasted for at least 30 days it averaged 0·004 in. per diem. The average fall during all the periods was 0·006 in. per diem.

Distribution of Rainfall throughout the Year.—Of the total rainfall, 21½ °/₀ fell during the winter months (Jan., Feb., and Dec.), 18 °/₀ during the spring (March to May), 28 °/₀ during the summer (June to Aug.), and 32½ °/₀ during the autumn (Sept. to Nov.). The fall during each quarter and each season, and the deviation from the mean for the half-century 1840–89, was as follows:—

	Fall.	Diff.		Fall.	Diff.
1st quarter	5·55 ins.	—0·08 in.	Winter	6·02 ins.	+0·02 in.
2nd ,,	5·49	—0·52	Spring	5·00	—0·52
3rd ,,	7·39	+0·07	Summer	7·73	+0·75
4th ,,	9·39	+1·92	Autumn	9·07	+1·14

November was excessively wet; August and October also were very wet. September was the only month much drier than usual. The difference in each month from the mean for the half-century was—

	in.		in.		in.		in.
Jan.	—0·01	April	—0·17	July	+0·08	Oct.	+0·25
Feb.	+0·07	May	—0·21	Aug.	+0·81	Nov.	+1·70
Mar.	—0·14	June	—0·14	Sept.	—0·81	Dec.	—0·04

Thus the fall for the first six months was about half an inch below the mean, and for the last six months about two inches above it.

The absolute maximum fall in any one day in each month, and the stations recording it, were—

	ins.		ins.
Jan. 14—Broxbourne and Cheshunt	0·50	July 10—Moor Park, Rickmansworth	0·90
Feb. 17—Odsey	0·64	Aug. 24—Frogmore, Watford	1·70
Mar. 14—Gorhambury, St. Albans	1·07	Sept. 23—Nash Mills	0·79
April 24—New Barnet	0·64	Oct. 30—Moor Park	1·20
May 31—The Firs, Hitchin	0·65	Nov. 12—Cowroast and Kensworth	1·68*
June 3—Pendley Manor, Tring	0·66	Dec. 14—Southgate	0·82

* Also at Moor Park on the 14th.

The wettest day in each month was—

January 8th at 1 station, 14th at 24 stations, 22nd at 6, 29th at 8, 14th and 29th at 1.

February 17th at 39, 23rd at 1.

March 12th at 28, 14th at 12.

April 16th at 2, 17th at 1, 18th at 4, 24th at 29, 25th at 2, 29th at 1, 16th, 18th, and 24th at 1.

May 10th at 2, 15th at 1, 26th at 30, 30th at 2, 31st at 3, 10th and 26th at 1.

June 3rd at 18, 4th at 4, 5th at 1, 6th at 15, 15th at 1, 3rd and 15th at 1.

July 10th at 29, 14th at 5, 22nd at 4, 24th at 1, 10th and 24th at 1.

August 10th at 5, 23rd at 17, 24th at 11, 25th at 5, 23rd and 24th at 1, 23rd and 25th at 1.

September 6th at 3, 7th at 1, 8th at 1, 9th at 1, 22nd at 2, 23rd at 14, 24th at 8, 25th at 5, 6th and 23rd at 2, 7th and 24th at 2, 23rd and 25th at 1.

October 24th at 8, 28th at 6, 30th at 26.

November 12th at 18, 14th at 22.

December 14th at all stations.

The day in each month on which a heavy fall of rain was most general over the county was therefore—

Jan. 14th	April 24th	July 10th	Oct. 30th
Feb. 17th	May 26th	Aug. 23rd	Nov. 14th
March 12th	June 3rd	Sept. 23rd	Dec. 14th

The number of wet days in the year (average of 39 gauges) was 191, being 23 above the mean for the 20 years 1870–89. Of the total number there were 54 (or 28¼ °/₀) in the winter months, 38 (or 20 °/₀) in the spring, 51 (or 26¾ °/₀) in the summer, and 48 (or 25 °/₀) in the autumn.

The average number of wet days in each month, and the deviation from the mean for the 20 years 1870–89, was as follows:—

Jan. 22 +7	April 13 =	July 18 +4	Oct. 19 +4
Feb. 15 +1	May 15 +2	Aug. 19 +6	Nov. 16 =
March 10 —3	June 14 +1	Sept. 13 =	Dec. 17 +1

Distribution of Rainfall throughout the County.—The following table (Table IV) gives the mean fall for each month and for the year in each of the five river-districts represented, and in the two main hydrographical divisions of the county, the catchment-basins of the Great Ouse and the Thames, and also the difference in the year from the mean for the decade 1880–89.

TABLE IV.—RAINFALL IN THE RIVER-DISTRICTS.

MONTHS.	CAM.	IVEL.	THAME.	COLNE.	LEA.	OUSE.	THAMES.
	ins.	ins.	ins.	ins.	ins.	ins.	ins.
Jan.	1·45	1·74	1·88	2·59	2·34	1·65	2·42
Feb.	1·56	1·61	1·65	1·93	1·75	1·60	1·81
March	·82	1·06	1·55	2·09	1·15	·97	1·56
April	·89	1·40	1·36	1·81	1·61	1·23	1·68
May	1·68	1·93	1·61	1·96	1·95	1·85	1·93
June	1·85	1·97	2·12	2·06	1·87	1·93	1·96
July	2·51	2·16	2·39	2·65	2·65	2·28	2·63
August	2·85	4·09	2·60	3·58	2·79	3·67	3·10
Sept.	1·51	1·82	1·97	1·87	1·34	1·72	1·60
October	2·51	2·37	3·71	3·66	3·03	2·42	3·33
Nov.	3·60	4·61	4·91	5·10	3·53	4·27	4·26
Dec.	1·48	1·60	2·11	2·17	1·86	1·56	2·00
Year	22·71	26·36	27·86	31·47	25·87	25·15	22·28
Diff. from 1880-89	—0·79	+1·09	.	+2·50	+0·32	+1·62	+1·14

The mean rainfall in each of the minor river-basins or sub-districts represented, was as follows:—

		ins.			ins.
CAM	Rhee	22·71	LEA	Mimram	25·72
IVEL	Hiz	26·36		Beane	25·75
THAME	Upper Thame	27·86		Rib	23·97
COLNE	Bulbourne	29·91		Ash	27·74
	Gade	30·79		Upper Lea	24·99
	Ver	31·80		Lower Lea	27·31
	Lower Colne	32·82			

The total yearly fall ranged from 22·57 ins. at Odsey to 34·80 ins. at Moor Park, Rickmansworth; and the total monthly fall from 0·70 in. at Odsey in March to 5·75 ins. at Kensworth in November. The greatest fall in any one day was 1·70 in. at Frogmore, Watford, on the 24th of August.

Distribution of Rainfall in each Month.—The nomenclature used in the following account of the chief falls of rain is the same as in my previous reports, falls of at least ½ inch being styled *considerable*, ¾ inch *very considerable*, 1 inch *great*, 1¼ inch *very great*, and 1½ inch *heavy*. There was no *very heavy* (1¾ inch) or *excessive* (2 inches) fall in the year. This analysis only applies to the 35 stations for which I have returns of the daily rainfall.

JANUARY.—Rainfall about the average but on an unusually large number of days, in the form of snow for a few days during the first week, and for the last day or two. There was a *considerable* fall of rain on the 14th at two stations (in the Lower Lea district).

FEBRUARY.—Rainfall about the average and on the usual number of days. There was a *considerable* fall at twenty-two stations on the 17th.

MARCH.—Rainfall a little below the average on a rather small number of days, nearly all during the first half of the month, only a very small quantity of rain falling after the 15th at about half the number of stations on one or two days. On the 12th there was a *considerable* fall of rain at five stations, and on the 14th the fall was *considerable* at four stations, *very considerable* at five, and *great* (1·07 in.) at Gorhambury.

APRIL.—Also a rather dry month, with rain on the usual number of days, nearly all during the second half of the month, very little rain falling before the 14th, and none at some stations. On the 18th there was a *considerable* fall at one station (Datchworth), and on the 24th at five stations.

MAY.—Although more rain fell than in either of the previous three months, May was considerably drier than usual, but with rather more than the usual number of wet days. On the 10th there was a *considerable* fall at one station (Gorhambury), on the 26th at seven stations, and on the 31st at two (in the Hiz district).

JUNE.—The fourth month in succession with the rainfall appreciably below the average, about the usual number of days being wet. All the rain fell during the first three weeks, none being recorded at any station after the 20th. On the 6th there was a *considerable* fall at five stations (all but one in the Lower Lea district).

July.—A wet month, with many rainy days; rain at most stations falling every day but one or two for the three weeks 6th to 26th. During a thunderstorm on the 10th the fall of rain was *considerable* at twenty-five stations, and *very considerable* at six, the only stations with less than half an inch of rain being Apsley Mills, Hamels Park, and the Red House and Fanhams Hall, Ware. On the 13th the fall was *considerable* at one station (Frogmore, Watford), on the 14th *considerable* at four stations and *very considerable* at two, on the 22nd *considerable* at three and *very considerable* at three, and on the 24th *considerable* at one (Weston Park).

August.—A very wet month, and, like July, with many rainy days. No rain fell after the 26th, but up to that date there were only seven days without rain on the average throughout the county. During a thunderstorm on the 10th, most violent in the neighbourhood of Hitchin, there was a *considerable* fall of rain at four stations, a *very considerable* fall at one station, and the fall was *great* at The Firs, Hitchin (1·06 in.), Fairhill, Berkhamsted, (1·12 in.), and Moor Park (1·15 in.). On the 16th there was a *considerable* fall at one station (Much Hadham). The 23rd, 24th, and 25th were very wet days, the fall of rain averaging 0·69 in. on 23rd, 0·57 in. on 24th, and 0·31 in. on 25th, or 1·57 in. in the three days. On the 23rd the fall was *considerable* at twenty-two stations, and *very considerable* at thirteen, thus being at least half an inch at all the stations; on the 24th it was *considerable* at three stations, *very considerable* at three, *great* at Gorhambury (1·14 in.), Moor Park (1·22 in.), and Brocket Hall (1·22 in.), *very great* at High Down, Hitchin (1·32 in.), The Grange, St. Albans (1·42 in.), and Oaklands, Watford (1·45 in.), and *heavy* at Frogmore, Watford (1·70 in.); and on the 25th it was *considerable* at five stations, *very considerable* at one station, and *great* at Weston Park (1·01 in.).

September.—A month with small rainfall, but on the usual number of days. On the 23rd there was a thunderstorm, with much rain, in the west of the county, the storm being very violent about St. Albans, Watford, and Rickmansworth, where much damage was done to growing crops. The fall, however, only exceeded half an inch at four stations, being *considerable* at two (Apsley Mills, Hemel Hempstead, and The Grange, St. Albans), and *very considerable* at two (Nash Mills, Hemel Hempstead, and Gorhambury, St. Albans).

October.—A very wet month with many rainy days, especially wet towards the end, the last nine days having an aggregate rainfall of 2·38 inches, being an average of rather more than 0·26 in. per diem. On the 10th the fall was *considerable* at one station (Kensworth), on the 24th *considerable* at twenty-two and *very considerable* at one, on the 26th *considerable* at four, on 28th *considerable* at twenty-two, and on the 30th *considerable* at five, *very considerable* at sixteen, and *great* at Oaklands, Watford (1·00 in.), Southgate (1·13 in.), and Moor Park (1·20 in.).

November.—An excessively wet month, but with rain on only the usual number of days. All the rain fell during the first three weeks, except a very slight fall on one or two days, the last eight days having an *aggregate* fall of less than 0·01 in. on the average throughout the county. On the 7th the fall was *considerable* at eleven stations and on the 11th at eight. On the 12th it was at least half an inch at every station but one, being *considerable* at eight stations; *very considerable* at six; *great* at The Grange, St. Albans (1·04 in.), Therfield Rectory (1·07 in.), Moor Park (1·11 in.), Gorhambury, St. Albans (1·12 in.), Apsley Mills, Hemel Hempstead (1·14 in.), Nash Mills, Hemel Hempstead (1·19 in.), Brocket Hall (1·20 in.), and Datchworth Rectory (1·21 in.); *very great* at Welwyn Rectory (1·25 in.), Odsey (1·30 in.), The Firs, Hitchin (1·37 in.), Bancroft, Hitchin (1·45 in.), and Elm House, Tring (1·47 in.); and *heavy* at High Down, Hitchin (1·50 in.), Great Gaddesden Vicarage (1·52 in.), Weston Park, Stevenage (1·54 in.), Fairhill, Berkhamsted (1·58 in.), Rosebank, Berkhamsted (1·62 in.), Cowroast (1·68 in.), and Kensworth (1·68 in.). On the 13th there was a *considerable* fall at four stations. The 14th was the wettest day in the year on the average throughout the county, at least half an inch falling at every station, although the maximum fall did not quite reach that on the 12th. The fall was *considerable* at one station; *very considerable* at ten stations; *great* at Bennington House, Stevenage (1·00 in.), Odsey (1·02 in.), Rosebank, Berkhamsted (1·02 in.), Bayfordbury, Hertford (1·04 in.), Broxbourne (1·05 in.), Fairhill, Berkhamsted (1·06 in.), The Firs, Hitchin (1·07 in.), Throcking Rectory (1·09 in.), Weston Park, Stevenage (1·10 in.), Bancroft, Hitchin (1·15 in.), Datchworth Rectory (1·19 in.), Elm House, Tring (1·20 in.), and Kensworth (1·21 in.); *very great* at Oaklands, Watford (1·25 in.), Cowroast (1·33 in.), Brocket Hall (1·36 in.), High Down, Hitchin (1·37 in.), Frogmore, Watford (1·39 in.), The Grange, St. Albans (1·40 in.), and Welwyn Rectory (1·40 in.); and *heavy* at Nash Mills, Hemel Hempstead (1·53 in.), Gorhambury, St. Albans (1·56 in.), Apsley Mills, Hemel Hempstead (1·62 in.), and Moor Park (1·68 in.). An account of the floods caused by the rainfall on this day and the 12th, the climax of a wet period of three weeks, follows this report.

December.—Rainfall about the average, and on about the usual number of days. On the 14th the fall was at least half an inch at every station but two, being *considerable* at thirty stations and *very considerable* at three.

XVIII.

THE FLOODS OF NOVEMBER, 1894, IN HERTFORDSHIRE.

By JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 26th March, 1895.

THE immediate cause of the floods which occurred in the South of England and South Wales in the middle of November, was a heavy fall of rain which commenced on Monday night the 11th, or Tuesday morning the 12th, and lasted until about mid-day or rather later on Wednesday the 14th, with one intermission of considerable duration in most districts. In Hertfordshire there were two distinct falls: the first commenced about the middle of the night of the 11th–12th and ceased about noon; the second commenced about the same time in the night of the 13th–14th and ceased early in the afternoon of the 14th—ceased, that is, as a heavy fall, for a little rain fell later in the day. On the morning of the 13th the sky at St. Albans was perfectly cloudless and the weather was fine throughout the day. Each of these falls lasted about twelve hours and averaged about an inch and a half. But the severity of the floods was due in great measure to another cause, the saturated state of the ground upon which this heavy rain fell. From the 1st to the 10th of November there was but little more than the average rainfall, but during the previous nine days, October 23rd to 31st, nearly two and a half inches of rain fell in our county. And it was much the same throughout the southern half of England and the greater part of Wales.

October and November are usually rather wet months, our rainfall in October being about three-quarters of an inch above the average for all the months in the year, and in November being about one-quarter of an inch above this average, so that we have to compare an exceptionally wet period with a season which is usually a wet one, otherwise the following comparisons would have been much more striking than they are.

During the nine days from October 23rd to 31st the mean rainfall in Hertfordshire was 2·38 inches, or an average of 0·265 inch per day, being nearly three times the usual fall for the time of the year; during the ten days from November 1st to 10th the fall was 1·02 inch, or an average of 0·102 inch per day, being only 20 per cent. above the usual fall for this period; and during the four days from November 11th to 14th the fall was 2·97 inches, or 0·742 inch per day, being very nearly nine times the usual daily fall for November. Taking the whole period of 23 days from October 23rd to November 14th it will be found that the fall was more than three times the usual quantity, for this gives an average of 0·277 inch per day against the usual average for October and November together of 0·088 inch per day. These comparisons are on the average of 50 years rainfall in Hertfordshire ending 31st March, 1892.

Details of the rainfall during the 23 days preceding the floods at 35 stations in Hertfordshire are given in the following table. The numbers in the first column are those of the river-districts (see p. 134).

TABLE I.—RAINFALL IN HERTFORDSHIRE, 23RD OCTOBER TO 14TH NOVEMBER, 1894.

No.	STATION.	Oct. 23-31	Nov. 1-10	Nov. 11-12	Nov. 13-14	Nov. 11-14	Oct. 23-Nov. 14
		ins.	ins.	ins.	ins.	ins.	ins.
1	Royston	1·69	·76	1·34	1·15	2·49	4·94
,,	Odsey	1·39	·82	1·64	1·12	2·76	4·97
3	Hitchin—The Firs	1·57	·92	1·79	1·32	3·11	5·60
,,	,, Bancroft	1·62	1·03	1·87	1·41	3·28	5·93
,,	,, High Down	1·71	1·31	1·91	1·66	3·57	6·59
4	Tring—Elm House	2·89	1·07	1·96	1·62	3·58	7·54
6	Cowroast	2·77	1·36	2·09	1·92	4·01	8·14
,,	Berkhamsted—Rosebank	2·59	1·24	2·13	1·57	3·70	7·53
,,	,, Fairhill	2·57	1·36	2·03	1·59	3·62	7·55
7	Great Gaddesden Vicarage.	2·45	1·29	2·02	1·47	3·49	7·23
,,	H. Hempstead—Apsley Mills	2·91	1·31	1·63	2·07	3·70	7·92
,,	,, Nash Mills	2·82	1·20	1·70	1·96	3·66	7·68
8	Kensworth—The Grove	2·28	1·39	2·23	1·76	3·99	7·66
,,	St. Albans—Gorhambury	2·79	1·33	1·64	2·02	3·66	7·78
,,	,, The Grange	2·81	1·27	1·54	1·73	3·27	7·35
10	Watford—Oaklands	3·35	1·44	1·45	1·55	3·00	7·79
,,	,, Frogmore	3·08	1·05	1·42	1·59	3·01	7·14
,,	Rickmansworth—Moor Park	3·77	1·49	1·60	1·88	3·48	8·74
12	Welwyn Rectory	2·27	·85	1·70	1·74	3·44	6·56
,,	Hatfield—Brocket Hall	2·59	·92	1·67	1·66	3·33	6·84
,,	Datchworth Rectory	1·96	·67	1·62	1·46	3·08	5·71
13	Stevenage—Weston Park	1·61	·86	1·91	1·26	3·17	5·64
,,	,, Bennington House	1·83	·69	1·37	1·23	2·60	5·12
14	Therfield Rectory	1·75	·82	1·43	1·14	2·57	5·14
,,	Throcking Rectory	1·57	·83	1·25	1·31	2·56	4·96
,,	Buntingford—Hamels Park	1·71	·64	1·23	1·01	2·24	4·59
15	Much Hadham	1·83	1·03	1·00	1·22	2·22	5·08
17	Hertford—Bayfordbury	2·34	·82	1·10	1·37	2·47	5·63
,,	Ware—Red House	2·33	·92	1·03	1·13	2·16	5·41
,,	,, Fanhams Hall	2·03	·87	1·06	1·40	2·46	5·36
18	Broxbourne—Stafford House	2·83	·79	1·04	1·23	2·27	5·89
,,	Cheshunt—Old Nurseries	2·92	·69	·88	1·02	1·90	5·51
,,	,, College	2·84	·93	·92	1·02	1·94	5·71
,,	New Barnet—Gas Works	2·92	·73	1·10	1·05	2·15	5·80
,,	Southgate—The Lawns	2·96	1·04	1·19	·68	1·87	5·87
	Mean	2·38	1·02	1·53	1·44	2·97	6·37

It will be seen that the distribution of the rain over the county followed the usual rule, the fall in the west being greater than in the east. If the rainfall stations were equably distributed, the mean of their records would represent the true mean rainfall in the county, and they are very nearly so. It will be well, however, to show their numerical relation to the area of the chief river-basins. The area of Hertfordshire is 633 square miles, but it will be convenient and sufficiently accurate for my purpose to consider it to be 630. This area may be approximately divided between the different river-basins as follows:—Great Ouse (Nos. 1–3), in the north of the county, 75 square miles; Thame (No. 4), in the north-west, 15; Colne (Nos. 6–10), in the west (including a small portion of the Brent), 210; and Lea (Nos. 11–18), in the east, 330. These areas are in the following ratios: 5, 1, 14, 22. The number of rainfall stations in the four river-basins is as follows: Ouse, 5; Thame, 1; Colne, 12; Lea, 17. There are therefore required, in order to get an exact representation—one rainfall station to every fifteen square miles—only two more stations in the basin of the Colne, and five more in that of the Lea. If the relative areas of the basins are considered, it will be seen that a result sufficiently accurate for any practical purpose would be attained if there were two more rainfall stations in the basin of the Lea.

The mean rainfall in each of the river-basins for the period under discussion is given in the following table:—

TABLE II.—RAINFALL IN THE RIVER-BASINS, 23RD OCTOBER TO 14TH NOVEMBER, 1894.

River-basin.	Area.	Oct. 23-31	Nov. 1-10	Nov. 11-12	Nov. 13-14	Nov. 11-14	Oct. 23-Nov. 14
	Square miles.	ins.	ins.	ins.	ins.	ins.	ins.
Ouse	75	1·60	0·97	1·71	1·33	3·04	5·61
Thame	15	2·89	1·07	1·95	1·62	3·58	7 54
Colne	210	2·85	1·31	1·79	1·76	3·55	7·71
Lea	330	2·25	0·83	1·27	1·23	2·50	5·58

From this table we may get a very near approximation to the actual mean rainfall in the county by multiplying the rainfall in each river-basin by its area, adding together the products, and dividing by the area of the county. The result of this operation for the four days 11th to 14th Nov. gives a mean for the county of 2·94 inches, and for the twenty-three days 23rd Oct. to 14th Nov., a mean of 6·34 inches.

An inch of rain in depth gives a weight of water of 64,636 tons per square mile (= nearly 101 tons per acre). Therefore, in the four days 11th to 14th Nov. there fell within the limits of the county in the river-basin of the Ouse nearly 15 million tons of water; in that of the Thame nearly 3½ million tons; in that of the Colne over 48 million tons; and in that of the Lea nearly 53½ million tons; giving a total for the whole of Hertfordshire of nearly 120 million tons. If the mean rainfall as shown in the first table were taken, the result would be 124½ million tons, which is greater than the quantity arrived at by taking the results for each river-basin (the more correct method) owing to the largest basin, that of the Lea, having the smallest rainfall; but if we take the corrected mean of 2·94 inches, the result is precisely the same as that given above, the exact number of tons of water given by this method being 119,718,799. When we consider that this gives a daily fall for four successive days of about 30 million tons of water on a soil already saturated by previous heavy rain, against an average daily fall in this usually wet month of about 3½ million tons, it is not surprising that the floods to which it gave rise were of exceptional, if not of unprecedented, severity.

The following account of these floods is compiled from reports which appeared at the time in three of our County newspapers—the 'Watford Observer,' the 'Herts Advertiser,' and the 'Hertfordshire Mercury,' except a short account of an experience of my own. The river-valleys will be taken in the usual order.

In the valley of the Gade the flood appears to have been the worst between Apsley End and Boxmoor. The village of Apsley End was flooded by mid-day on Monday the 12th of November, the water rising over the kerbing of the footpaths and flowing into the shops. On Wednesday it had risen so high that the residents had to remove their furniture upstairs, and the roadway was impassable except by wading deep in water. At several points the water in the Grand Junction Canal overflowed the banks and swamped the adjacent meadows, the football-ground in the Salmon Meadow presenting the appearance of a group of ponds. At Apsley Mills operations had to be temporarily suspended owing to a portion of the works being flooded. At Boxmoor the cellars of the houses were flooded, and much damage was done to the extensive water-cress beds in the locality.

In the higher part of the valley of the Colne the brook at Water End, which during the greater part of the year is simply a dry water-course, overflowed its banks, and carried down a large volume of water to Colney Heath near to where it joins the Colne. At Welham Green, on Wednesday the 14th, the roads were under water and almost impassable, the water being more than a foot deep in places. On the afternoon of the following day, wishing to see something of the effects of the heavy rain in this district, I walked to North Mimms past Smallford and Colney Heath. A short distance beyond the ford I found the road submerged to the depth of nearly two feet, but was able to avoid wading through the deeper part of the water by going through a cottager's garden and crossing the water on a plank which he had kindly provided and supported on chairs. My dog would not follow me, but waited, yelping, for a passing cart, in which he was taken across the water. Not wishing to return this way in the dark, I found that it was necessary to go round by Water End and Mimms Hall into the London Road at South Mimms, passing places near Warren Gate where the road was then just under water, but, as I was informed, had been impassable earlier in the day.

In the valley of the Colne where the river permanently flows, the floods seem to have put people to the most serious inconvenience at Watford. On Monday the 12th, the meadows bordering the Colne were inundated, and the water flowed into Water Lane and the lower part of High Street. On Tuesday the water retreated, but the floods rose again on Wednesday morning and attained their highest point about midnight, submerging three roads in the town for several hundred yards. High Street was the most seriously affected, the water being three feet deep in some parts. The river rose to within six inches of the girders of the new High Street bridge. All the houses between the bridge and Dalton House, where Mr. Schreiber had to remove his dogs for safety from his stables to the loft, were flooded, as well as those in the courts, and the workmen were surprised on looking out of their windows on Thursday morning to see that they would have to make the first part of their journey to their work by water. Horses and carts were soon secured and several men were lowered from their bedroom windows. A boat in which it was intended to row up High Street was carried away by the flood. In Water Lane the water extended from a few yards beyond the river to the railway-arch, and a great part of Loates Lane was also under water, the fields between being inundated. In the direction of Aldenham the water was like an inland sea. At ten o'clock on Thursday morning the waters began to abate, but carts were still busily engaged, until late in the day, in carrying passengers along the flooded streets. A few pigs and sheep escaped from the flooded meadows by swimming, but one sheep and a large number of rabbits belonging to Mr. Blathwayt, of Frogmore House, were drowned. Water was pumped out of the cellars of many houses by Messrs. Sedgwick and Co.'s steam fire-engine.

At the meeting of the Watford Local Board on the same day (Thursday, 15th Nov.) the Engineer reported as follows:—"The heavy rains during yesterday caused various parts of the town to be flooded, notably St. Albans Road over the railway bridge, the lower part of Queen's Road, Merton Road, and Pinner Road. This morning the river has overflowed its banks and risen above the underside of the girders of the new bridge, flooding the length of High Street from the bridge to the mill-tail between two feet and three feet deep."

Lower down the Colne several low-lying portions of Rickmansworth and its vicinity were flooded, most seriously at Batchworth and West Hyde.

In the valley of the Lea the neighbourhood of Hertford and Ware suffered most from the floods. The road from Hertford towards Essendon was rendered almost impassable from Tuesday the 13th to Thursday the 15th, presenting more the appearance of a running stream than of a public highway, the water in some parts of it being three feet deep; the Brickendon Road was also flooded to a considerable depth. The Castle Meads, Hartham, and the King's Meads, were more or less under water, and for miles along the course of the River Lea its banks were submerged, and a great quantity of the adjoining land was flooded. The members of the Hertford Fire Brigade were engaged on Wednesday evening in pumping the water out of the basement of Dr. J. T. Tasker-Evans' residence in Fore Street, which had become flooded owing to the overflowing of the Gulphs. The water rushed down through the garden and into Dr. Tasker-Evans' and Mrs. C. Young's houses, while a stream rushed underneath Dr. Tasker-Evans' gateway into Fore Street, which for a time became a water-course, part of the water running down Fore Street and part through Market Street and Railway Street. In The Folly there appeared every likelihood of a serious flood; when the gates near the old waterworks were opened the torrent rushed through, and the strip of land between the old River Lea and Paper Mill Ditch was soon submerged, a portion of the pathway being washed away to the depth of four feet by the force of the water. At the Lock several of the pleasure-boats were washed away and were subsequently found upon the towing-path.

At Ware the cellars of many of the houses in the lower part of Star Street were flooded during Wednesday night by the rising of the Barge river, and the cottages in the vicinity of Angel Road were swamped. The meadows near the river were flooded, and the water on the towing-path was two or three feet deep. The road between Dane End and Sacombe Pond for a length of about a mile and a half was rendered impassable for foot-passengers, the water in some places being between three and four feet deep.

This is the greatest flood which has occurred in Hertfordshire since the flood in the valley of the Gade on the 3rd of August, 1879, which was described in our 'Transactions' (Vol. I, p. 159) by the late Mr. J. E. Littleboy, but that was partial, occurring only in the west of Hertfordshire, while this was general, affecting the greater part of the county. The heavy rainfall, also, which immediately preceded the 1879 flood, was confined to the Midland counties, while on this occasion the fall was excessive over nearly the whole of the South of England and the whole of Wales except the extreme north.

XIX.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1894.

By Henry Lewis.

Read at Watford, 26th March, 1895.

It is now nearly eighteen years since the late Mr. J. E. Littleboy read before the Watford Natural History Society his first paper on birds, entitled "The Birds of our District," but including some notes on birds observed in distant parts of Hertfordshire, and since then a yearly report on the birds observed in our county has been written, the second of these annual reports being read to the Hertfordshire Natural History Society, for the Society had, in 1879, extended its sphere of influence, and its title, to embrace the whole of the county. These annual notes on our birds show that for a long time a large amount of interest has been taken by many of our members in this particular branch of Natural History.

One reason for this interest in the study of Ornithology may not be far to seek to those of us who, perhaps as mere lads, may have caught the love of Nature, for we may have partaken of the abounding joy and happiness surrounding us as we wandered forth in one of our early morning walks amid sylvan scenes on a glorious May day, so few of which, however, we get in this fickle climate. It would be vain and fruitless for me to attempt to give a faithful or perfect description of such a morning, when the sun is rising in glorious light in the eastern sky. the thirsty earth is teeming with new life and energy after the refreshing rain, and the balmy air is resonant with the pleasant hum of insect-life, and with the love-notes and joy-songs of innumerable happy birds. The eye is delighted with the beauty of form and colour, and the grace of movement all around, with the lovely green leaves quivering in the gentle breeze, and with the meadows rich in varied hues, every blade of grass decked as it were with a sparkling gem. The beautiful effects of light and shade in the early morning, the delicate odours of trees and flowers, the rippling murmur of running water, the graceful flight of the swallow, the lazy caw of the rook, the laugh of the woodpecker, the gambol of squirrels, the coo of wood-pigeons, the call of the cuckoo, and the song of the nightingale, all help to increase the charm.

How cheerless would our land be without the birds! A scientific writer, in speaking of the destruction of the dinornis, has said that the destruction of the individual is unimportant, but the destruction of the type is a crime. Yet as matters go now, unless some stringent measures are taken, most of the birds of Europe will in the next century be as extinct as is now the dinornis. In an article on "Birds and their Persecutors," in the January number of the 'Nineteenth Century,' "Ouida" says that "the craze for devouring birds of all kinds is a species of fury from the Alps to Etna," and maintains that "unless birds be protected in Italy they must perish all over Europe, since so great a variety of races wing their way to the south in winter" As "Ouida" also says that "it is admitted by all who know anything of the subject that agriculture would be impossible without the aid of birds, as the larvæ and developed insects of all kinds would make a desert of the entire area of cultivated land," I think it well and quite within my province to direct the attention of the members of our Society to such an important question, especially as the craze of fashion has even in our own land filled many a shop window with the wretched remnants and barbarous spoils of bird-life.

I am unable in this report to make any additions to the list of birds which have been observed in our county, but, through the kindness of the Honourable Walter Rothschild, I have been favoured by Mr. E. Hartert, in his name, with some interesting notes on birds (some rare) which have been obtained in the Tring district during the past year, specimens of all of which are to be found in the Tring Museum.

Grey Wagtail (*Motacilla melanope*).—This graceful little bird was seen by Mr. Hartert in December, 1894, near the Reservoirs. My own acquaintance with this wagtail is but slight. For some years I have noticed the arrival of the long-tailed wagtails on the banks of our river Ver. They seem plentiful this winter. Mr. Alan F. Crossman, of St. Cuthbert's, Berkhamsted, wrote to me in the winter: "During this hard weather I have seen several grey wagtails; the bird seems to be a fairly common winter visitor to this part of Herts." It runs, with a buoyancy and lightness unsurpassed in my opinion by that of any other of our wagtails, after the insects which are its food, often alighting on the floating weed, as it passes along, then flying off in graceful dips, uttering "chiz-zit, chiz-zit" either when flying or when alighting on the trees overhanging the water. The late Mr. Frank Buckland said: "The wagtails have different calls. The call of the black-and-white wagtail is 'physic, physic, physic.' . . Listen to the first wagtail you hear, and you will find that he invokes the aid of the medical profession." ('White's Selborne,' with notes by Frank Buckland, p. 301.) Mr. Dresser ('Birds of Europe,' vol. iii, p. 251) states that "In Great Britain it is, as a species, a permanent resident, though individually a partial migrant"; and our President, Mr. Henry Seebohm ('British Birds,' vol. ii, p. 203), says: "The grey wagtail is sparingly distributed throughout England and Wales, breeding in the mountainous districts and migrating into the lower valleys and into the plains for the winter." I generally notice its arrival here in autumn, but Mr. Littleboy alludes to the nesting of this species at the Tring Reservoirs.

Crossbills (*Loxia curvirostra*).—Some of these birds were seen and shot in the woods at Tring in December, 1894, and January, 1895. In Mr. Littleboy's register I find it recorded that early in the year 1879 a flock of these birds frequented the Gorhambury

Woods between St. Michaels and the London and North Western station. Probably this was the same year that I received specimens of these birds from the boys of the town, who had procured them in Verulam Woods. Mr. Crossman writes: "On January the 27th (1895), I saw a flock of about fifty common crossbills in a wood about three-quarters of a mile from Berkhamsted, just on the borders of the county. I was first attracted by the note 'gip, gip,' which I am well acquainted with, and just as I perceived them they flew over my head and circled round and settled. I got nearly underneath a larch tree on which a small party of them settled, and I had a very good view of them through my field-glasses. In this small party there was one orange-tinted bird, and the rest were either crimson or green, one of the latter being very dull-coloured. They were feeding on the cones of the larch, and their mode of procedure was to break off a cone and carry it to a stronger branch and there peck it over and then drop it. I picked up several of these cones that had been dropped, and examined them, and found that they were very slightly pulled about, some of their leaves being split up. I heard one of the birds singing: the song is sweet, but not loud, some parts of it being like the song of a robin, sweeter, though not so loud. The attitude of these birds when feeding (sometimes hanging with the head downwards) is very like that of a parrot or a titmouse."

Cirl Bunting (*Emberiza cirlus*).—During the year 1894 several pairs of these birds were observed in spring and summer near Tring. Dresser (iv, 179–182) says that this bunting "is particularly abundant in the Isle of Wight"; and also that Naumann states that "It frequents the same kind of places as the yellow bunting, such as the bushy banks of streams, meadows, and hedges, small groves in mountainous districts, in the neighbourhood of fields and gardens." "In England," Dresser also says, "it is gregarious in winter, and may be observed in flocks on the southern coast."

The Raven (*Corvus corax*).—Mr. Hartert writes: "A raven was caught in the woods above Tring by a village boy, in the middle of October. He saw the bird on a branch and crept close enough to hit it on the head with a stone, which only bedazzled it, but did not kill it. When we got it first it was rather quiet, but became wilder afterwards. The bird did not show signs of having been in captivity, and it seems inexplicable what made such a wary bird so foolish that it could be thrown over with a stone. A dead raven was found by Mr. Minall, the museum's taxidermist, in the same woods on the 26th of December. It was half rotten and only fit for a skeleton." Some of us may remember the interesting account Mr. Rooper gave us of the raven in his report for the year 1889. From this bird's wide distribution we may hope that it would escape the fate, which in these days befalls so many species of birds, of becoming extinct, or nearly so, through the agency of man, possessing as it does a very ancient if not honourable history, and associated as it is with the cherished beliefs of many nations.

Mr. Seebohm ('British Birds,' vol. i, p. 532) says: "The raven, once so famous in fable, and held by the ancients in such respect as a bird of destiny, is now rapidly becoming scarce in England . . . . almost the only places where a few scattered pairs are found are the bold rocky headlands of our coasts, in districts little frequented by man, where the bird, gifted as it is with no small amount of sagacity and prudence, is able still to maintain its ground. But slowly and surely these English ravens are passing away; their deserted eyries possess only historical interest; and the day is probably not far distant when it can no longer be counted as an English bird." Mr. Dresser (iv, 573) states that "As a rule the raven is a shy, cautious bird, as crafty and clever amongst birds as the fox is amongst quadrupeds. . . Amongst the early Scandinavians," he adds, "the raven was looked on as possessing wisdom to a peculiar extent; and in the Sagas it is related that Odin possessed two ravens which traversed great distances, and, returning to their master, whispered into his ears the information they had gained during their journey."

Bittern (*Botaurus stellaris*).—The Hon. Walter Rothschild informs me that an adult bittern was shot on the Reservoirs, in December, 1894. From Mr. Littleboy's register I gather that a nest with four eggs was taken at one of the reservoirs in 1849 by the Rev. James Williams. Dresser (vi, 282) informs us that "it is now merely a rare straggler [to England] and no longer breeds here." Three of these rare birds have been obtained in this county which have never been recorded in our 'Transactions.' One was brought to me alive some years since, wounded in the wing. It was shot near St. Albans. The other two were shot near a small pond close to the late Mr. Thrale's house at No-Man's-Land. Dresser (vi, 285) remarks of the bittern: "When winged or wounded it is by no means an easy task to get hold of it; for it defends itself with great pluck and determination, throwing itself back and using bill and claws as weapons of defence, and I have seen a dog get considerably the worst of it in an attack on a wounded bird." Mr. Seebohm ('British Birds,' vol. ii, p. 502) says: "There are about five-and-twenty species of bitterns, which are distributed throughout the world, except in the extreme north. Two species are European, both of which are very rare residents in the British Islands, and a third has repeatedly visited our islands from the American continent." This bird, from its habit of choosing solitary swamps and dismal morasses, is intimately associated in our minds with all that is desolate and forsaken.

The Teal (*Querquedula crecca*).—This little duck, Mr. Hartert says, was observed "in flocks on the Reservoirs at the end of December and beginning of January."

The Shoveller (*Spatula clypeata*), Pochard (*Fuligula ferina*), and Tufted Duck (*F. cristata*).—These ducks, Mr. Hartert writes, "were shot on the Reservoirs at different times during the shooting-season." "The range of the shoveller," Dresser (vi, 498) states, "is very extensive . . . . Though more particularly a fresh-water duck, still the shoveller is met with not unfrequently on the coast." This bird nests at the Reservoirs. The pochard, Dresser (vi, 503) says, "frequents both the sea-coast and inland waters, and obtains its food chiefly under the surface of the water. It is consequently an expert diver and able to remain below for some time, and to swallow its food when under water." The tufted duck is stated by Dresser (vi, 574) to be, "as a rule, only a winter visitant" in Great Britain.

GOLDEN-EYE (*Clangula glaucion*).—Mr. Hartert says that the golden-eye "was seen in flocks on the Reservoirs at the end of December, 1894, and the beginning of January, 1895." Dresser (vi, 595) says of this bird that "In Great Britain it is known only as a winter visitant. Mr. Grey says that it probably breeds occasionally in Sutherlandshire, as specimens have been obtained in that county as late as the end of May. It frequents the sea-coast, and appears to obtain its food chiefly under water, being a most expert diver, so much so that it will dive at the flash when fired at. When undisturbed it sits rather lightly on the surface of the water, but when alarmed can swim so low that the back is only just shown above the surface of the water."

WOODCOCK (*Scolopax rusticula*).—"Woodcocks were seen more often than during the last few years," so Mr. Hartert writes. This must be welcome news to those of us who have tasted woodcock (and who has not?). It is to be hoped that some of these winter visitors may prolong their visits into the nesting-season, as they have previously done. Mr. Littleboy reported that woodcocks "have once or twice nested in Tring Park"; and from Dresser (vii, 623) we learn that in Germany "it is supposed to make its first appearance on the so-called 'Occuli' Sunday (the third Sunday in Lent), which is usually termed Woodcock Sunday." I alluded in a former report to the habit this bird possesses of carrying its young, which it does from the wood to the swamp to feed, as well as in case of danger.

This completes the report from the Tring district.

MISCELLANEOUS NOTES.

REDBREAST (*Erithacus rubecula*).—On the 28th of August I received two dead robins, picked up by Mr. Ashwell in his garden at The Priory, St. Albans. They were found about fifteen yards from each other. He had separated them only a short time before, and they must have succumbed to the injuries they received whilst engaged in mortal combat. They were both severely pecked about the head, the injuries being quite sufficient to account for their death. One bird had a much duller-coloured breast than the other. I have often been asked the question, "Do the young robins kill the old ones?" Mrs. Brightwen ('Wild Nature Won by Kindness,' p. 194) observes: "Every robin fights his neighbour all the year through, except when paired and busy with domestic duties." Yarrell ('British Birds,' vol. i, p. 306) tells us that after their annual moult, "The old birds, then in renewed vigour, proceed to engage the young, and each lawn and thicket becomes a battle-field; but so far from the vulgar belief of the latter destroying the former being well founded, the young are almost invariably worsted, and possession remains with the victorious parents."

WOOD-WREN (*Phylloscopus sibilatrix*).—Mr. Alan F. Crossman informs me that in May or June last year, whilst riding through Ashridge Park and across Berkhamsted Common, he noticed that the wood-wren "was fairly plentiful, there being a bird singing in most of the clumps of beeches."

WREN (*Troglodytes parvulus*).—On one occasion during a hard frost, when walking along a lane, I chanced to see a wren on the hedge-bank actively engaged, and I wondered how the little creature managed to exist during such cold weather. However, the bird soon found two or three larvæ (they looked like wire-worms) which I noticed in its bill. I searched in vain myself for any.

STARLING (*Sturnus vulgaris*).—Mrs. Kember, of Harpenden, on the 5th of November, 1894, reported having seen "not long since," near Harpenden, one of those wondrous gatherings of starlings which occasionally take place.

CUCKOO (*Cuculus canorus*).—From the reports and correspondence which have appeared both in the 'Zoologist' and the 'Field' newspaper of last year, there can be no doubt that the cuckoo visited this country at an unusually early date. The lovely weather we experienced in March appears to have tempted that wonderful bird, "a March cuckoo," to pay us a visit.

WILD DUCK (*Anas boscas*).—Immense flocks of birds, probably of different species, passed over St. Albans at different times during the month of December. Mr. Coles, Worley Street; Mr. Garner, Christ Church; Mr. Pelley, and others, called my attention to the fact, and asked me if I had seen them. Amongst them I noticed wild duck passing over, and Mr. Coles did the same.

POCHARD (*Fuligula ferina*).—Mr. T. V. Roberts, in a letter dated 22nd January, 1894, says: "Last Saturday afternoon, when walking by the Colne below Hamper Mills, I saw four ducks on the water. They took to flight as I approached, three disappearing, the fourth flying heavily for a short distance. Overtaking, I got quite close to the last-mentioned bird, and found that it was a pochard. It was much distressed and had evidently been wounded. No doubt its companions were of the same species."

PUFFIN (*Fratercula arctica*).—Mr. Martin, a local taxidermist, showed a puffin to me which had been picked up alive in St. Albans on the 15th of November.

ALBINISM.—Mr. H. Sexton reports that just below Ridge Hill he observed on the 5th of October a blackbird (*Turdus merula*) with a white patch of feathers on its back.

I have received reports of rare birds having been picked up alive or shot during the severe frost experienced at the beginning of this year, which must appear in the next annual report.

The following is a list of dates on which the arrival and departure of some of our summer migrants and winter visitors have been reported:—

Summer Migrants.

Species.	Locality.	Date.	Observer.
Wheatear (*Saxicola œnanthe*)	Harpenden Road, St. Albans	Sept. 3	C. Dickinson.
Nightingale (*Daulias luscinia*)	St. Albans	April 10	Mrs. Hopkinson.
	Newberries, Radlett	,, 10	Miss E. M. Lubbock.
	Symonds Hyde, Hatfield	,, 12	T. Brown.
	Berkhamsted	,, 15	Mrs. E. Mawley.
	Harpenden	,, 16	J. J. Willis.
	Watford	,, 17	Mrs. Bishop.
	Odsey, Ashwell	,, 17	H. G. Fordham.
Whitethroat (*Sylvia cinerea*)	St. Albans	,, 15	H. L.
(Last seen)	St. Albans	Sept. 15	H. L.
Blackcap (*Sylvia atricapilla*)	St. Albans	April 29	H. L.
Chiff-Chaff (*Phylloscopus rufus*)	St. Albans	Mar. 23	Arthur Lewis.
	Newberries, Radlett	,, 26	Miss E. M. Lubbock.
	Hitchin	,, 26	J. E. Little.
Willow-Wren (*Phylloscopus trochilus*)	Newberries, Radlett	April 8	Miss E. M. Lubbock.
	St. Albans	,, 8	H. L.
	Rickmansworth	,, 11	A. Sainsbury Verey.
Sedge-Warbler (*Acrocephalus phragmitis*)	St. Albans	May 6	H. L.
Grasshopper-Warbler (*Locustella nævia*)	Loudwater, Rickmansworth	Mar. 24	T. Hope.
	Symonds Hyde, Hatfield	April 16	T. Brown.
	Harpenden	May 5	J. Lewis.
	St. Albans	,, 13	H. L.
Yellow Wagtail (*Motacilla Raii*)	Rickmansworth	April 11	A. Sainsbury Verey.
	Harpenden Road, St. Albans	,, 20	A. Dickinson.
Tree-Pipit (*Anthus trivialis*)	St. Albans	,, 8	H. L.
Spotted Flycatcher (*Muscicapa grisola*)	Berkhamsted	,, 20	Mrs. E. Mawley.
	Newberries, Radlett	May 16	Miss E. M. Lubbock.
	Harpenden Road, St. Albans	,, 18	Mrs. C. Dickinson.
	Odsey, Ashwell	,, 20	H. G. Fordham.
	Oaklands, St. Albans	,, 25	H. L.
(Last seen)	Odsey	Aug. 30	H. G. Fordham.
Swallow (*Hirundo rustica*)	Harpenden	April 4	J. J. Willis.
	Berkhamsted	,, 7	Mrs. E. Mawley.
	Watford	,, 11	D. Little.
	Hitchin	,, 12	J. E. Little.
	St. Albans	,, 15	F. Hibbert.
	Two Waters, Hemel Hempstead	,, 17	T. Hope.
	Ware	,, 17	Arthur Lewis.
	Newberries, Radlett	,, 19	Miss E. M. Lubbock.
	Odsey, Ashwell	,, 21	H. G. Fordham.
	Symonds Hyde, Hatfield	,, 24	T. Brown.
(Last seen)	Berkhamsted	Oct. 23	Mrs. E. Mawley.

Species.	Locality.	Date.	Observer.
Swallow (Last seen)	Odsey, Ashwell	Oct. 27	H. G. Fordham.
(*Hirundo rustica*) ,,	St. Albans	,, 28	Monckton White.
House-Martin	Odsey, Ashwell	April 30	H. G. Fordham.
(*Chelidon urbica*) (Last seen)	Odsey, Ashwell	Oct. 3	H. G. Fordham.
	St. Albans	,, 28	A. Dickinson.
Sand-Martin	Ware	April 17	Arthur Lewis.
(*Cotile riparia*)			
Swift	St. Albans	May 6	H. L.
(*Cypselus apus*)	Odsey, Ashwell	,, 10	H. G. Fordham.
(Last seen)	St. Albans	Aug. 25	H. L.
,,	Odsey, Ashwell	Sept. 7	H. G. Fordham.
Nightjar	High Down, Hitchin	July 1	John Hopkinson.
(*Caprimulgus europæus*)			
Wryneck	Harpenden Road, St. Albans	April 8	Mrs. C. Dickinson.
(*Iÿnx torquilla*)	St. Albans	,, 8	H. L.
	Rickmansworth	,, 13	A. Sainsbury Verey.
Cuckoo	Stevenage (from newspaper)	Mar. 22	Rev. — Ruddock.
(*Cuculus canorus*)	Arkley, near Barnet	April 3	H. R. Potter.
	Bricket Wood	,, 7	J. Bamforth.
	Newberries, Radlett	,, 7	Miss E M. Lubbock.
	Watford	,, 8	D. Hill.
	St. Albans	,, 8	Mrs. C. Dickinson.
	Berkhamsted	,, 8	Mrs. E. Mawley.
	Harpenden	,, 8	J. J. Willis.
	Symonds Hyde, Hatfield	,, 9	T. Brown.
	Hitchin	,, 11	J. E. Little.
	Odsey, Ashwell	,, 11	H. G. Fordham.
Turtle-Dove	Odsey, Ashwell	May 4	H. G. Fordham.
(*Turtur communis*)			
Landrail	Park Street	April 28	T. Hope.
(*Crex pratensis*)	King's Langley	,, 28	T. Hope.

Winter Visitors.

Redwing	St. Albans	Sept. 26	A. Dickinson.
(*Turdus iliacus*)			
Fieldfare	St. Albans	,, 17	H. L.
(*Turdus pilaris*)			
Woodcock	St. Albans	,, 23	F. Dickinson.
(*Scolopax rusticula*)			

In conclusion allow me to thank those ladies and gentlemen who have so kindly supplied me with observations, information, and records of various kinds, both for this paper as well as on former occasions. I am happy to inform our members that Mr. Alan Fairfax Crossman, of St. Cuthbert's, Berkhamsted, has consented to occupy the position I am now resigning as Recorder of Aves. May I ask our members who have any observations on birds they may make, or information they may obtain of rare birds visiting our county, to forward the same to Mr. Crossman.

XX.

NOTES ON BIRDS FREQUENTING THE NEIGHBOURHOOD OF HERONSGATE, HERTS.

By A. SAINSBURY VEREY, Memb. Brit. Ornithologists' Union.

Read at Watford, 26th March, 1895.

THE ways of birds are in many respects our ways. Acted upon by the same external influences, swayed by the like impulses and emotions, belittled by frailties in common with ourselves, no sooner do we set foot within the borders of Birdland than we feel ourselves irresistibly attracted to the observation of its inhabitants.

Troubles are to be met with in Birdland, yet how transient are they! Hard enough are the times when frost and snow usurp the sway, but they are short, and when winter gives place to spring the only hard time for our birds is at an end.

Frailties exist in Birdland. What could better exemplify this fact than the behaviour of a missel-thrush who came flying in hot haste to the tree under which I was standing one evening last summer, and then coursed madly round it, screaming to his utmost bent? It was difficult at first to discover what his trouble was, but soon an explanation was afforded, for shortly another bird appeared, making her way towards him, slowly and wearily. No rest for her, however, for, seeing her, he at once resumed his journey, leaving her to follow him as best she could. And the explanation seemed to be that they had been spending the day far from their usual resting-place and still had some distance to go, and that she, tired as she was, did not make sufficient haste to please him.

And again, I can almost hear even now the querulous screeching of an ill-conditioned barn-owl who flew across the path which I was pursuing in the dusk of evening, also last summer, making the air resonant with his cries. I stopped to watch him as he took his flight towards some hilly ground, crested by a wood. But he had not gone far when an answering cry came from the direction of the wood, and soon another owl appeared in sight; then he abruptly turned round, and, still screaming as loudly as ever, retraced his flight, taking good care, however, to keep some considerable distance from his partner. It seemed evident that something had gone wrong in the house of the owls, and the distempered bird had come out to put it right. It could not have been a matter of selecting a mate, for it was too late in the season.

Deeds of emprise are performed in Birdland. Observe the sparrows as they fight promiscuously, fluttering about on the ground. It might appear that they are only engaged in a game of "peck who peck can," but there is method in the mad conflict, for they are obeying one of the laws of Nature. Of course there is a lady in the case, and now, in a momentary cessation of hostilities, she creeps towards the one most favoured in the combat, encouraging him to further valour. Now retiring, the battle again rages, until at length the victor is proclaimed, the award is made, and the vanquished fly off, apparently as self-satisfied as sparrows can be. And the reason for the battle was, as I have said, the observance of one of Nature's laws,—the selection and survival of the fittest.

Courtship is to be studied in Birdland. Out in the field, and perched upon a rail-fence, a rook with tail expanded is propelling himself painfully to and fro, and as now and again he gives vent to low and laboured groans, one might imagine him to be in the throes of immediate dissolution. Yet there is meaning in his behaviour: he is striving to attain an object; for, ludicrous as it all appears to us, grace and attraction are evinced in every antic, poetry and music also in those weird utterances, passing sweet and full of import to the dusky lady sitting arbitrative upon his fate. And soon his reward comes to him; love, the gauge thrown down, and love as quickly taken up again. Then away he flies with his bride to the tree-top whereon his nest will be rudely swayed, and for cradle-song the wild, hard wind of spring will shriek a lullaby, fit rearing-place for his hardy brood.

And pathos is to be met with in Birdland. Yearly, when I am gathering strawberries in my garden, just in front of me a fragile feathered form flutters timorously from her nest under one of the plants, and then, scarcely out of reach, flits around me on the ground, as, with palpitating breast and plaintive cry, she upturns her eyes beseechingly to mine, hoping, yet gravely doubting, that the shrine of her affections may escape unravished.

Birdland, in these and many other interesting aspects, may be profitably studied at Heronsgate, near Rickmansworth. The following are a few observations which I have made on the habits of some of the more familiar birds which frequent this neighbourhood.

THE WHITETHROAT (*Sylvia cinerea*).—I was very much interested last summer in the behaviour of a whitethroat, and could but regard it as an instance of protective mimicry. I had found her nest with eggs, and stooped over it, watching the bird as it glided off into the surrounding brambles. Then, and all at once, she adopted the motions of a dormouse, and so admirably did she play the *rôle* that—aided, as naturally she was, by the dense brush—had I not known it to be the bird, it would have been difficult indeed to determine it to be anything but a mouse. Never for a moment still, but gliding swiftly along the branches and twigs after the manner of the animal, she made no use whatever of her wings, which were kept closely pressed to the body, but, when arrived at the end of one twig, she would spring to another in a perfectly mouse-like way. Very often she was quite close to me, yet her movements were so rapid and confusing to the eye, and the part she had elected to play was so cleverly performed, that at any other time the deception might well have been complete.

THE GRASSHOPPER-WARBLER (*Locustella nævia*).—The grasshopper-warbler, a distant relative of the Dartford warbler of our southern heaths, and equally gorse-loving in its habits, seems, however, to prefer the stunted oaks and solitary hawthorn bushes there to be met with from which to pour forth its curious song. There is no other bird coming under my observation that yields itself more completely to the tender passion. When standing on one side of a bush, I have watched a pair of these birds engaged in their love-passages on the other side, and quite indifferent to my proximity; the male singing all the while to his mate, and imparting to his wings that peculiar tremulous movement characteristic of the bird. And it is very interesting when, a little later in the season, one has again had the good fortune to trace the song to its source, to mark the artifice of the little bird. Even when this has been accomplished, however, it is by no means easy to discover the bird, for love being a thing of the past, it becomes more wary. But presently, guided by the upturned bead-like eyes, it is discovered crouching low upon a fork near the ground, its olivaceous plumage exactly resembling the surroundings. After watching one for a time, I have made a feint to look aside, when, instantly, the bird dropped like a stone to the ground, and then, threading its way through the rank grass in a mouse-like manner, it emerged at a point furthest from danger, and, flying off to another bush, recommenced its song. If there be any meaning in the song of a bird, and, indeed, I believe there is a very great deal, its notes were then, undoubtedly, those of self-approval and congratulation that the cunning displayed had so successfully outwitted the intruder.

THE HEDGE-SPARROW (*Accentor modularis*).—A curious instance of receptivity in a bird came to my notice a year or two ago. One morning—I think it was early in March—I was surprised to hear, quite close to me, the trill uttered by the tree-pipit when flying upward from its perch on the topmost branch of a tree. Upon looking about for the cause, I saw a hedge-sparrow sitting upon a shed and singing these notes. Much interested, I waited to hear if the bird had also acquired the song of the pipit when in downward flight, but that apparently formed no part of its *répertoire*.

THE GOLDFINCH (*Chrysomitris elegans*).—Alone among the finches, unless, indeed, the allied species the siskin (*Chrysomitris spinus*) affects the same habit, the goldfinch feeds its young with partially-digested food from its crop. And, from very careful study of the bird, I am induced to think that the food consists solely of various seeds, in this respect differing from that of the young of other finches, the parent birds in their case supplying them with a large proportion of insect-food. If it be really a fact that seeds only are fed to its young by a goldfinch, the reason of this apparently abnormal method of administering the food becomes easily understood, because the dry hard seeds would, necessarily, require some degree of preparation before being submitted to the feeble digestive powers of the young birds.

THE CHAFFINCH (*Fringilla cœlebs*).—An interesting nest of the chaffinch was found by a hedger last summer, and Mr. Hughes, of The Swillet, called my attention to it. A hollow piece of stoneware had been thrown into a hedge, and, lodging in the centre, the birds had made choice of it as a foundation for their nest. The man carried the nest in to show Mr. Hughes, and, after he had replaced it, the birds took to it as before. The circumstance suggests the thought that the chaffinches may have considered that the safety of their nest would be better assured by making the choice they did, particularly as the hedge was close to a highway and also to a field-path; but, if so, their hopes were doomed to disappointment, for, after the young were hatched, they were discovered by the marauding and too evident boy, and, alas! destroyed.

The Bullfinch (*Pyrrhula europæa*).—Hard words are often spoken against the bullfinch, and if the matter rested there, "Bullie" would not be ruffled by so much as a feather. Unfortunately, however, powder and shot are too often resorted to by way of settlement. Nevertheless a little fact speaks for itself. In the early part of last spring I noticed that the bullfinches were exceedingly busy among the gooseberry-bushes in my garden, yet there was afterwards a magnificent crop of fruit, so good, indeed, as to excite the admiration of my neighbours, many of whom came to see it.

It is very amusing to watch my bullfinches of a winter's evening. One portion of the hedge surrounding the garden terminates in a bushy growth of *Salix capræa*, and there nightly at dusk the birds assemble before betaking themselves to a wood adjacent, where apparently they roost at night. I can only suppose that it is their time for relaxation after the serious business of the day, and that, so met together, the news current in Birdland is fully discussed, and many indeed and anxious must be the forecasts of the weather, a very weighty subject with these children of the wild, and perhaps the only one that ever seriously obscures the horizon of their lives. The bullfinch is exceedingly partial to the berries of the privet when mellowed by frost, and it also eats those of the woody nightshade (*Solanum dulcamara*).

Yellow-Hammer (*Emberiza citrinella*).—The yellow-hammer is very partial to strawberry-plants as nesting-sites in my garden. The nest is placed close to the roots of the plants and is well concealed by the foliage, and I usually have one, and frequently more, every season. I once found a nest of this species placed in an ash sapling some five or six feet from the ground.

The Rook (*Corvus frugilegus*).—The term "*frugilegus*"—fruit-gatherer—applied to the rook, seems at first sight to be somewhat undeserved, and I have seen it criticized and even ridiculed in print. Nevertheless the bestowal of the epithet is evidence of very correct observation of the habits of the rook on the part of its sponsor. I myself have seen it feasting upon cherries, curiously enough preferring them before they were ripe. Notwithstanding this, such instances are so infrequent as to appear to be merely aberrant behaviour on the part of the rook, for it is pre-eminently and inseparably a bird of the soil, and one to which agriculture owes much. Before the frost set in, and when the plough was busily at work, a vast assemblage of rooks collected in the fields near here, and I was much impressed by the important help the friendly birds were rendering to the farmer by freeing the ground of harmful grubs. The flock, at a low computation, must have numbered some 500 or 600 individuals, and if we estimate the probable amount of food consumed by each at only half-a-pint a day—and the bird has a very voracious appetite—it becomes evident that the rook is a factor of very considerable importance in the economics of agriculture. So that, under all the circumstances, and although the epithet "*frugilegus*" is not entirely undeserved, I have come to think that a better term might and should be devised for our friend the rook; because it is very invidious thus to record the fact of his occasional deviations from an ordinarily strict rule of conduct, and truly ungracious to fasten this name upon him, overlooking his claim to acknowledgment for good honest services rendered, and keeping him in our remembrance only as the "fruit-gatherer."

THE LESSER SPOTTED WOODPECKER (*Dendrocopus minor*).—This species is by far the commonest of the three woodpeckers at Heronsgate. It is very difficult to approach, and, although frequently heard, is not so often to be seen, but this is sometimes to be done by creeping up to the tree. When disturbed it may be observed flying off to the wood. It seems to have a great partiality for oaks on the outskirts of woods, its preference for those trees being due probably to the fact that the rough bark being full of holes and crevices affords a better return in insect-food than is the case with other trees having smooth bark.

THE GREEN WOODPECKER (*Gecinus viridis*).—This species occurs occasionally on the highest ground where the soil is light and sandy, attracted no doubt by the ants' nests, the "eggs" in which form a not inconsiderable part of this woodpecker's diet. Some fragments of the eggs of this species were brought to me for determination last summer, the parent bird having been seen by the ubiquitous boy to enter a hole in a birch tree, whereupon he climbed up and found the nest.

THE HEN-HARRIER (*Circus cyaneus*).—Hill, the keeper of the shooting about here, tells me that he often sees a strange hawk, but that it is too wary for him to shoot it. From his description, "blue on the back," "with white feathers above the tail," the bird seems pretty clearly referable to the hen-harrier (*Circus cyaneus*). It may be, of course, although less probably, Montagu's harrier (*Circus cineraceus*), but that could only be determined with the bird in hand—not that I am at all desirous of doing so. The presence of a few individuals of our rarer species of hawks might well be encouraged, for by reason of their extreme scarcity they could never appreciably interfere with the preservation of game, and a little protection afforded them would not seriously conflict with any existing interests. Still there is much to be said for the gamekeeper. A servant only, it is true, his position is nevertheless an exceedingly responsible, anxious, and arduous one, and, with every man's hand against him, too often a very dangerous one. Not so very long ago, an old friend of mine was cruelly and cowardly assailed in the woods round here, and but for assistance opportunely arriving, would in all probability have been very seriously injured. I am glad to find that many keepers take an interest in bird-life, destroying only those birds which are destructive to their charges, and I gladly avail myself of this opportunity to acknowledge their readiness at all times to converse upon wild nature. Keeper Hill also informs me that a buzzard (*Buteo vulgaris*) has made its home in our woods, and that he frequently meets with the bird.

The Sparrow-Hawk (*Accipiter nisus*)—Keeper Hill related to me an instance of solicitude in a domestic hen. He told me that as he was one day walking beside a hedge his attention was attracted by the cries of a hen. Upon looking through the hedge, he saw the hen in the midst of her chickens, struggling with something on the ground, which he at first supposed to be a stoat, but which afterwards proved to be a sparrow-hawk. Three times he observed the mother fly at the hawk, rolling it over on the ground as it attempted to escape with one of the chicks in its talons. At length, however, it succeeded in shaking off the hen, and rose in the air, but only to fall at once by the keeper's gun.

XXI.

METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, DURING THE YEAR 1894.

By JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 23rd April, 1895.

Longitude of Station, 0° 20′ 7″ W.; Latitude, 51° 45′ 9″ N. Cistern of barometer 388 feet, ground-level at thermometer-screen 380 feet, and at rain-gauge 379 feet, above Ordnance Datum. Thermometers (in Stevenson screen) 4 feet, and top of rain-gauge 1 foot, above the ground. Observations taken at 9 a.m.

The accompanying tables (pp. 162, 163) give the monthly means, etc., of the daily observations in 1894, and the following is the usual summary for the seasons :—

MEANS FOR THE SEASONS FROM DEC. 1893 TO NOV. 1894.

Seasons, 1893-94.	Pressure.	Temperature. Mean.	Temperature. Daily Range.	Humidity.	Cloud.	Force of Wind.	Rainfall. Total.	Rainfall. Days.
	ins.	°	°	%	0–10	0–12	ins.	
Winter	29·993	38·5	11·6	90	6·7	2·1	6·85	57
Spring	29·958	47·5	16·8	78	6·4	1·7	6·96	44
Summer.....	29·971	58·8	15·1	76	6·6	1·5	8·50	55
Autumn.....	30·033	49·0	11·3	87	7·0	1·5	10·21	54

In the next table the chief results, monthly and annual, are compared with the means for the ten years 1877–86 at Watford.

DIFFERENCE IN 1894 FROM MEANS OF 1877-86 AT WATFORD.

Months.	Pressure.	Temperature. Mean.	Temperature. Daily Range.	Humidity.	Cloud.	Force of Wind.	Rainfall. Total.	Rainfall. Days.
	in.	°	°	%	0-10	0-12	in.	
January.....	—·133	+0·1	+1·6	=	+0·7	+·3	—0·01	+ 7
February	+·096	+0·1	+1·8	=	—1·0	+·6	—0·73	— 1
March	+·025	+2·7	+2·2	— 2	—0·9	—·3	+0·70	=
April	+·024	+3·6	+1·2	+ 3	+0·7	—·7	—0·19	+ 1
May	+·007	—3·0	—2·3	+ 2	+0·1	+·1	=	+ 1
June	+·078	—1·6	—2·3	+ 2	—0·1	—·1	—0·92	=
July	—·032	—0·2	—1·5	+ 1	+0·5	—·2	+0·25	+ 5
August	+·015	—2·5	—2·4	+ 1	—0·4	—·2	+1·16	+ 7
September	+·199	—3·1	—3·9	=	+0·7	—·5	—0·73	+ 2
October.....	+·004	+0·5	—3·3	+ 1	+1·2	—·6	+0·46	+ 4
November	+·086	+3·0	—0·8	=	—0·3	—·3	+1·79	=
December	+·079	+2·9	—0·1	=	+0·2	+·3	—0·54	+ 2
Year	+·038	+0·2	—0·8	+ 1	=	—·1	+1·24	+28

Results of Meteorological Observations taken at The Grange, St. Albans, in 1894.

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.	Temperature of			Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.		Evaporation.	Dew-point.	Dryness.	
	ins.	°	°	°	°	°	°		°		°	°	°	°	%
January	29·896	36·4	31·4	42·4	36·7	11·0	10·9	6th	51·2	12th	40·3	35·3	33·6	2·8	90
February	30·055	38·7	34·4	46·5	39·9	12·1	23·0	19th	54·5	7th	29·5	37·5	35·8	2·9	89
March	30·001	42·9	35·7	52·7	43·8	17·0	30·2	3rd	64·0	27th	33·8	40·3	37·1	5·8	80
April	29·900	49·6	41·0	58·6	49·7	17·6	35·3	22nd	69·9	8th	34·6	46·7	43·6	6·0	79
May	29·972	49·2	41·2	57·0	49·1	15·8	32·8	22nd	67·3	16th	34·5	45·5	41·5	7·7	74
June	30·047	57·0	49·0	64·8	56·9	15·8	42·9	1st	79·8	30th	36·9	53·0	49·3	7·7	75
July	29·920	60·9	53·2	68·9	61·0	15·7	46·3	8th	81·6	6th	35·3	56·7	53·0	7·9	75
August	29·946	58·3	51·7	65·6	58·5	13·9	44·5	21st	75·7	14th	31·2	54·7	51·4	6·9	78
September	30·170	52·8	47·3	59·7	53·3	12·4	37·9	29th	67·5	1st	29·6	50·4	48·0	4·8	83
October	29·932	48·2	44·0	54·2	48·8	10·2	34·6	22nd	60·5	13th	25·9	46·7	45·1	3·1	88
November	29·998	44·5	39·6	50·8	45·0	11·2	30·9	23rd	62·1	1st	31·2	43·2	41·6	2·9	89
December	30·045	39·7	35·5	45·5	40·2	10·0	25·8	31st	50·6	13th	24·8	38·5	36·9	2·8	82
Year	29·990	48·2	42·0	55·6	48·6	13·6	10·9	Jan.	81·6	July	70·7	45·7	43·1	5·1	82

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, IN 1894—(*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	2·58	·29	14th	24	7	6·8	6	14	2·0	2	2	3	4	6	7	3	3	1
February	1·86	·50	17th	16	3	6·6	6	14	2·3	0	1	2	3	5	9	6	1	1
March	2·36	·92	14th	12	0	5·4	11	11	1·7	3	4	5	1	5	7	3	3	0
April	2·19	·39	24th	16	0	7·2	4	13	1·4	3	4	6	6	4	4	3	0	0
May	2·41	·48	26th	16	1	6·5	3	8	2·0	6	3	1	3	3	5	4	4	2
June	1·94	·47	3rd	14	0	6·2	5	14	1·5	3	4	1	1	7	7	4	3	0
July	2·78	·76	10th	20	0	7·0	4	13	1·3	3	1	2	4	5	9	5	0	2
August	3·78	1·42	24th	21	0	6·5	3	11	1·6	1	3	2	3	2	8	8	3	1
September	1·88	·50	24th	15	0	7·1	4	15	1·2	8	7	5	0	0	1	1	5	3
October	3·52	·90	30th	21	1	7·7	2	15	1·6	4	5	2	3	4	4	1	4	4
November	4·81	1·40	14th	18	0	6·2	6	14	1·5	2	3	1	4	7	4	4	3	2
December	2·09	·64	14th	19	2	7·5	5	20	1·9	1	1	2	4	3	6	5	4	5
Year	32·20	1·42	Aug.	212	14	6·7	57	162	1·7	36	38	32	36	51	71	47	33	21

The year 1894 was rather warm, the excess of temperature occurring in the early part of spring and towards the close of the year, the summer being rather cold. The mean daily range of temperature was less than usual, and although the low minimum of 10°·9 occurred in January, the absolute range was not great, the maximum not exceeding 81°·6. The temperature was considerably above the average in March, April, November, and December, and considerably below it in May, August, and September. The mean pressure of the atmosphere was above the average of the ten years 1877–86 at Watford. The lowest pressures recorded at 9 a.m. were 29·150 ins. on 14th November and 29·156 ins. on 13th March, and the highest was 30·642 ins. on 27th December, giving a range of 1·492 in. The rainfall was a little above the average of the ten years 1877–86, and much above a long-period average. The number of wet days was much greater than usual. August, October, and November were very wet months; February, June, and September were rather dry. The air was a little more humid than usual. The prevailing direction of the wind was from south, through south-west to west.

In the winter of 1893–94 (December to February) the mean pressure of the atmosphere was about the average, the mean temperature a little above the average, with a considerable mean daily range, the air was of average humidity, the sky a little brighter than usual, and the rainfall about the average, though there was an unusually large number of wet days. There was only one cold period of considerable duration, the twelve days from 30th December to 10th January. There were ten days in succession in December (18th to 27th), thirteen in January (11th to 23rd), and twelve in February (2nd to 13th) without a single night on which the temperature of the air fell below freezing point.

In the spring (March to May) the mean pressure of the atmosphere was rather high, the mean temperature was high with about an average mean daily range, the air was rather humid, the sky of average brightness, and the rainfall rather heavy, but on about the usual number of days. The high mean temperature was due more to the warmth of the days than of the nights, the mean daily range being considerable. Owing to the warmth and moisture the weather was very favourable to vegetation.

In the summer (June to August) the pressure of the atmosphere was again rather high, the mean temperature was low, except in July, when it was about the average, the daily range of temperature was small, the air rather humid, the sky of average brightness, and the rainfall rather heavy and on an unusually large number of days. While very favourable to vegetation during the early part of the summer, the weather was disappointing towards the end, there being very few fine days together to favour hay-making.

In the autumn (September to November) the pressure of the atmosphere was very high, the mean temperature was about the average, the daily range of temperature was small, the air rather humid, the sky rather cloudy, and the rainfall excessive and very frequent. This last is the chief feature of the autumn, the excess in the rainfall being an inch and a half above the average of the ten years 1877–86 at Watford, and two and a quarter inches above the average of the seven years 1887–93 at St. Albans.

The difference between these seasons and the means of the seasons for 1877–86 at Watford, is shown in the following table:—

DIFFERENCE IN 1893–94 FROM MEANS OF 1877–86 AT WATFORD.

Seasons, 1893–94.	Pressure.	Temperature. Mean.	Temperature. Daily Range.	Humidity.	Cloud, 0–10.	Force of Wind.	Rainfall. Total.	Rainfall. Days.
	in.	°	°	%		0-12	ins.	
Winter	+·009	+0·4	+1·6	=	—0·8	+·4	—0·96	+ 6
Spring	+·019	+1·2	+0·4	+ 1	=	—·3	+0·51	+ 2
Summer.....	+·020	—1·2	—2·1	+ 1	=	—·1	+0·49	+12
Autumn.....	+·096	+0·1	—2·6	+ 1	+0·5	—·3	+1·52	+ 6

NOTES ON THE MONTHS.

JANUARY.—Rather warm, with a considerable daily range of temperature, an atmosphere of average humidity and rather low pressure, a bright sky, and a considerable rainfall on a large number of days. Coldest day 6th, mean 19°·3; warmest day 12th, mean 44°·7. Min. below 32° on 12 days, below 22° on 5 (5th to 9th), below 12° on one day (6th); max. above 42° on 21 days (below 32° on 5). The first ten days were very cold, having a mean temperature of only 27°·3 (9 a.m. 27°·3, min. 21°·7, max. 32°·8); the 23rd and 24th also were rather cold days (mean 33°·9); the rest of the month was warm. Rain (or snow) fell every day from 8th to 20th (13 days), and the only two successive days without either were the 6th and 7th.

FEBRUARY.—Rather warm, with a considerable daily range of temperature, an atmosphere of average humidity and rather high pressure, a bright sky, and a rather small rainfall on about an average number of days. Coldest day 19th, mean 29°·9; warmest day 7th, mean 49°·6. Min. below 32° on 9 days; max. above 42° on 22 days, above 52° on 4 (6th, 7th, 26th, and 27th). The thirteen days from the 12th to the 24th were colder than the rest of the month; the five days 19th to 23rd were very cold, having a mean temperature of only 30°·7 (9 a.m. 28°·3, min. 24°·1, max. 39°·7). The rainfall during the last half of the month was twice as much as it was during the first half.

MARCH.—Very warm, with a large daily range of temperature, a dry atmosphere of rather high pressure, a very bright sky, and a rather heavy rainfall, but on an average number of days Coldest day 3rd, mean 38° 2; warmest day 31st, mean 53°·2. Min. below 32° on 4 days (3rd, 5th, 17th, and 18th); max. above 52° on 13 days, above 62° on 3 (27th, 30th, and 31st). The last seven days were much the warmest; there was no really cold period, and on only four nights was the minimum below 32°; but the temperature was very variable, especially during the drought of 16th to 30th; thus at 9 a.m. it was on 19th 37°·5, and on 20th 46°·9; on 24th 37°·7, and on 25th 50°·8; on 29th 39°·0, and on 30th 48°·8. No rain fell from 16th to 30th, there being thus an *absolute* drought of fifteen days; on the other hand the rainfall for the five days 11th to 15th was an inch and a half, nearly all, however, falling on 12th and 14th.

April.—Very warm, especially during the first half of the month, with a considerable daily range of temperature, a humid atmosphere of rather high pressure, a rather cloudy sky, and about the average rainfall on the usual number of days. Coldest days 21st, mean 43°·6, and 22nd, mean 43°·5; warmest day 8th, mean 57°·2. Min. below 42° on 14 days; max. above 52° on 26 days, above 62° on 8 (1st, 3rd, 7th to 11th, and 29th). For the first 13 days in the month only 0·15 inch of rain fell, on three days; but rain fell every day from 14th to 18th and from 23rd to 30th, none falling for the 4 days 19th to 22nd. A *partial* drought of 30 days, with 0·26 inches of rain, terminated on 13th. The maximum temperature recorded has but slightly been exceeded during the previous seven years; the minimum has been 9 degrees lower during that period.

May.—A cold month, being about half a degree colder than April, with a small daily range of temperature, a rather humid atmosphere of about average pressure, a sky of ordinary brightness, and an average rainfall on the usual number of days. Coldest day 20th, mean 42°·4; warmest day 16th, mean 59°·8. Min. below 42° on 20 days; max. above 52° on 28 days, above 62° on 6 (14th to 17th, 24th, and 25th). On the first eight days only 0·06 inch of rain fell, on two days; between 9th and 15th 0·80 inch fell, and between 21st and 31st 1·55 inch; none falling on the five days 4th to 8th nor on the five days 16th to 20th. There was a slight fall of snow on 20th, and on the night of 21st–22nd a sharp ground-frost, which did much damage to young fruit and vegetation generally, potatoes, gooseberries and currants, and the blossoms of the earlier strawberries, specially suffering.

June.—A rather cold month, with a small daily range of temperature, a rather humid atmosphere of considerable pressure, a sky of average brightness, and a small rainfall on about the usual number of days. Coldest day 6th, mean 49°·4; warmest day 31st, mean 67°·0. Min. below 52° on 26 days; max. above 62° on 18 days, above 72° on 3 (28th, 29th, and 30th). The month may be divided into a cold and wet, and a warm and dry period, all the rain falling during the first 20 days, the mean temperature of which period was 54°·9 (9 a.m. 55°·1, min. 48°·1, max. 61°·5); while the last ten days—the rainless period—had a mean temperature of 60°·4 (9 a.m. 60°·2, min. 50°·5, max. 70°·6). The highest temperature during the wet period was 67°·7: this was exceeded every day but one during the dry period, and on each of the last three days the maximum exceeded 76°.

JULY.—Of average temperature, with a rather large daily range, an atmosphere of average humidity and rather low pressure, a rather cloudy sky, and about the average rainfall, but on a large number of days. Coldest day 23rd, mean 56°·2; warmest day 1st, mean 69°·7. Min. below 52° on 8 days; max. above 62° every day but one (23rd), above 72° on 9 days. The first week and the last week were very warm, the mean temperature of the first seven days being 65°·8, and that of the last seven days 62°·9, while the intermediate period of seventeen days had a mean temperature of only 58°·4. An *absolute* drought of 15 days terminated on 5th, after which rain fell on nineteen consecutive days, 6th to 24th, to the amount of 2½ inches. The only other fall of rain during the month was 0·28 inch on the 29th. There was a thunderstorm on the evening of the 6th, and another on the afternoon of the 14th, when nearly a quarter of an inch of rain fell in half an hour (2 to 2.30). A *double* rainbow was observed on the 7th, lasting from about 7.45 to 8 p.m. As usual, the colours in the larger arc were fainter than in the smaller one, and in reversed succession. On the 29th, between 1.55 and 2 p.m., Miss E. A. Ormerod observed at Torrington House, St. Albans, "a mass of very much broken cloud behaving most peculiarly. . . The chief part was floating from east to west, but several straggling masses at the highest point, or pieces of neighbouring cloud, became detached, or rather turned back in the contrary direction, and the two bodies, or fragments of clouds, crossed each other. In about a minute the air in the valley was full of dust, the wind bringing it up, with a quantity of smoke also, and by about two o'clock the curling cloud was dispersed. It did not fall as rain, nor did it float on, but appeared as if it were simply blown to pieces." While Miss Ormerod was making these observations in the valley, a miniature whirlwind was observed on the hill above, at The Grange, the air being suddenly filled with particles of dust whirling rapidly round and round. At about the same time there were thunderstorms, with heavy rain, in several parts of the Midland counties.

AUGUST.—A rather cold month, with a very small daily range of temperature, an atmosphere of average humidity and pressure, a rather bright sky, and a very heavy rainfall on a large number of days. Coldest day 17th, mean 53°·7; warmest day 14th, mean 64°·7. Min. below 52° on 14 days; max. above 62° on 26 days, above 72° on 3 (14th, 26th, and 31st). All the rain in the month fell during the first twenty-five days, and only four of these (6th, 14th, 17th, and 20th) were without rain. On the 23rd 0·77 inch fell, and on the 24th 1·42 inch, giving over two inches in the two days. It is entirely due to this excessive fall that the month was a wet one.

SEPTEMBER.—A cold month, with a very small daily range of temperature, an atmosphere of average humidity and pressure, a cloudy sky, and a rather small rainfall on about the usual number of days. Coldest day 29th, mean 46°·5; warmest day 1st, mean 58°·8. Min. below 42° on 5 days; max. above 52°

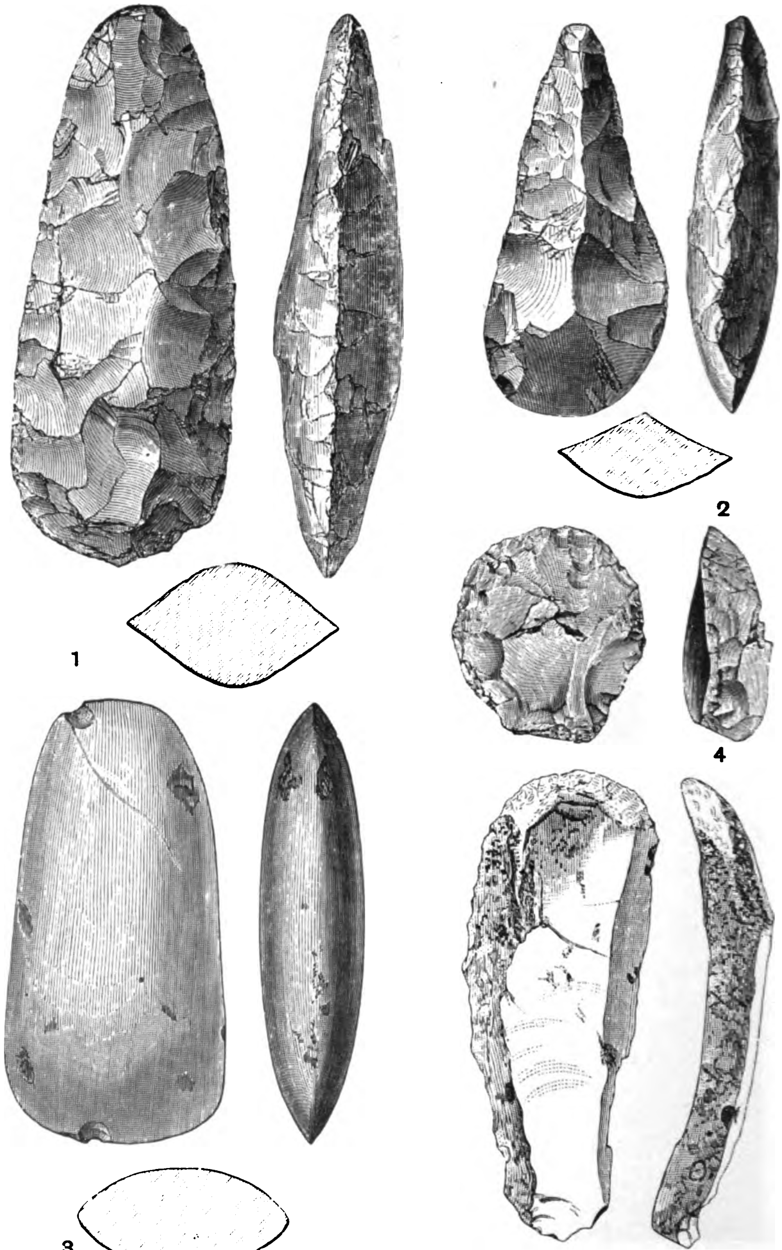
every day, above 62° on 7 days. Rain fell every day from 3rd to 9th (0·75 inch), and every day from 21st to 26th (0·98 inch), also on 15th and 16th (0·15 inch).

OCTOBER.—A rather warm month, with a very small daily range of temperature, an atmosphere of average humidity and pressure, a very cloudy sky, and a heavy rainfall on a large number of days. Coldest day 22nd, mean 39°·4; warmest day 26th, mean 53°·8. Min. below 42° on 10 days; max. above 52° on 22 days, the nine days on which it did not exceed 52° being 14th to 22nd, a cold period having a mean temperature of 44°·0 (9 a.m. 43°·5, min. 39°·5, max. 48°·9). The nights were much warmer than usual and the days rather colder. A few flakes of snow fell on the 23rd, and from that day to the end of the month rain fell daily, the total fall for the last nine days being 2·81 inches, leaving only 0·71 inch for the rest of the month.

NOVEMBER.—Very warm, with about an average daily range of temperature, an atmosphere of average humidity and considerable pressure, a rather bright sky, and a very heavy rainfall, but on the usual number of days. Coldest day 23rd, mean 36°·1; warmest day 1st, mean 56°·2. Min. below 42° on 24 days, below 32° on one day (23rd); max. above 52° on 9 days, above 62° on one day (1st). The first five days were very warm, having a mean temperature of 54°·8 (9 a.m. 54°·9, min. 50°·9, max. 58°·5). The rainfall on the five days 10th to 14th was 3·52 inches, and on the eight days 7th to 14th 4·23 inches, leaving only 0·58 inch for the rest of the month. An account of the floods in Hertfordshire to which this heavy rain gave rise, was given at the previous meeting of the Society (see p. 141). During the last ten days the fall was only 0·01 inch, on the 23rd, due to condensed fog rather than actual rain.

DECEMBER.—Another warm month, with an average daily range of temperature, an atmosphere of average humidity and considerable pressure, a rather cloudy sky, and a rather small rainfall, but on a considerable number of days. Coldest day 31st, mean 32°·4; warmest day 14th, mean 48°·4. Min. below 32° on 10 days; max. above 42° on 27 days. During the nine days 13th to 21st 1·47 inch of rain fell, leaving only 0·62 inch for the rest of the month. The large number of days (20) on which an overcast sky is recorded is due in great measure to the prevalence of fog in the mornings.

Trans. Herts Nat. Hist. Soc., Vol. VIII, Plate IX.



ANCIENT STONE IMPLEMENTS.

XXII.

ANNIVERSARY ADDRESS.

THE STONE AGE IN HERTFORDSHIRE.

By Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., etc., Vice-President of the Society.

Delivered at the Annual Meeting, 26th February, 1895, at Watford.

PLATES IX–XIV.

Ladies and Gentlemen,—

I am sure that all who are present this evening, at the twentieth Anniversary Meeting of our Society, sincerely regret the absence of our President, especially as he is away from us on account of ill-health; but of all who regret his absence I do not think that there is anyone who does so more sincerely than I do. The reason why I am now addressing you is that about ten days ago our Secretary, Mr. Hopkinson, called upon me and pathetically appealed to me to help the Society out of a difficulty. I suggested that as on this occasion a new President was to be elected, he might be willing to anticipate the Address which he would have to give in twelve months' time. I found, however, that Mr. Henry Seebohm had already been approached on the subject, but had more work on hand than would allow him to prepare an Address, and out of sheer compassion for our Honorary Secretary I agreed to deliver the Anniversary Address in the place of our President, Mr. Stradling.

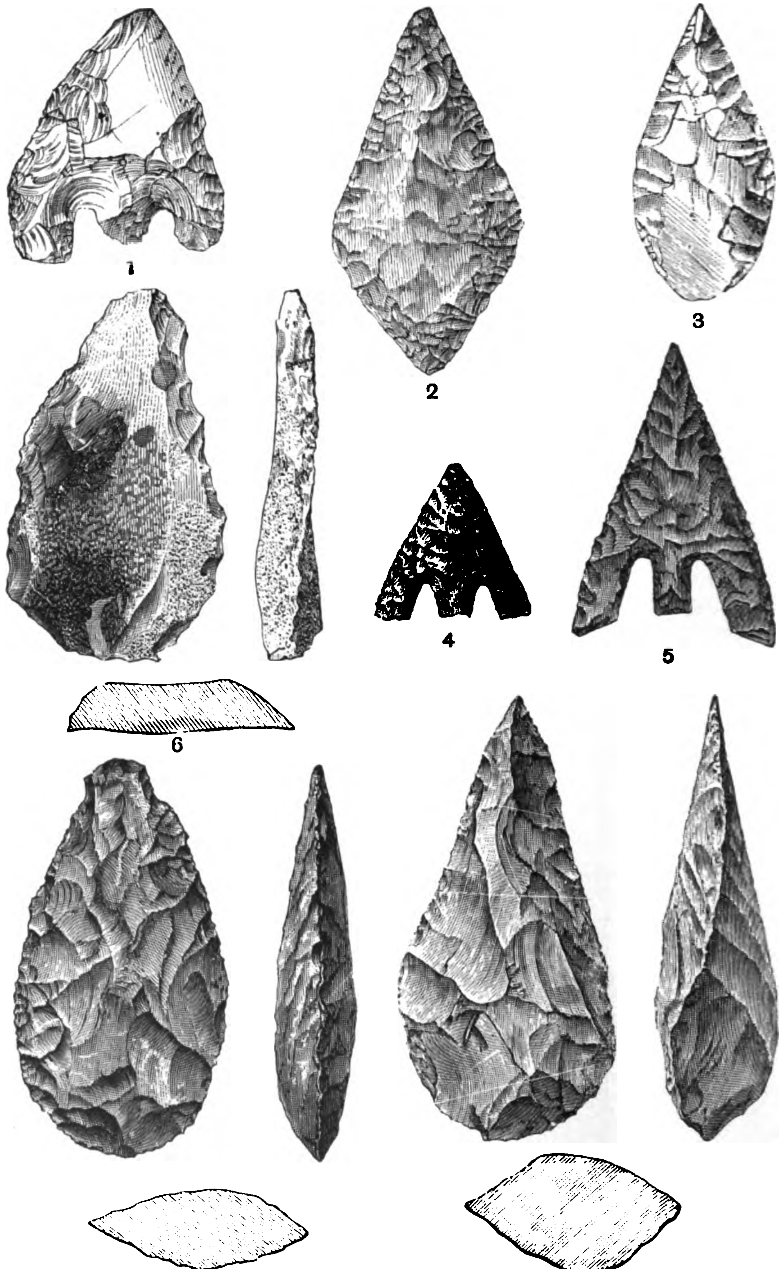
The subject which I have selected is "The Stone Age in Hertfordshire." But before I proceed to discuss this subject I wish to congratulate the Society on having completed its twenty years of existence. I was present when the Society was inaugurated; I had the honour of being its first President; I have watched over its growth and prosperity during the last twenty years; and I am glad to think that at the end of this year it will have attained its majority. The Society is in a very favourable condition compared with that of a great many of the local societies which are spread over the length and breadth of the land, and I think that our 'Transactions' contain as valuable papers as any that are published by other local societies. They are admirably edited by our Honorary Editor, Mr. Hopkinson, and I am sure that without his aid the Society would on more occasions than one have found itself in circumstances of great difficulty.

I believe that during the past year there has been no event in the proceedings of the Society of sufficient importance to require mention by me, and I will now, therefore, address a few words to you on the subject of the Stone Age in Hertfordshire,—and the consideration of the Stone Age in Hertfordshire involves that of the Stone Age in many other parts of the world.

The last time that I had the honour of addressing the Society, about fifteen months ago, I spoke with regard to the Bronze Age, and I then pointed out that the history and progress of human civilization had been divided into three great periods, namely the Stone Age, the Bronze Age, and the Iron Age. There was a period during which mankind was entirely unacquainted with the use of metals, and to that period the name of the Stone Age has been given, inasmuch as for those ordinary purposes to which metal is now applied, stone implements were used instead of those of metal. But after a time it was found that bronze, a metal consisting of a mixture of copper and tin, the origin of the manufacture of which was probably due to the previous use of copper only, was more durable and more effective for tools than stone, though stone implements continued in use during the Bronze Period for certain purposes, especially for pointing arrows, which were readily lost, and of which it was therefore desirable that the intrinsic value should be but small.

The Bronze Age was succeeded by the Iron Age, and it is known that at all events for three or four centuries before our era iron was in use among the Gaulish, and therefore probably among the British, tribes. When I last addressed you I suggested that bronze came into use in this country about 1,000 or 1,200 years B.C., but I added that before that time there must have been a lengthened period during which stone alone was the material in use for cutting-instruments. The period which immediately preceded the Bronze Age was characterized by tools and weapons of a fairly civilized kind, that is to say their edges were in many cases ground, and as much care was taken in fashioning them as if they had been made of metal. But behind that age—the Neolithic or Surface Stone Period—there lay a far earlier period, separated from it by a gap which no one has been able to measure, but which carries the traces of man back to an almost incalculable antiquity.

I purpose on the present occasion to treat first of the Neolithic or Surface Stone Period, a period during which the surface configuration of the country had assumed very much the same appearance as that which it now shows; and then to treat of the Palæolithic or Early Stone Period, a period which carries us



ANCIENT STONE IMPLEMENTS.

back to the time when the valleys which now exist were not excavated to anything like their present depth, and when various animals now extinct inhabited this country.

The ordinary forms of implements which characterize the Neolithic Period are celts (a kind of hatchet), picks, chisels, gouges (rare in Britain), hammers, hammer-stones of various kinds, grinding-stones, flakes, cores, scrapers (with a rounded or a semicircular edge), borers, knives, javelins, arrow-heads, and perforated axes. Personal ornaments also occur, such as buttons or studs, beads, rings, armlets, and necklaces.

The manner in which some of these articles were manufactured may first be considered. To make a flint implement, such as a small flint knife with two sharp edges to it, would at first sight not appear to be an easy thing to do; but the manufacture of such flint implements is still carried on in this country, at Icklingham in Suffolk, and at Brandon on the borders of Norfolk and Suffolk, at both of which places I have seen the process of making gun-flints. At Brandon some twenty or thirty workmen are employed, producing from 200,000 to 300,000 gun-flints per week. The flint-blocks used in the manufacture are there obtained by sinking small shafts into the ground until one of the bands of flints occurring in the Upper Chalk is met with which contains flints of the right quality; and along this band low horizontal galleries are then worked, and the large flints extracted.

The same method was followed not far from the same spot by the ancient flint-workers of the Neolithic Age. At Grime's Graves, near Brandon, in Norfolk, the whole surface of the ground is studded with pits which were evidently made at that remote period for the purpose of extracting flints from the chalk. One of these pits was explored by Canon Greenwell, the well-known barrow-digger, and it was found that after passing through a layer of flints of inferior quality, the very layer from which gun-flints are manufactured at the present day, known as the "floor-stone," was met with, and that along it horizontal galleries had been driven, the excavations having been made by means of picks formed from the antlers of the red deer. Similar pits have also been explored at Cissbury, near Worthing, in Sussex; and at Spiennes, near Mons, in Belgium.

The process of making a sharp-edged flint flake or knife with two sharp edges is really easy. A large piece of flint is first broken across so as to give it a flat surface; a blow is then given near the margin of the flint with a spherical-ended hammer (which may be of iron or merely a large pebble) almost at right angles to the flat surface. By this means a flake or splinter is struck off. Another blow detaches another flake, and a ridge is left between the two plane surfaces from which the flakes have been removed; a blow immediately behind this ridge will bring off a third flake of triangular section and having two sharp knife-like edges. If the blow be administered at some distance from the edge of the flint, a perfect cone will be produced. The flint being elastic, the small circular spot on which the blow falls is driven slightly inwards into the body of the flint; and the result is that a circular fissure is made which gradually enlarges in diameter as it descends below the surface, so that the piece of flint within the circular fissure is in the form of a cone, with a slightly-truncated apex at the small circle struck by the hammer. It is then an easy matter to strike off the surrounding flint. The cone or portion of a cone made by the blow is known as the bulb of percussion. A cone of flint thus made by a single blow of a hammer is shown in Fig. 1.

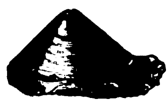


FIG. 1. Artificial cone of flint. ½.

Gun-flints are manufactured in a rather different manner. After one flake has been struck off, the next blow is given at a distance of about an inch from the spot where the first blow fell, and then others are given at similar distances. By this means splinters are struck off until the block of flint assumes, at least in some portion of it, a more or less regular polygonal outline; flakes are then struck off by blows behind a flat surface and not a ridge, so as to produce flat four-sided blades with two edges, and these are converted into gun-flints by breaking them into short lengths and trimming them.

I will now show you, by practical demonstration, how flakes can be struck off a block of flint by blows from a round-pointed hammer. After being thus struck off they can be pieced together again, the flint being built up into its original form, as you will see by Fig. 2. The central block from which flakes have been removed is known as a 'core' or 'nucleus.' You can readily imagine how one of the simpler forms of hatchets can be manufactured. The stone hatchet represented on the scale of one-half in Plate IX, fig. 1, has not been ground, but was produced by a series of blows, first on one side and then on the other, so as to produce a regular form, having a cutting edge at the broader end. When I was out shooting one day I picked up, in a field at Bedmond, a roughly-formed hatchet of this kind, and showed it to my keeper. Before we had proceeded many hundred yards, the keeper, whose eyes were sharper than mine, discovered a flint hatchet of somewhat narrower proportions, and almost uninjured. It is figured in Plate XI, fig. 1. I have found four or five of these roughly-chipped hatchets in a single field of my own, and no doubt those who would take the trouble to look in the fields around them would have their efforts rewarded. The roughly-chipped hatchets which have afterwards been ground and polished have in all cases been finished on a grindstone which was fixed and not rotatory, and the striæ on them are nearly always longitudinal, thus proving that they were rubbed lengthways, not crossways, on the grindstone. I have a hatchet, which I found in a field of my own at Abbot's Langley, ground at the edge, which has afterwards been intentionally blunted by grinding. A specimen ground at the edge only is shown in Plate IX, fig. 2. Rough-hewn hatchets

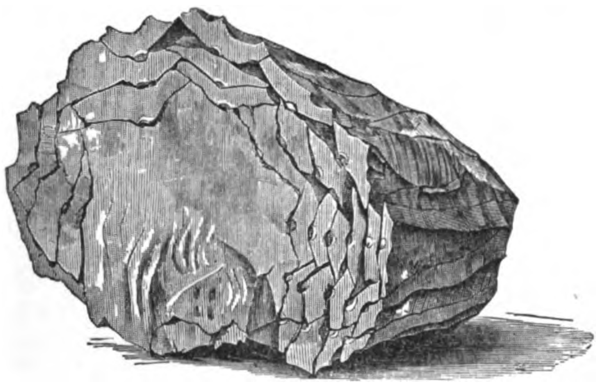


FIG. 2. Flint core with flakes replaced upon it. ½.

have been found in the neighbourhood of Ware, and a fine specimen of a polished hatchet, found in the neighbourhood of Panshanger, is in the possession of Earl Cowper; others have been found at Albury near Bishop's Stortford, and at Hitchin, the latter not being of flint but of some other hard stone. The hatchet or celt found at Albury is sharp or but slightly rounded at the sides, and presents a pointed oval in section; that from Panshanger is flatter at the sides, and has the butt end semicircular, and, like the sides, rounded. Both are polished all over and attain a length of about seven inches. An example of such a celt is shown in Plate IX, fig. 3.

From the hatchets the step to the chisels and the gouges or hollow chisels is easy. In this country the latter are of extreme rarity, but in Scandinavia they are often to be found, chiefly near the sea-coast, where they were probably used in the construction of canoes cut out of solid trunks of trees, and for other purposes.

Other forms of implements are perforated. A block of stone of a hard character was generally selected, and a hole bored in the middle, in all probability by pecking with a flint implement, and then grinding the rough holes thus made on either face with a piece of hard wood and sand, drilling until the two conical depressions met in the middle of the block. In other specimens in which the hole is nearly parallel, and which may be of later date, it is probable that some other method of boring was adopted. It has been found that with a piece of ox's horn and wet sand or emery-powder a hole can easily be bored by turning the horn round and round. I have myself taken an old stone hatchet and cut it in two with a bit of string and some sand; and I have bored a hole in it partly by means of wood and partly by means of a marrow-bone, used with sand and water, but I found that the latter answered better than the former. I am not aware of a perforated hatchet having been found in this county, but some years ago a small stone hammer-head, with a hole for the shaft or handle which must have been bored in some similar manner to that which I have described, was found near Sandridge by Dr. Griffith, and is now in the British Museum. This type of hammer is shown in Fig. 3. A perforated adze or hoe formed of a dark grey grit,

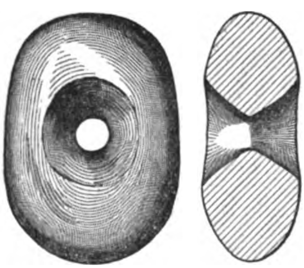
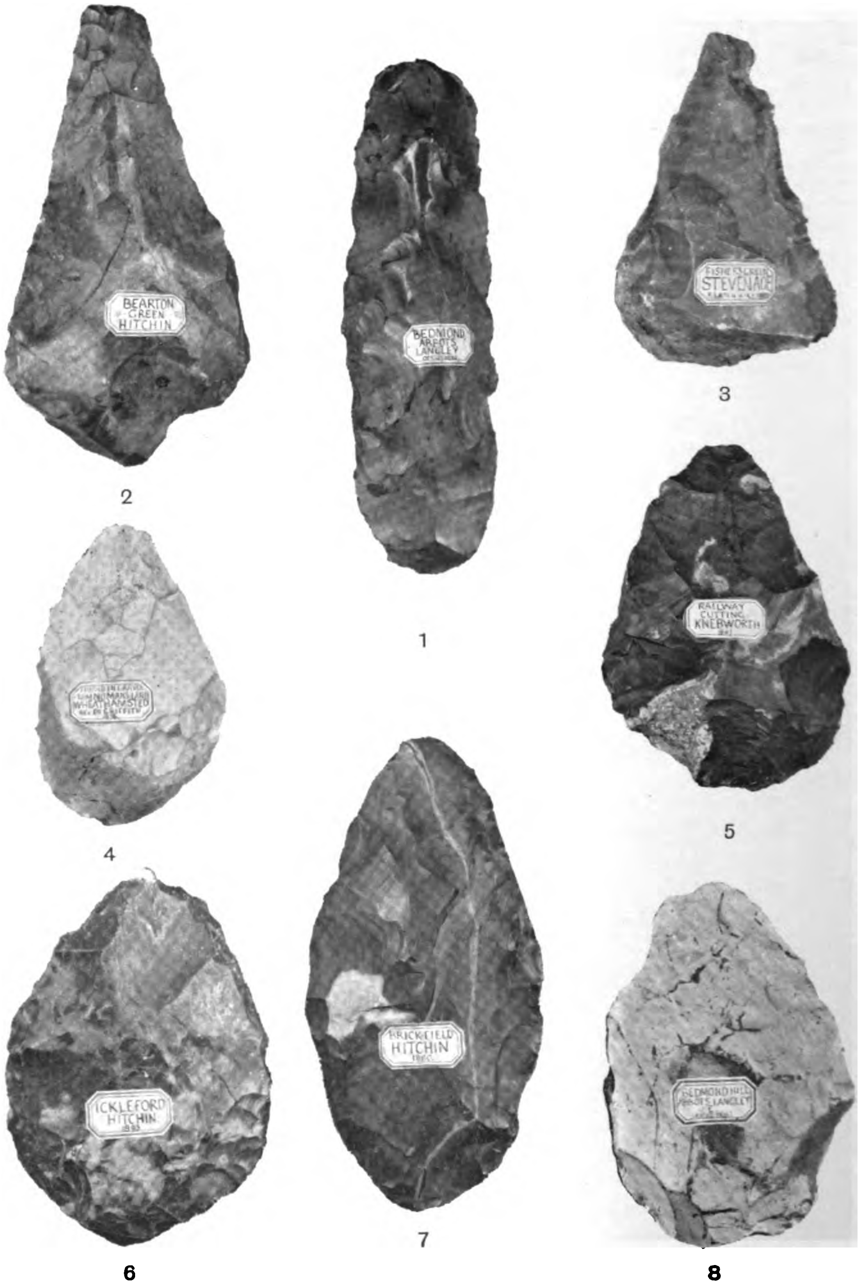


FIG. 3. Hammer found in Redmore Fen, Cambs. ½.

and found at Welbury, near Offley, is shown in Fig. 4. The original is in the collection of Mr. W. Ransom, F.S.A., of Hitchin.

Flakes are plentiful, but it is difficult to say to what period they belong. A certain number may have been made by the plough coming in contact with flints, and others may have been used in comparatively modern times for the purpose of striking a light.



HERTFORDSHIRE STONE IMPLEMENTS.

Flint flakes are often found on Roman sites, and one reason for this I may explain. The word "tribulation" is well-known to all of you, and some may have thought that they may have suffered what they call tribulation; but probably all do not know that tribulation means being placed under a "sharp threshing instrument having teeth," the Latin name for which was "tribulum." It was a kind of wooden sledge in which a number of holes were bored,

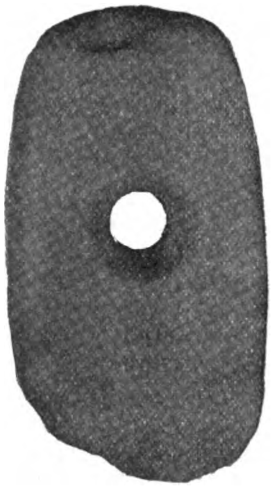


FIG. 4. Stone adze or hoe, Welbury, Offley. ½.

and in each one of these holes, some hundred in number, a sharp flake of flint was inserted. The implement was drawn over the threshing-floor by a yoke of oxen, and the corn was thus subjected to the process of tribulation. It was no doubt his *tribulum* that Araunah gave to David with which to make a fire for his burnt-offering. I have seen threshing-machines of this kind in use in Spain, and they are still used in the East. Some of the chipped flints probably used for this purpose in Roman times are frequently found on Roman sites. I have myself noticed them at Verulamium (St. Albans). A long flint-flake from Highbury, Hitchin, is shown in Plate XII, fig. 6, from Mr. Ransom's collection. It is probably Palæolithic.

Flint-flakes with ground edges are occasionally found. They appear to be well adapted for use as knives when held between the ball of the thumb and the end of the first finger, no handle being required. I have one of these flakes, which I found in a field of my own in the parish of Abbot's Langley. It is about 2½ inches long, ridged, pointed at one end, and ground at the other; one side has been very carefully ground to an edge. Fig. 5 shows a flake thus sharpened.

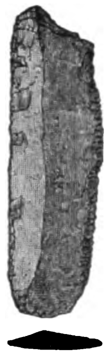


FIG. 5. Flint-flake, ground at edges, Charlton, Yorkshire, E.R. ½.

I will next direct your attention to the scraper, an implement still used in North America for the purpose of scraping the insides of hides in order to remove the fatty matter and so prepare them for tanning. I am not aware how the Esquimaux make these instruments, but I have found by experiment that, taking a flake of flint, made with a stone hammer consisting of a flint or quartzite pebble held in the hand, and placing the flake on a smooth block of stone, I can, by successive blows of the pebble, chip the end of the flake without any difficulty into the desired form. The face of the stone hammer must be brought to bear a slight distance only within the margin of the flake, and, however sharp the blow, the smooth block of stone on which the flake is placed, and which of course projects beyond it, acts as a stop to prevent the hammer from being carried forward so as to injure the form, and it is brought up sharply directly it has done its work of striking off a splinter from the end of the flake. The upper face of the flake remains quite uninjured, and there is no difficulty in producing the evenly-circular edge of the scraper by successive blows of the convex pebble. A typical scraper is shown in Plate IX, fig. 4. A longer form of scraper, to which the term duck-bill scraper has been applied, is of frequent occurrence. One of these, found by myself on the Sussex Downs, is represented in Plate IX, fig. 5. A flat flake, trimmed into a scraper-like form, and found near Hitchin, is shown in Fig. 6. It is in the collection of Mr. J. Hopkinson.

I have frequently shown how scrapers may have been made in the manner described, and once it led to an amusing incident. You all know what an admirable lecturer the late Professor Tyndall was. I once met him by appointment at Watford station and we took a walk into the country together, during which I showed him the process of making a scraper, and he was very much interested in it. When near Red Heath a shower came on and we stopped to take shelter. A country girl about twelve years of age came up to us, and Professor Tyndall proceeded to explain to her the process by which a flint scraper could be made; and whether it was more amusing to watch the amazed expression on the face of the girl who was being instructed, or the intellectual countenance of the Professor who was giving the lecture, I am not prepared to say, but it was certainly a quite unlooked-for result of the little insight which I had given Professor Tyndall into the manner in which stone implements were made.

FIG. 6. Flint-flake, near Hitchin. ½.

In olden times it was necessary to produce a state of combustion by some violent frictional action in order to obtain fire. It has been supposed by some that by striking two flints together a spark can be obtained that will ignite tinder, but that is not the case, as however much flint may be heated it will not burn as some metals do. A spark may be obtained by striking together a piece of iron and a piece of flint, but iron was not known to early man. Pyrites (sulphide of iron), however, has the same property in this respect as iron itself, and Pliny records the tradition that fire was the offspring of Cilix and Pyrodes, which seems to refer to the method of making fire by means of silex and pyrites. I have myself been able to light tinder by means of pyrites and a piece of flint, and this may have been another purpose for which these scrapers were made, as long scrapers worn at the end have been found in graves, together with blocks of pyrites, also showing signs of wear.

Turning from these homely implements to weapons of war or of the chase, I will now refer to the small flint weapons, varying in size and also considerably in shape, known as arrow-heads. The variation in size probably arises from some of them having tipped spears to be held in the hand for close encounters, and others having been attached to lighter shafts to form javelins for throwing at objects at a distance; but most of the smaller kinds were undoubtedly the heads of arrows discharged from bows. Lance-heads are usually more or less lozenge-shaped, while arrow-heads, though sometimes of that form or more nearly leaf-shaped, with or without a decided stem like the petiole of a leaf, are often of more complicated form, being stemmed and barbed. These are of most common occurrence, but one leaf-shaped form appears to be almost peculiar to a certain class of long barrows, though the stemmed and barbed, lozenge and leaf-shaped forms have been found together in the soil of the same grave-mound.

I have this morning received by post three arrow-heads which have been found in the neighbourhood of Hitchin by Mr. Frank Latchford. I have also arrow-heads found near Ware, and others from Pirton and Tring. The irregularly-barbed arrow-head represented in Plate X, fig. 1, was found by myself in 1866 on the surface of a field at the foot of the Chalk escarpment between Eddlesborough and Tring. One of the surfaces is very rough, and the outline is far from symmetrical, though it can hardly be regarded as unfinished, but rather as showing how rude were some of the appliances of our savage predecessors in Hertfordshire, even in the Neolithic Age. Some tanged and barbed flint arrow-heads of nearly the same form, but apparently a little more symmetrical, were found about 1763 at Tring Grove when the Grand Junction Canal was being made. The remains of a warrior were then found, and between the legs of the extended skeleton were several of these arrow-heads, at the feet being some perforated plates of greenish stone used as bracers or arm-guards, and similar in character to those still worn by archers to prevent the string of the bow from hitting the arm. A bracer from Scotland is represented in Fig. 7, and some more arrow-heads are shown in Plate X, figs. 2, 3, 4, and 5. A specimen from Ashwell, Baldock, in the collection of Mr. A. E. Gibbs, is shown in Plate XII, fig. 1. It is a debatable question whether the majority of the flint arrow-heads do not belong to the Bronze Period rather than to the Stone Period.

Flint arrow-heads are not so difficult to make as they appear to

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be. I have made them both with and without barbs, in this way. Placing a flake of flint against a stop on a flat piece of wood, and raising its edge when necessary by placing a small blocking-piece, also of wood, underneath it, by pressure of a large flake of flint,

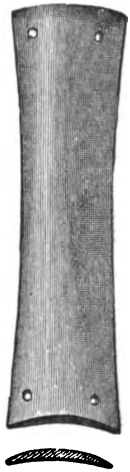


Fig. 7. Bracer, Evantown, Ross-shire. ½.

such as when now found is called an "arrow-flaker," or "fabricator," upon the edge of the flake, I have detached successive splinters until I have reduced the flake into the required form. But the edges of the arrow-heads made entirely with these flint "arrow-flakers" are more obtuse and rounded than are those of ancient specimens, so that these flint tools were probably used rather for the main chipping-out than for the final finishing. This process can be best performed by means of a piece of stag's horn. Placing the flake of flint which is to be converted into an arrow-head against a wooden stop, and pressing the horn against the edge of the flake, this edge enters slightly into the body of the horn; minute splinters can then be detached by bringing the pressure of the horn to bear sideways, and the arrow-head may in this manner be formed by degrees without much risk of its breaking. The leaf-shaped arrow-heads are the most easy to manufacture, and they were probably the earliest in use; but not only can these simple forms be produced by this means, but also the barbed arrow-heads, both with and without the central stem. Here is one leaf-shaped (like that in Plate X, fig. 3), which I may describe as a Hertfordshire stone implement, for I made it myself out of a Hertfordshire flint in the manner which I have described.

At the International Congress of Pre-historic Archæology held at Norwich in 1868 I gave an account of the method by which I believed various forms of stone implements were made, and afterwards when at our warehouse in the City I was told that a man wanted to see me. I found myself confronted by a disreputable-looking individual who informed me that he was known as "Flint Jack." He was a notorious forger of stone implements and of fossils in general, carrying on his iniquitous trade in Yorkshire. On my enquiring how he came to be in London he said to me: "I understand that you have been showing them at Norwich how to make these things, and I wish you would show me some of your specimens, for I understand that you are likely to attain to an equal degree of eminence with myself." I did not satisfy his curiosity, but gave him a trifle and advised him to get back to Yorkshire. Since that time I have always looked with a certain amount of interest at "Flint Jack's" productions, although I consider my own arrow-heads to be superior to those which he was in the habit of making.

I will not detain you with any account of the other forms of implements which were in use in the Neolithic Age, nor of the ornaments with which the ladies of that period adorned themselves, but I may say that there was already at that time a certain number of domesticated animals, that spinning and weaving were practised to some extent, and civilization was fairly advanced, considering that metals were almost unknown. It is now necessary to say a few words about the Palæolithic or River-drift Period.

The Palæolithic or Old Stone Age is also known as the River-drift Period, because the majority of the implements belonging to that age have been found in river-gravels, near the course of the present rivers but above their present levels. It is, however, a mistake to suppose that the occupation of the country by Palæolithic man was limited to river-valleys, for a considerable number of implements has been found a long way from any stream.

Let us briefly consider how our rivers have been able to deepen their courses. As it is chiefly in the gravels of such Chalk districts as those of our own county that such implements are found, it will be sufficient to trace the probable origin of one of our Hertfordshire river-valleys.

We may assume that the central part of our county, over which the upper portions of the rivers Lea and Colne and their tributaries now flow, was an almost horizontal area of chalk, with beds of marine clay and shingle upon it, rising from beneath the sea more rapidly than a river flowing over it could excavate its valley to the level of the sea by any subaërial action. We may also assume that the winter climate was more rigorous than it is at present, and that the annual rainfall was much greater. At the present time there is no geological formation less liable to floods than the upper portion of the Chalk. It is so absorbent that under ordinary circumstances it takes in the rain as fast as it falls upon it, and the moisture, when once in the soil, is either carried off again by evaporation and vegetation, or descends to the plane at which the chalk is saturated with water. This plane of saturation varies much in different seasons; near the Chalk escarpment in Hertfordshire, at a spot several miles away from any stream, I have known its level to vary as much as 70 feet in a single year; but with a greater rainfall than at present the chalk might at all times be saturated nearly up to its surface. Floods might then be as readily produced as if the soil were the most unabsorbent of rocks.

As the land rose from beneath the retreating sea, shallow channels might be formed by its waters, a course thus being marked out along which streams would subsequently flow; on the bare surface of this newly-elevated tract the eroding power of heavy rains would be great; and with a rigorous climate there would be a large accumulation of snow and ice in the winter, the rapid thawing of which in the summer would add enormously to the volume and the eroding power of the streams, causing them to deepen and widen their channels. The valleys being at first broad and shallow, the floods would cause the streams to overflow their banks and spread over the bottom of the valleys, carrying with them and depositing fine mud or clay, sand, small pebbles, larger pebbles, and flints or other stones, according to the velocity of the current. With each succeeding flood the valley would be deepened and narrowed, the river would become less sinuous, and the deposits spread by former floods over the bottom and the slopes of the valley would gradually be left out of the way of subsequent floods, the earliest-formed deposits being on the highest levels, which first escaped from the disturbing action of the repeated floods. Assuming, as I have done, that there were beds of marine clay and shingle upon the surface of the chalk, there would be in the higher and older gravels a much larger proportion of pebbles derived from these beds than of flints from the chalk than would be found in the lower and newer deposits; for when the latter formed the river would have worked its way below the level of these upper beds, and it would be excavating the chalk and forming the gravel in its bed chiefly from flints derived from the chalk.

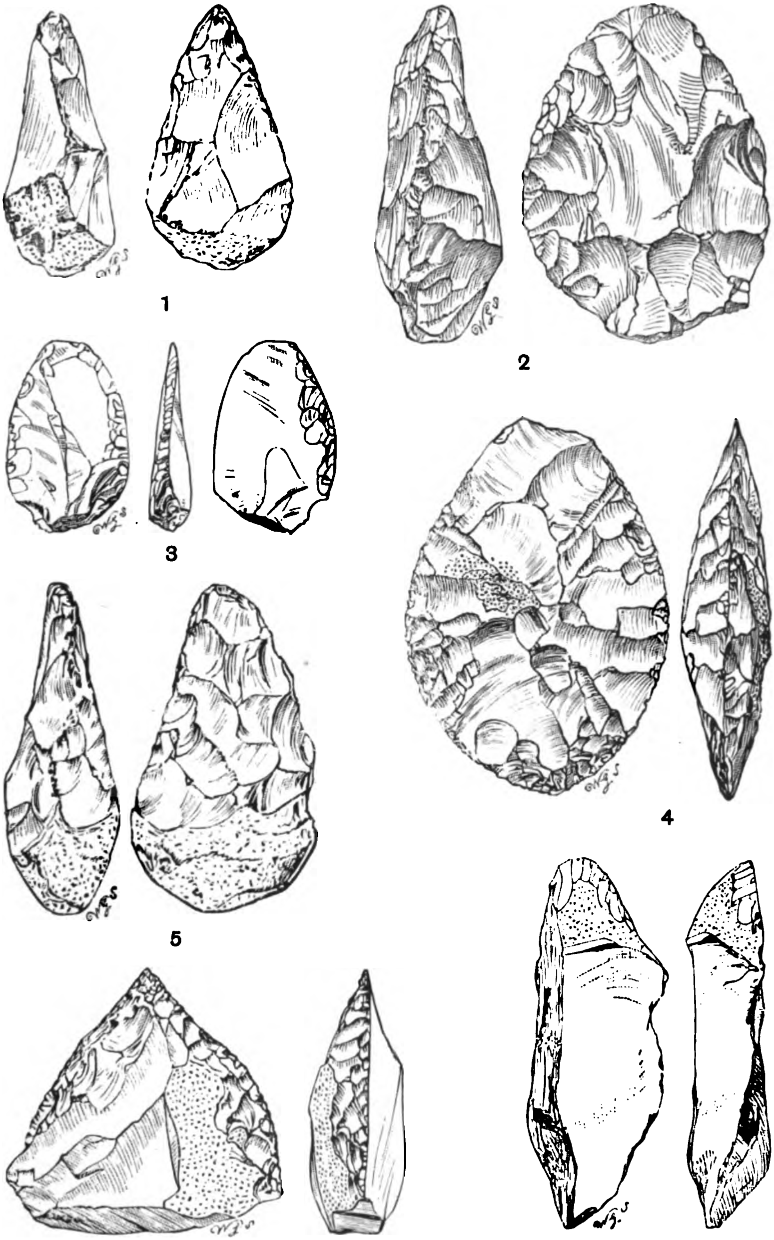
With a severe climate, also, ground-ice and shore-ice, both of which have considerable transporting power, would be formed; the rocks would be disintegrated by frost, and the fragments or talus formed would be easily carried away by the streams.

There is also another reason why we have these valleys formed in Chalk districts. Rain-water is enabled to dissolve chalk by becoming charged with carbonic acid from the decomposition of vegetable matter on the soil on which it falls, and from every square mile of chalk country no less than 140 tons of chalk are carried away in solution each year by the water which percolates through the chalk, thus eventually lowering the surface of the country.

The fact that the constituent parts of the drift gravels containing Palæolithic implements are always of the same petrological character as are the rocks in the existing river-basins, proves that the gravels are due to some local cause; and that they frequently contain land and fresh-water shells and mammalian bones of the Quaternary period, is conclusive evidence of their fresh-water origin. The character of the beds and their manner of deposition also exactly accord with the river hypothesis; and, moreover, they occur in such positions as might have been expected had their presence been due to the action of a stream excavating its valley in the manner I have described; indeed, in several instances the probability that certain gravels contained Palæolithic implements was pointed out before implements were actually discovered in them. There are other points of agreement between the actual phenomena and those of such river-action as I have supposed to have taken place, and we may, without any doubt, accept the implements as being truly characteristic fossils of the deposits in which they are found, and these as being Quaternary river-deposits.

Some important discoveries of Palæolithic implements have recently been made in the gravel in the valley of the Colne by Mr. Clouston, a resident at Watford, whom I am pleased to see here this evening. As the gravel in which he has found them is 40 feet above the level of the existing river, it follows that at the time this gravel was deposited the bed of the river was at that height above its present level.

In the valley of the Gade discoveries of Palæolithic implements have been made by myself. One implement was lying on the surface of a ploughed field near Bedmond, at a spot which, though probably 160 feet above the level of the nearest part of the river, is nearly at the bottom of one of the lateral valleys leading into the main valley of the Colne between Boxmoor and Watford. The



HERTFORDSHIRE STONE IMPLEMENTS.

implement, which was originally of nearly triangular form, has unfortunately lost its point. It was probably held in the hand and used as a weapon of offence. The flint of which it is formed has become nearly white and porcellanous on both faces, and it has in some places been so much altered in structure that it can be cut with a knife, which leads me to suppose that it may have been derived from some beds of pervious red brick-earth which occur at the spot where it was found. I have lately found a smaller ovate specimen at a higher level at Bedmond Hill Farm, about half-a-mile away. This is represented in Plate XI, fig. 8. In 1868 I found two other implements in gravel laid on the towing-path of the Grand Junction Canal, where it is united with the Gade, between Apsley and Nash Mills. I do not know exactly whence the gravel in which they lay was obtained, but there is little doubt of its having been dredged or dug from the bottom of the valley in the immediate neighbourhood. One of the implements is of grey flint, flat, of ovate outline, neatly chipped, and about 4 inches long by 2½ inches broad. The other is of an ochreous colour, of much the same form, though flatter on one face, and with its angles considerably water-worn. Other implements have been found near the head of the tributary valley of the Bulbourn, at Wigginton, near Tring.

In the valley of the Lea specimens have been found in gravel from No-Man's-Land Common by the late Rev. Dr. Griffith, including one very well-formed implement in my possession, of which a photograph is given in Plate XI, fig. 4. In all probability the Lea at one time flowed past No-Man's-Land, instead of Wheathampstead as at present, and these specimens have been left by the river. We may not only look for such implements in the valleys, but also on the tops of the hills where the rivers have been in many cases. Further down the valley of the Lea Mr. Worthington Smith has been successful in finding implements at Hertford and Ware, specimens of some of which I have. Still further down they have been found at Cheshunt (see Plate XIII, fig. 5), and on the west side of the Lea Mr. Smith has found implements at a height of 100 feet above the existing level of the Thames; and not only implements but the place where they were manufactured. He has there found the flints from which the various implements had been made, and flint flakes which can be put together in their original position; there is also other evidence of the occupation of the spot by primeval man, the traces of which occupation were subsequently embedded in the gravel. Specimens have also been found at Knebworth, Stevenage,* Hitchin, and Ippollitts. Examples from most of these places are figured in Plates XI and XII; particulars of which are given in the Description of the Plates.

In the valley of the Stort two Palæolithic implements have been found by Mr. W. H. Penning near Bishop's Stortford. Though both were found on the surface, yet their condition is such that there can be no doubt as to their having been but recently dug out of the soil, their colour being dark brown and ochreous in places. One of them was found at a short distance from the river, by the side of a ditch cut in a thin deposit of valley brick-earth, about a mile north of Bishop's Stortford, and it had probably been thrown out with the soil from the ditch. It is oval in outline, rather flatter on one side than on the other, and a little thinner at one end than at the other. The second was found on the sandy surface of a ploughed field close to Pesterford Bridge. It is of the same character, but is somewhat broader, and square at the base. An additional idea of some of the most prevalent forms of Palæolithic implements may be gained from Plate X, figs. 6, 7, and 8, of which fig. 6 represents a flake. That from Hoxne, Suffolk, is singularly like the one described by Mr. Frere so long ago as 1797.

I must now refer to one of the most remarkable discoveries of such implements which have been made in Hertfordshire. On the hills in the neighbourhood of Caddington,† Mr. Worthington Smith has made a similar discovery to that on the west side of the lower part of the valley of the Lea, to which I have already alluded.

He has there discovered what he believes to be the site of an ancient lake, the shores of which were once tenanted by men of the Early Stone Period, who have left evidences not only of their occupation of the site but also of their having made their stone implements on the spot, for they have left the flint tools with which they made them and the flakes they chipped off them in the process of manufacture. Mr. Smith has pieced together many of these flakes, reconstructing the original block of flint and thus showing that the flakes were struck off on the spot. He considers that the men who made these implements were skilful workmen, and therefore that they were not nearly the most ancient of the human race, having probably migrated from some country with a warmer climate. The implements which he has found comprise nodules of flint artificially pointed at one end, and with an unworked butt end, which was very convenient for holding in the hand; drills

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. lxi.

† See 'Man, the Primeval Savage,' by Worthington G. Smith. Stanford, London, 1894.

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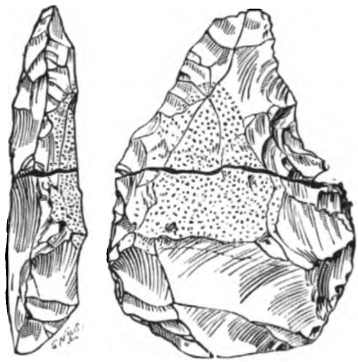

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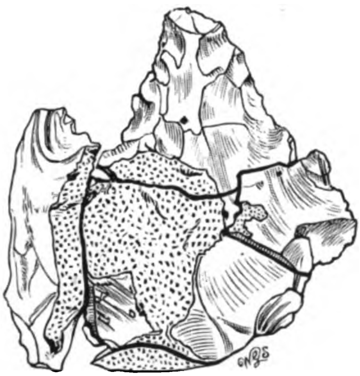

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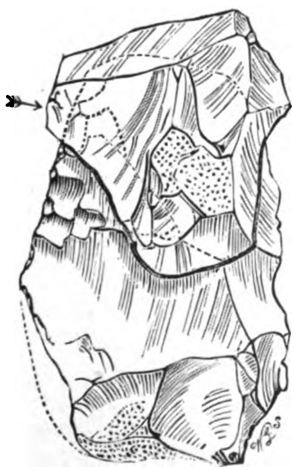

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HERTFORDSHIRE STONE IMPLEMENTS.

or borers; trimmed flakes; knives and scrapers; hammer-stones; punches; and other tools the use of which is unknown. Amongst the implements are some which have been re-pointed, and others which appear to have been broken in use. In several places there are artificially-raised heaps of flints, a further indication that this was a workshop where the implements were manufactured.

In illustration of these important discoveries, Mr. Worthington Smith has kindly lent to the Society a selection of the wood-blocks used in his excellent little book, "Man, the Primeval Savage." Impressions from these are given in Plates XIII and XIV, and full particulars concerning them will be found in the Description of the Plates.

Mr. Smith believes that the Palæolithic implements which he has exhumed at Caddington are not all of the same age, for they occur in distinct layers, the tools in the highest layer being different in their nature and colour from those in the layers below.

It does not by any means follow that a rudely-chipped implement belongs to the Palæolithic Period, for although the forms of such implements afford a comparatively safe guide as to their antiquity, their age can with safety be determined by geological evidence only. The character of the fauna with which the worked flints are associated, comprising as it does the elephant, rhinoceros, hippopotamus, and other animals now extinct in this country, affords corroborative evidence as to the length of time that has elapsed since these flints were fashioned.

These appear to afford the earliest traces of the existence of man which occur in our own county, but if we visit the South of England we find more striking proofs of his antiquity, for there, capping the cliffs some 80 or 90 feet above the level of the sea, what was once the bed of a river now forms the surface of the hills which stretch along the coast, the other side of the valley having been removed by the inroads of the sea, and in these high-level and almost inconceivably ancient river-deposits flint-implements have been discovered.

In Kent what have been regarded as worked flints have been found in ancient beds upon the plateaux, and these if rightly regarded as implements, seem to belong to a still earlier period than the ordinary Palæolithic forms.

But early as may possibly be the period to which these discoveries point, I should not venture to affirm that they designate the origin of primeval man, for discoveries which have been made in India and other southern countries seem to indicate a still earlier period for human existence; and although these carry us long ages back in our history, I should still be far from saying that we have as yet discovered the very earliest traces of the existence of man upon the earth.

EXPLANATION OF THE PLATES.

PLATE IX.

FIG. NEOLITHIC IMPLEMENTS.

1. Symmetrically-chipped, unground, celt. Reach Fen, Cambridge. Scale, one-half. In the collection of the author. ('Ancient Stone Implements.' Fig. 23.)
2. Celt, pointed and unpolished at the butt-end, and ground to a thin circular edge at the broad end. Near Mildenhall, Suffolk. Scale, one-half. *Coll.* the author. (A.S.I. Fig. 32.)
3. Celt of porphyritic greenstone, polished all over. Coton, Cambridge. Scale, one-half. *Coll.* the author. (A.S I. Fig. 48.)
4. Discoidal scraper made from a broad and short flake. Helperthorpe, Yorkshire Wolds. Natural size. *Coll.* the author. (A.S.I. Fig. 207.)
5. "Duck-bill" scraper made from a flat flake. Near Cuckmere Haven, Sussex Downs. Natural size. *Coll.* the author. (A.S.I. Fig. 213.)

PLATE X.

FIG. NEOLITHIC IMPLEMENTS.

1. Unsymmetrical barbed flint arrow-head. Eddlesborough, near Tring, Herts. Natural size. *Coll.* the author. (A.S.I. Fig. 315.)
2. Lozenge-shaped arrow-head made from a flat flake. Grindale, Bridlington, Yorkshire. Natural size. *Coll.* the author. (A.S.I. Fig. 296.)
3. Leaf-shaped arrow-head. Yorkshire Wolds. Natural size. *Coll.* Rev. W. Greenwell, F.R.S., F.S.A. (A.S.I. Fig. 282.)
4. Small barbed arrow-head, with the ends cut straight. Yorkshire Wolds. Natural size. *Coll.* Rev. W. Greenwell. (A.S.I. Fig. 312.)
5. Barbed arrow-head, the ends forming an acute angle with the sides. Lamborne Down, Berks. (from a barrow). Natural size. *Coll.* British Museum. (A.S.I. Fig. 319.)

PALÆOLITHIC IMPLEMENTS.

6. Flint flake, with both its edges re-chipped. Redhill, Thetford. Scale, one-half. *Coll.* the author. (A.S.I. Fig. 431.)
7. Flint implement, worked to an edge all round. Near Dartford Heath, Kent. Scale, one-half. *Coll.* Mr. F. C. J. Spurrell, F.G.S. (A.S.I. Fig. 456.)
8. Acutely-pointed flint implement, with twisted blade. Hoxne, Suffolk. Scale, one-half. *Coll.* the author. (A.S.I. Fig. 450.)

PLATE XI.

FIG.

1. Neolithic celt. Bedmond, Abbot's Langley. Scale, one-half. *Coll.* the author.
2. Palæolithic instrument. Bearton Green, Hitchin. Scale, one-half. *Coll.* the author.
3. Ditto. Fisher's Green, Stevenage. Scale, one-half. *Coll.* the author.
4. Ditto. No-Man's-Land, Wheathampstead. Scale, one-half. *Coll.* the author.
5. Ditto. Railway-cutting, Knebworth. Scale, one-half. *Coll.* the author.
6. Ditto. Ickleford, Hitchin. Scale, one-half. *Coll.* the author.
7. Ditto. Brickfield, Hitchin. Scale, one-half. *Coll.* the author.
8. Ditto. Bedmond Hill, Abbot's Langley. Scale, one-half. *Coll.* the author.

PLATE XII.

FIG.

1. Neolithic arrow-head. Ashwell, Baldock. Scale, one-half. *Coll.* Mr. A. E. Gibbs, F.L.S.
2. Palæolithic implement. Folly Pit, Hitchin. Scale, one-half. *Coll.* Mr. William Ransom, F.S.A.
3. Ditto. Highbury, Hitchin. Scale, one-half. *Coll.* Mr. W. Ransom.
4. Ditto. Highbury, Hitchin. Scale, one-half. *Coll.* Mr. W. Ransom.
5. Ditto. Ickleford, Hitchin. Scale, one-half. *Coll.* Mr. W. Ransom.
6. Flint flake. Highbury, Hitchin. Scale, one-half. *Coll.* Mr. W. Ransom.
7. Palæolithic implement. Highbury, Hitchin. Scale, one-half. *Coll.* Mr. W. Ransom.

PLATE XIII.

FIG.

PALÆOLITHIC IMPLEMENTS.

1. First flint implement found *in situ* at Caddington, Herts. Scale, one-half. *Coll.* Mr. Worthington G. Smith. ('Man, the Primeval Savage.' Fig. 55.)
2. Ovate flint implement. Caddington. Scale, one-half. *Coll.* the author. (Fig. 57.)
3. Small scraper-like flint knife. Caddington. Scale, one-half. *Coll.* the author. (Fig. 81.)
4. Ovate flint implement, with sharp cutting edge all round. Caddington. Scale, one-half. *Coll.* the author. (Fig. 69.)
5. Slightly-abraded flint tool. Flamstead End, Cheshunt, Herts. Scale, one-half. *Coll.* the author. (Fig. 130.)
6. Flint flake trimmed on one face. Caddington. Scale, one-half. *Coll.* Mr. W. G. Smith. (Fig. 70.)
7. Scraper-like flint tool. No-Man's-Land Common, Wheathampstead, Herts. Scale, one-half. *Coll.* Mr. W. G. Smith. (Fig. 128.)

PLATE XIV.

FIG.

PALÆOLITHIC IMPLEMENTS.

1. Small unfinished flint implement, with one flake replaced. Caddington. Scale, one-half. *Coll.* Mr. W. G. Smith. (Fig. 94.)
2. Finished flint implement, broken in Palæolithic times; both pieces found and conjoined. Caddington. Scale, one-half. *Coll.* the author. (Fig. 97.)
3. Other side of the same implement, with three flakes replaced. (Fig. 98.)
4. The same implement, with a fourth flake replaced. (Fig. 99.)
5. Finished flint implement, with one large flake replaced. Caddington. Scale, one-half. *Coll.* the author. (Fig. 96.)
6. The opposite side of the same implement. (Fig. 96.)
7. Edge view of the same implement. (Fig. 96.)

The figures in Plates IX and X are from the author's 'Ancient Stone Implements, Weapons, and Ornaments of Great Britain' (1872); those in Plates XI and XII are process-reproductions of original photographs of the actual implements; and those in Plates XIII and XIV are from Mr. Worthington G. Smith's 'Man, the Primeval Savage' (1894).

XXIII.

NOTES ON LEPIDOPTERA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1894.

By A. E. Gibbs, F.L.S., F.E.S.

Read at Watford, 23rd April, 1894.

The year 1894 was marked by a dearth of insect-life, so far, at least, as the Lepidoptera are concerned. Whether this was due to the excessively wet season following the very dry summer of 1893, I cannot say, but it is probable that meteorological conditions were the chief cause of it. All my correspondents tell the same tale of want of success. "Sugaring" locally yielded no results, and a few days in July spent in the New Forest, where insects are generally very abundant, proved most disappointing. Mr. Arthur Lewis and your Recorder tramped many miles, visiting plantation after plantation, only to return home with empty boxes.

Mr. S. H. Spencer, jun., of Watford, says that while he found the sallows in his neighbourhood very productive, sugaring was quite a failure, although the evenings selected for this work were such as are known in the ordinary way to be good ones. A great many Geometers and a few Noctuæ were taken by him on the lamps, and he expressed the opinion that "lamping" was fairly successful on the whole.

I regret that the number of our local observers is falling off. One gentleman—Mr. Pilbrow—who has in past years supplied me with valuable information from Colney Heath, has left the neighbourhood, and others have been too much occupied by business and other engagements to devote their time to Entomology. My report this year will therefore be a short one.

Butterflies.

Mr. A. C. Smith, of St. Peter's Street, St. Albans, brought to me a specimen of the large tortoise-shell butterfly (*Vanessa polychloros*) which he captured in his house. This is the first specimen of this insect which I have seen alive in St. Albans for some years. I alluded in my last report to the fact that it is getting scarce in Hertfordshire, and Messrs. F. Latchmore and Harold Gatward, of Hitchin, again write that the large tortoise-shell "is not nearly so common here as it was a few years back." It is interesting to notice that Miss E. A. Ormerod has included this butterfly amongst the injurious insects of 1894, and has devoted a chapter to it in her last annual 'Report of Observations of Injurious Insects.' Mr. D. D. Gibb, of Ossemsley Manor Farm, Lymington, wrote to Miss Ormerod on the 19th of June asking advice as to dealing with a caterpillar-infestation, a cherry-tree on his lawn having been stripped of its leaves in a very rapid manner. The larvæ proved to be those of the large tortoise-shell butterfly, and they were easily found and destroyed. Miss Ormerod points out that, "generally speaking, the large and beautiful insects are so scarce that they might be left uninjured with little fear of consequences," and all naturalists, I am sure, will thank her for speaking a word in favour of such a comparatively-rare and therefore harmless species.

Messrs. Latchmore and Gatward report that the peacock butterfly (*Vanessa Io*) was abundant at Hitchin, both in the larval and perfect state, and that the painted lady (*V. cardui*) was observed on the wing in several places. The red admiral (*V. atalanta*) was plentiful in both the larva and the pupa state, and was very common, even through the cold days of October, feeding in the rolled-up leaves of the nettle. *Colias edusa* is not reported as having been observed in 1894.

Moths.

Very few observers have sent notes to me with regard to the hawk-moths. My correspondents at Hitchin, Messrs. Latchmore and Gatward, report that the poplar, lime, and eyed hawk-moths were the species principally noticed by them at Hitchin, the first-named insect being very abundant. Mr. R. W. Bowyer, of Haileybury, reports that the elephant hawk-moth (*Chærocampa elpenor*) came rather commonly to light. A new Hertfordshire locality has to be recorded for the broad-bordered five-spot burnet-moth (*Zygæna trifolii*). On the 14th of July Mr. S. H. Spencer had a specimen of this insect taken to him by his friend, Mr. Edwin Jackson, who found it drying its wings on a thistle at Watford.

Mr. Latchmore tells me that he noticed a number of webs of the little eggar-moth (*Eriogaster lanestris*) on hawthorn and sloe bushes, but did not attempt to rear any. Two years ago I drew the attention of our members to this moth, which is interesting on account of the length of time during which it will remain in the chrysalis state. I captured a number of the larvæ both in 1892 and 1893, and they fed-up and in due time became chrysalises. Many of those reared in 1892 are still in the pupa state, and scarcely one of the 1893 brood has yet become a perfect insect, although I have some scores of them. They emerge at the rate of about three a year, so that it takes a considerable amount of time and patience to obtain a nice series for the cabinet.

In 1893 I alluded to the fact that four years previously Mr. Arthur Lewis, of Sparrowswick, St. Albans, liberated some larvæ of the emperor-moth (*Saturnia pavonia*) in his garden, and the insect appears to have established itself on Bernard's Heath, which adjoins his grounds. On the 31st of August last Miss E. A. Ormerod kindly sent to me four larvæ and a pupa of this handsome insect which had been taken on the Heath and sent to her. The larvæ were full-grown, and three of them began to spin their cocoons at once, the other feeding on sloe and plum for some days longer. On the 4th of April Mr. E. G. Bryant, of St. Peter's Street, St. Albans, sent to me a female imago of this species which his little boy had picked up in the street. She laid a number of bright green eggs, but they proved to be infertile. Specimens of the caterpillar feeding upon heather are adorned with a number of beautiful pink tubercles, each surrounded by a black ring, but in the specimens from Bernard's Heath the tubercles were golden. Probably this is the original colour, and the pink tint of the heather-feeding individuals may be developed for the purposes of protection in order to assimilate with the colour of the heather-blossom.

At the beginning of August Mr. Latchmore, of Hitchin, found a beautiful specimen of the sallow kitten-moth (*Dicranura furcula*) on a sallow-leaf. It so strongly resembled the white deposit of a bird that he nearly overlooked it. Unfortunately a friend to whom he showed it shook it off the twig and killed it on the floor.

Mr. Arthur Lewis reports the occurrence of the bullrush-moth (*Nonagria arundinis*) in his grounds at Sparrowswick. When he cut the bullrushes growing in a small pond in August or September, he found that they had been attacked by the larvæ of this moth, and he succeeded in finding one pupa from which the perfect insect had not yet emerged. He preserved it, but the drying of the rush caused the moth to appear in a crippled state. The larva of this species feeds in the stem of the bullrush, eating a gallery in the pith until nearly fully fed, when it prepares a circular hole for its escape, leaving only the epidermis. It then pupates in its gallery and in due time emerges through the hole which it has made. Mr. Arthur Griffith includes this moth in his Sandridge list, but this is the only other Hertfordshire record.

One of the insect-pests of last season, in the south-west of Scotland, was the antler-moth (*Charæas graminis*). Miss Ormerod, in her recently-issued 'Report,' alludes to this infestation as "one of the most remarkable insect-appearances of the past year." The caterpillars were present on the sheep-farms in vast numbers, and as they feed upon the tender shoots of the grass they did incalculable mischief by devastating the pastures. This moth was present in Hertfordshire, but not in any great numbers. In July Mr. Albert Piffard, of Felden, Boxmoor, sent to me for identification a specimen which he had taken in the day-time on heracleum.

Mr. Bowyer tells me that *Agrotis obscura* (*ravida*) was the rarest insect seen by him on Hertford Heath in 1894. There are only two other Hertfordshire localities entered for it, namely, Hitchin and East Barnet. Mr. Bowyer says that it is scarce in his neighbourhood.

In March and April sallow-beating proved fairly remunerative; indeed, this work was the most productive of the year. The common *Tæniocampæ* were, as usual, very abundant, and for the first time I took *T. populeti* at Bricket Wood. Mr. S. H. Spencer took six specimens on the 19th and 24th of April, and Mr. Arthur Lewis and I each captured a few. *T. munda* was plentiful, but we did not take a single specimen of *T. gracilis*.

Mr. Cutts, of Nascot Wood, Watford, had two specimens of the green arches-moth (*Aplecta prasina*) emerge in his insect-cage on the 6th of June. This beautiful moth is far from common, but

I have taken two or three specimens at "sugar." The only other observer who has recorded it is Mr. Bowyer, who has found it on Hertford Heath.

The handsome caterpillars of the mullein-moth (*Cucullia verbasci*) were observed by Mr. Harold Gatward, of Hitchin, feeding on a mullein plant in his garden in Tilehouse Street. Mr. Cutts has also taken the larva of this insect abundantly on mulleins at his residence at Nascot Wood, Watford. The allied species, the water-betony moth (*C. scrophulariæ*), was, as usual, very abundant on the plant from which it takes its name, at Ickleford and other water-side places in the north of the county. It is not easy to determine these two moths in their perfect state. Mr. Cutts records the capture of a specimen of the chamomile shark-moth (*C. chamomillæ*) at Nascot Wood. This is the second record for Hertfordshire. He also adds the treble-bar moth (*Anaitis plagiata*) to his Watford list.

When searching some sallow-bushes for kitten-moths in July, Mr. Latchmore found several beautiful cocoons which contained very black-looking chrysalises. One moth had not emerged. A few days later he was delighted to find in the box a specimen of the herald-moth (*Gonoptera libatrix*). Mr. Latchmore says: "I cannot conceive of a more beautiful insect than this is on its emergence from the pupa state."

The common silver Y-moth (*Plusia gamma*) was remarkably abundant in the autumn in my garden at Avenue House, St. Albans. I had a number of plants of *Lilium auratum* in flower, and they proved to be very attractive to these species, several moths being frequently seen in a blossom at the same time. I did not notice that other species were attracted by the lilies.

A very pretty insect is the least-yellow underwing (*Heliaca tenebrata*), of which Mr. Spencer and his friend Mr. Wigg caught four specimens on the 14th of May at Bricket Wood, a locality in which I captured it ten or twelve years ago. They were flying over the blossoms of the wild strawberry and several other small flowers. This species appears to be generally distributed throughout the county, though it is nowhere very abundant.

One bitterly cold evening in October Mr. Latchmore took at "sugar," at Grove Mill, a fine specimen of the red underwing (*Catocala nupta*). This insect he reports as being quite common at Hitchin, by the water-side. On the 26th of March Mr. Spencer, who, like myself, was at Bricket Wood in the day-time with the net, caught a specimen of the orange underwing (*Brephos parthenias*), and saw several more flying among the sallows and birch bushes. I also caught sight of this insect, but as it flies very high it is not easy to capture it. This moth appears in our record-book as having been captured at Haileybury, Hertford, and East Barnet. It is a good insect for the cabinet, its under-wings having a striking orange tint, and its fore-wings being of a reddish colour.

Mr. Spencer records the occurrence of the bordered white (*Bupalus piniaria*) at Chipperfield Common on the 30th of June. He writes: "I saw this insect flying in considerable numbers round the tops of some Scotch firs and other conifers. I was unable to catch a single specimen, though they came all but within the reach of my net. I know the insect well, so there can be no mistake as to its identity." The only other Hertfordshire record for it is that given by Mr. J. H. Durrant, who has taken it at Hitchin. The two sexes of this insect are quite dissimilar. The male has white as the ground-colour of its wings, with a black apical patch, while the female has wings of an orange-brown tint.

The little moths known as pugs are a very difficult genus to make out, and are very apt to be neglected. The larvæ mostly feed in the blossoms of plants, eating the floral organs and sometimes penetrating the seed-vessel. We have fifty British species of these *Eupitheciæ*, of which exactly one half have, up to the present time, been recorded as occurring in Hertfordshire. To our local list Mr. Spencer now contributes one more. He records the capture of a specimen of the dwarf pug-moth (*Eupithecia pusillata*) in Rowse Barn Lane, Watford, in May last.

Early in July, Mr. B. Piffard, of Hill House, Hemel Hempstead, sent to me a pretty little olive-brown and white moth, one of the Tineina, the larva of which he had found feeding in the centre of the base of the peduncle of the common ash, he believes in May. Before turning to a pupa the larva crawled out and spun a thin web. The infestation of this insect caused many leaves to fall off. The species proved to be *Prays curtisellus*, a moth which is known to cause mischief to ash-trees through the ravages of its larvæ.

Mr. Spencer has sent the following notes:—"Melanism: I took one specimen of *Tæniocampa stabilis* in which the brown has changed to black, and one specimen of *Apamea oculea*, which is one of the darkest I have ever seen.—*Colias hyale*: two specimens of this butterfly were taken by some boys in the gravel-pits near Cassio Bridge during the year 1892.—*Euchloë cardamines*: I have a specimen of this butterfly, captured in 1893, which measures $1\frac{7}{32}$ inch from tip to tip, the markings being the same as in the ordinary typical form.—*Acidalia remutata*: several specimens taken during June, 1893.—*Acidalia bisetata*: several specimens taken at dusk in 1893."

I desire, in conclusion, to thank my correspondents for kindly sending to me notes of their observations. As the number of our observers is declining, I again appeal to all entomologists in the county to assist in the work of compiling as complete a list of the Lepidoptera of Hertfordshire as possible. This can only be done by united effort, and it will be a great help if those who take an interest in Entomology will communicate with the Recorder of the Lepidoptera.

XXIV.

REPORT ON PHENOLOGICAL PHENOMENA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1894.

By EDWARD MAWLEY, Pres.R.Met.Soc., F.R.H.S.,
Phenological Recorder to the Royal Meteorological Society.

Read at Watford, 23rd April, 1895.

THE number of observers remains the same as in the previous year. No returns were received from Broxbourne, but on the other hand a new station has been started at Hatfield. The observing stations are now well distributed over the county, the only districts unrepresented being those in the neighbourhood of Cheshunt in the south-east, Bishop's Stortford in the east, and Buntingford in the north-east, from any of which localities I shall be very glad to receive observations.

The names of the stations, their height above sea-level, and the names of the observers are as follows:—

STATION.	Height above Sea-level.	OBSERVER.
Watford (The Platts)	240 feet.	Mrs. G. E. Bishop.
Radlett (Newberries)	320 ,,	Miss E. M. Lubbock.
St. Albans (The Grange)	380 ,,	Mrs. J. Hopkinson.
St. Albans (Addiscombe Lodge)	400 ,,	Miss E. F. Smith.
St. Albans (Worley Road)	300 ,,	Henry Lewis.
Berkhamsted (Rosebank)	400 ,,	Mrs. E. Mawley.
Harpenden	370 ,,	J. J. Willis.
Hatfield (Symons Hyde)	300 ,,	T. Brown.
Hertford	140 ,,	W. Graveson.
Hitchin	230 ,,	J. E. Little, M.A.
Ashwell (Odsey)	260 ,,	H. G. Fordham.

THE WINTER OF 1893–94.

With the exception of two cold periods, one lasting nearly a fortnight and the other about a week, the weather during this winter continued persistently mild. The first frost set in at the end of December, and lasted until the 8th of January. For several successive nights very low readings were registered at Berkhamsted, and on one of them a thermometer exposed on the surface of the snow fell to zero of the Fahrenheit scale—thus indicating 32° of frost. The second cold period, which occurred soon after the middle of February, was not nearly so severe, the exposed thermometer at no time showing more than 18° of frost.

Notwithstanding the exceptional keenness of the January frost, very little harm was done to vegetation. This is no doubt accounted for (1) by the gradual way in which the temperature declined from night to night, until the lowest reading was reached,

TABLE I.—DATES OF FLOWERING OF PLANTS OBSERVED IN 1894, WITH THE MEAN DATE FOR 1876–1893.

SPECIES.	WATFORD.	RADLETT.	ST. ALBANS. The Grange.	ST. ALBANS. Addiscombe Lodge.	BERKHAMSTED.	HARPENDEN.	HATFIELD.	HERTFORD.	HITCHIN.	ASHWELL	MEAN, 1876–93.
Hazel (*Corylus avellana*)	Feb. 3	Feb. 7	Feb. 3	Jan. 30	Feb. 8	Jan. 30	.....	Jan. 18	Feb. 3	Jan. 19	Jan. 27
Coltsfoot (*Tussilago farfara*)	Mar. 15	.....	.....	Mar. 3	Feb. 27	Mar. 1	.....	Feb. 8	Feb. 4	Feb. 27	Feb. 25
Wood Anemone (*Anemone nemorosa*)	Mar. 30	.....	Mar. 18	.....	Mar. 30	.....	Mar. 29	Mar. 11	Mar. 17	.....	Mar. 19
Blackthorn (*Prunus spinosa*)	Mar. 26	Mar. 29	Mar. 30	Mar. 7	Mar. 30	Mar. 28	Mar. 27	Mar. 8	Mar. 20	Mar. 24	Apl. 2
Garlic Hedge Mustard (*Alliaria officinalis*)	Apl. 20	Apl. 20	Apl. 14	Apl. 10	Apl. 9	Apl. 12	.....	Apl. 5	Apl. 8	.....	Apl. 20
Horse Chestnut (*Æsculus hippocastanum*)	Apl. 30	Apl. 18	Apl. 20	Apl. 13	Apl. 26	Apl. 23	Apl. 14	Apl. 20	Apl. 13	Apl. 25	May 11
Hawthorn (*Cratægus oxyacantha*)	May 1	May 1	Apl. 28	Apl. 26	May 13	Apl. 25	Apl. 21	Apl. 12	Apl. 13	Apl. 20	May 14
White Ox-Eye (*Leucanthemum vulgare*)	May 30	.....	May 27	Apl. 28	June 1	May 6	.....	May 10	May 11	.....	May 20
Dog Rose (*Rosa canina*)	June 2	.....	.....	June 8	May 30	June 3	May 30	May 24	May 20	.....	June 5
Black Knapweed (*Centaurea nigra*)	.....	.....	July 1	June 29	July 6	.....	.....	June 10	June 17	.....	June 21
Harebell (*Campanula rotundifolia*)	.....	.....	.....	July 19	July 20	.....	.....	July 12	June 28	.....	July 5
Greater Bindweed (*Convolvulus sepium*)	.....	.....	.....	(Aug. 11)	July 6	.....	.....	July 10	July 12	.....	July 9
Ivy (*Hedera helix*)	Oct. 11	.....	Oct. 16	Oct. 20	Oct. 16	.....	.....	Sept. 16	Sept. 28	.....	Sept. 27

TABLE II.—EARLIEST DATES OF OBSERVATION OF BIRDS AND INSECTS IN 1894, WITH THE MEAN DATE FOR 1876–1893.

SPECIES.	WATFORD.	RADLETT.	ST. ALBANS.			BERKHAMSTED.	HARPENDEN.	HATFIELD.	HITCHIN.	ASHWELL	MEAN, 1876-93.
			The Grange.	Addiscombe Lodge.	Worley Road.						
BIRDS.											
Song-Thrush (*Turdus musicus*)	....	Feb. 4	....	Jan. 22	Jan. 22	Jan. 14	....	....	Jan. 14	....	Jan. 16
Swallow (*Hirundo rustica*)	Apl. 12	Apl. 19	....	Apl. 26	Apl. 15	Apl. 7	Apl. 4	Apl. 24	Apl. 12	Apl. 21	Apl. 12
Cuckoo (*Cuculus canorus*)	....	Apl. 7	Apl. 10	Apl. 22	Apl. 8	Apl. 8	Apl. 8	Apl. 9	Apl. 11	Apl. 12	Apl. 13
Nightingale (*Daulias luscinia*)	Apl. 17	Apl. 10	Apl. 10	Apl. 16	Apl. 15	Apl. 15	Apl. 16	Apl. 12	....	Apl. 17	Apl. 15
Spotted Flycatcher (*Muscicapa grisola*)	....	May 16	....	....	May 18	Apl. 20	....	....	....	May 20	....
Swallow (last seen) (*Hirundo rustica*)	....	....	....	....	Oct. 28	Oct. 23	....	....	....	Oct. 27	....
INSECTS.											
Honey Bee (*Apis mellifica*)	....	Feb. 27	....	Feb. 8	....	Mar. 3	....	....	Jan. 12	....	Jan. 28
Wasp (*Vespa vulgaris*)	Apl. 2	Apl. 1	Mar. 16	Feb. 11	....	Mar. 21	Apl. 14	....	Mar. 12	....	Apl. 5
Small White Butterfly (*Pieris rapæ*)	Mar. 31	....	Mar. 23	Mar. 25	....	Mar. 21	Apl. 5	....	Mar. 28	....	Apl. 2
Orange-Tip Butterfly (*Anthocaris cardamines*)	....	....	....	Apl. 29	....	May 13	Apl. 2	....	....	....	May 8
Meadow-Brown Butterfly (*Epinephele janira*)	....	....	....	....	....	....	....	....	....	....	May 17

(2) the covering of snow protecting low-growing plants, (3) the perfectly matured condition of the wood of fruit-trees, shrubs, etc. In fact, when I came to prune my roses in March, I found that the shoots of even the most tender hybrid perpetuals were perfectly sound.

Mr. Little, writing from Hitchin, remarks that queen wasps hibernated together in large numbers, as many as filled an old teapot having been found under a large tarpaulin on the roof of an outhouse.

Taking all the returns sent in, the hazel flowered four days later than its mean date for the county for the previous seventeen years; the song-thrush was first heard five days later than usual; and the honey-bee first visited flowers about a fortnight later.

The Spring.

Until the middle of April there did not occur a single unseasonably cold day, while only a few of the nights were even moderately cold. From that time seasonable temperatures mostly prevailed until the end of the third week in May. A change to cold weather then took place which lasted until the end of the quarter. This change was remarkably complete, and took place very suddenly. Indeed, on two nights, those preceding the 21st and 22nd of May, my exposed thermometer registered 11° of frost.

These frosts, which were followed by cold north-easterly winds, proved most disastrous to fruit-blossoms and potatoes, as well as to the young shoots and the foliage of trees, shrubs, roses, etc. It must be remembered that at the time they occurred everything was in a singularly forward condition, owing to the previous long spell of warm weather, and the absence of anything like a check from low night temperatures. Fortunately, beyond arresting temporarily their growth, no damage was done either to the young corn or to the grass. The effects of these frosts varied greatly in different localities according to their elevation, exposure to sunshine or cold winds, and other causes. Previous to their occurrence the fruit-trees were laden with blossom, and having well-ripened shoots, the promise of grand crops never seemed more assured. The apple-trees and strawberries were in most places the greatest sufferers.

At Watford, Mrs. G. E. Bishop states, potatoes and strawberry blossoms were very much cut, while bedding plants in frames unprotected were much injured and many were killed.

Mr. Hopkinson reports that May was the first month last year in which the mean temperature had up to that time been below the average, and that on the nights preceding the 21st and 22nd there occurred at St. Albans sharp ground-frosts which did much damage to fruit-blossoms and vegetation generally. Our earliest and best strawberries were, he says, cut off, making the crop very poor, and a fortnight later than usual.

Nearly all the potatoes in my garden at Berkhamsted had their tops destroyed, with the exception of those growing on a south border under a high wall. These, although a foot high, were scarcely touched.

At Harpenden these frosts are described by Mr. Willis as having done an immense amount of damage to fruit-trees, and to some vegetables. The apple-blossom, of which there was in this neighbourhood an abundance, was almost entirely destroyed, with the consequence that this fruit was exceedingly scarce. Gooseberries could be gathered from under the bushes by quarts, many trees being almost bared of their fruit. Strawberry-bloom suffered greatly in exposed situations. Potatoes were cut down in many places, and so greatly were the plants injured that they never recovered, and yielded minute tubers only.

At Hitchin the May frosts appear to have been severely felt, for Mr. Little states that in that neighbourhood potatoes, beans, and all tender plants such as geraniums, placed out too early, were destroyed. Many native trees and other plants such as the oak, ash, beech, elm, maple, elder, ivy, thistles, plantains, and bladder campion (*Silene inflata*) were frost-bitten. In the gardens, gooseberries, currants, and strawberries were much injured.

Mr. Fordham mentions that at Ashwell, geraniums, dahlias, etc., were cut down by the frosts of the 21st and 22nd of May.

According to the returns sent in coltsfoot came into flower one day earlier than its mean date, the wood-anemone four days later, blackthorn ten days earlier, garlic hedge-mustard eight days earlier, and the horse-chestnut and hawthorn respectively twenty-one days and nineteen days in advance of their usual time, whereas the white ox-eye, which flowered in many places after the May frosts, was only four days early.

The swallow made its first appearance four days late, but the cuckoo was first heard two days earlier than the average, while the nightingale was one day early.

The wasp was first seen sixteen days earlier than usual, the small white butterfly six days earlier, and the orange-tip butterfly nearly a fortnight in advance of the mean date.

The Summer.

There was a little warm weather at the end of June and at the beginning and end of July, but with these exceptions the temperature remained cold for the season. The summer rainfall was in excess of the average, and there was a marked deficiency of sunshine, especially during August.

The crop of hay was an unusually heavy one, and was in most districts harvested in capital condition. The cereal crops were also good, but their ingathering took place under trying conditions, much of the corn having been laid by heavy thunderstorms, while rain fell almost every day until nearly the end of August. The yield of wheat, barley, and oats was above the average, but the heaviest crop of the year was that of oats.

By the middle of June the potatoes in my garden at Berkhamsted, which had had their tops destroyed by the May frosts, appeared to have quite recovered, and were looking as vigorous as ever. On the roses, however, many more "scorched" leaves were to be seen than immediately after the frost occurred.

Owing to the frosts in May and the two droughts of the previous year, there were in most places but few strawberries, while raspberries, currants, and gooseberries were less plentiful than usual.

Throughout the summer very few wasps or butterflies were to be seen.

The dog-rose came into flower six days in advance of the average, but after this time most of the plants on the list were late in blossoming, black knapweed being two days late, the harebell a week late, and the greater bindweed one day late.

The Autumn.

During the whole of September and the greater part of October the weather continued cold, while November on the other hand remained unusually warm throughout. The three weeks ending November 14th were excessively wet, but during the rest of the quarter the rainfall was very light.

This was a favourable season for the farmer, as the land during the first half of it was in a capital state for working and for sowing autumn corn; and later on the weather was so mild and the rainfall so plentiful that until unusually late in the year the supply of keep for cattle and sheep in the meadows remained singularly abundant.

The apple-crop was a very scanty one in most places, while that of plums was only about the average. The yield of pears, on the contrary, was a heavy one. Wild berries of all kinds were especially abundant, and notably holly-berries. Mr. Little remarks that at Hitchin the whitethorn haws were as abundant as the spring blossom promised. Holly-berries also were very plentiful there.

Owing to the sunless character of October the autumn tints were, as a rule, very poor. During November Mr. Little noticed at Hitchin that thrushes were singing throughout the month, and that the leaves on the elms at Bearton Green remained on the trees with little change of colour, and in considerable masses, much beyond their usual time. Mrs. Bishop noted at Watford on November 5th that the leaves of the ash were still very green, while the oak leaves had nearly all fallen.

The ivy came into flower eleven days later than its mean date.

XXV.

THE GALE OF THE 24TH OF MARCH, 1895, IN HERTFORDSHIRE.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 23rd April, 1895.

During the last few months, rain, frost, and wind have been vying with each other as to which could do the greatest amount of damage, but far more irreparable injury was done by last month's gale than by the frosts of January and February or by the floods of November. In a few days nearly all traces of the greatest flood probably ever recorded in the annals of Hertfordshire had passed away; in a few months our burst mains and service-pipes may all be renewed or repaired; but never will the many mighty monarchs of our parks and woods, relics of our primeval English forests, which have been laid low by the recent gale, again raise their heads and look proudly down upon their companions of more recent growth. The damage done to churches and other buildings throughout the Midland Counties and the South of England can easily be repaired, but when thousands of trees are uprooted on a single estate, as at Sandringham in Norfolk and on the adjoining estate of Castle Rising, the loss is irreparable—generations will pass away before younger trees can take their place.

Although there was not such wholesale destruction as this in Hertfordshire, our loss has been heavy, and the gale swept with devastating force over the greater part if not the whole of the county. The maximum velocity of the wind appears to have been about that of an express train, as will be seen from the following observation of Mr. Edward Mawley at Rosebank, Berkhamsted:—

"Throughout the day of the 23rd of March and during the following night the wind blew constantly from S.S.W., and at an average velocity of 17 miles an hour. By noon of the 24th the direction had changed to S.W., and the velocity had increased to 25 miles an hour. At 1 p.m. the wind was still in the S.W., and the mean rate of movement had increased further to 32 miles. During the next hour the wind was veering gradually from S.W. to W.S.W., and the record for the hour reached 40 miles. Between 2 and 3 p.m. the direction changed slowly from W.S.W. to W., and it was during this time that the gale reached its height, the velocity for that hour amounting to 44 miles. After this the strength of the wind gradually decreased until between 3 and 4 o'clock the next morning, when the velocity had fallen to 5 miles an hour. Since observations were first made here ten years ago I have never before recorded so high a velocity as 44 miles for a single hour. The individual gusts were often very fierce. At 3 p.m. during the gale I obtained a mean velocity for a quarter of a minute of 60 miles an hour."

We have here given not only the velocity of the wind and its variation from time to time as recorded by an anemometer, but also its direction; and that the wind, when at its height, blew from the west or slightly south of west is fully borne out by the direction in which most of the trees fell. I walked through several of the parks in the west of the county and as far east as Panshanger after the gale, compass in hand, and found nearly all the trees lying towards the east or slightly north of east. Elms seem to have suffered most, and next I think were oaks.

At St. Albans the gale was at its height rather earlier than at Berkhamsted. Writing from Hedges, St. Albans, Mr. F. W. Silvester says:—

"The wind began to gather force at about 1 o'clock, and at 1.45 exactly a tremendous gust swept over Hedges Farm from a north-westerly direction. At that moment our garden-wall, seven feet high, was levelled to the ground for a distance of forty feet, and the best fruit-tree in the garden, a greengage, was buried beneath the ruins. At the same time ricks were stripped and the straw was blown all over the place; a wild cherry-tree hard by was cut in two, the top being blown several yards from the trunk; an immense poplar on Mr. Wigg's estate fell; and several large and valuable trees on Lord Grimston's property at Sopwell were blown down. The high chimney-shaft of my engine-house oscillated so much that it was considered prudent to remove the cart-horses from the stable-yard adjoining it until the gale was over, and all the afternoon men were engaged putting harrows, etc., on the ricks in order to prevent further damage. Some straw in one of my fields was blown a distance of two fields' length back to the homestead. It appeared that the shepherd wanted a special heap of straw as a shelter for his lambs. The foreman wished him to use some other. He, however, took three or four bundles out of the forbidden heap, and strange to say each one was blown back to the rickyard, no doubt much to the delight of the foreman, who thought that the act of disobedience was justly punished. Later in the afternoon I had occasion to drive to Leavesden, and the havoc effected on the route bore evidence to the north-westerly direction of the wind as far as I could see. A large tree at Leavesden Asylum fell at the time we felt the full force of the gale at Hedges."

I now give a brief account of the damage done by the gale chiefly as recorded at the time in three of our county newspapers —the 'Watford Observer,' the 'Herts Advertiser,' and the 'Hertfordshire Mercury.'

In the north of Hertfordshire the gale did much damage to Royston and its neighbourhood. The cupola in the cemetery was blown off, falling upon and damaging the roof of the building. Tiles and slates were scattered about the streets, straw stacks were blown to pieces, and many trees were torn up by the roots or snapped in two. At Hitchin the gale did much damage to roofs and chimneys, and uprooted a large number of trees, chiefly elms, some of which fell across the roads, interrupting the traffic.

In the west the gale was severely felt in Hemel Hempstead. The parapet on the eastern side of the Midland Railway bridge was blown over on to the line of railway. Exposed farmyards suffered much, the thatch and some of the contents of ricks being scattered to a great distance.

In the south-west the gale was severely felt. At Rickmansworth, slates, tiles, and fencing were blown down, and some shop-shutters in High Street were blown in. A stable at Woodcock Hill was blown down. Fine trees were uprooted in Moor Park and Rickmansworth Park, and at Loudwater Hill and Croxley Green. In Watford a garden-wall and palisading in Clarendon Road were blown down, plate glass windows in High Street were smashed by shutters being blown through them, and chimneys fell through the roof of Field House. The trees in Cassiobury Park suffered severely, several being uprooted and branches of others torn off. At Aldenham stacks were much damaged and many large trees were blown down or had branches torn off them.

Proceeding towards the centre of the county the havoc wrought by the gale was even greater than in the west and south-west. An account of some of its effects in the neighbourhood of St. Albans has already been given. Three of the finest old trees at Halls Place fell not many minutes before I saw them lying prostrate in St. Peter's church-yard. Some of the oldest trees in Gorhambury Park were uprooted and others were broken off near the ground. On the Sandridge road the hedges presented a strange appearance, being lined with straw from demolished stacks; straw was also hanging over the telegraph wires of the Midland Railway for miles. At Harpenden a wall near Mardell's brewery was blown down, several stacks and outbuildings were stripped of their thatch, and many trees were blown down in the neighbourhood. Similar damage was done at Hatfield, slates and chimney-pots being blown off, and the contents of ricks scattered in all directions, while trees were uprooted and huge branches were torn off others. Several trees were blown down in Hatfield Park and Brocket Park, while further north the fine avenues of Knebworth Park suffered irretrievable damage. In the neighbourhood of Welwyn many trees, chiefly elms, fell, and others lost large branches. The trees in Digswell and Tewin Water Parks suffered severely.

In the east of Hertfordshire similar damage was done in Panshanger, Watton, and Sacombe Parks, and also in the parks and woods in the neighbourhood of Buntingford. At Hertford the gable-end of a house in Villiers Street was blown down, several other houses were damaged in various ways, and roofs were blown off sheds and stables. A considerable length of the wall round The Grove, Port Hill, was demolished. A tree in the Castle grounds was blown down, and also one in Morgan's Walk, several others in the neighbourhood sharing a similar fate. Stacks also were much injured. Several slates were blown off the roof of the dome of Haileybury Chapel and carried some sixty yards across the quadrangle and through one of the dormitory windows. At Ware the gable-end of a house in Little Horse Lane was blown down, roofs and cowls of malting-houses were much damaged, and a large window at the west end of Christ Church was blown in, crashing through the flooring-boards, without being broken. The brick wall bordering the Presdales estate on the London Road was blown to the ground for a length of from sixty to seventy yards. Hay and straw stacks were unroofed and scattered, and many trees in the neighbourhood were uprooted. Three large trees on the side of the road leading from Baldock Street to Wadesmill fell across the road, stopping traffic until the following day, when they were removed. The fine old avenue in Ware Park suffered severely, no less than sixteen of its trees being levelled to the ground. At Hoddesdon considerable damage was done in several parts of the town; a stone cross was blown off the top of the church; and large boughs of trees were wrenched off at Rose Hill and elsewhere in the neighbourhood.

Our record is a long one, but it can by no means be considered exhaustive. It covers nearly the whole of Hertfordshire, and it must not be inferred that in the few districts which have not been alluded to, no damage, or but little, was done, but rather that these districts have not been visited by me and no reports from them have appeared in the newspapers from which my information has been derived. Most of the damage seems to have been done by two gusts of wind, one at about 1.45 p.m., the other at 3. The severe frost of February, which penetrated far into the ground, must have considerably loosened the surface-soil, and this may account to some extent for the very large number of trees which were uprooted, especially in the case of such shallow-rooted trees as elms, which suffered most. It is also possible that some trees which withstood the first gust had their roots somewhat loosened by it and succumbed to the second, though neither gust alone would have brought them down. The great force of the wind is, however, amply testified to by the snapping of large trees just above their roots, as in Gorhambury Park, and by the huge branches torn off others.

It is to be hoped that our county may not again for many years be visited by such a devastating gale as swept over it on this memorable Sunday afternoon.

XXVI.

MISCELLANEOUS NOTES AND OBSERVATIONS.

Entomology.

Read at Watford, 28th December, 1894.

Tree-Wasp's Nest at Herga, Watford.—About the middle of last June a man whom I had employed to mow the grass around some trees in my garden informed me that he had been a great deal troubled by wasps, and after much search (for he had looked on the ground) had discovered a wasp's nest on a *Cedrus deodara*. The nest was on a lower branch about two feet from the ground, and, when I first saw it, was a little larger than a big cocoa-nut.

As this was the first nest of the tree-wasp (*Vespa silvestris*) which I had met with, I asked my neighbour, Mr. George Rooper, to look at it, and he informed me that the nest would grow much larger, and that the wasps were not nearly so pugnacious as our common ground-wasp (*Vespa vulgaris*). Such I found to be the case, as though I looked at the wasps every day quite closely, they never attacked me, and the nest grew imperceptibly and apparently by expansion from within, for I could never detect any fresh addition to the exterior.

My time being much occupied from the middle of July, I had but few opportunities of watching the nest after then, and on the 21st I went on a visit to some friends. Returning on the 1st of August, I went to look at the nest and found but very few wasps about, and these were extremely inactive. On visiting it a few days later I saw that all the wasps were gone. I then cut off the branch with the nest and had them mounted in a case.

The wasps appeared to me to be darker in colour than the ground-wasp, the yellow being of rather a duller hue, while the black bands were somewhat wider.

A short time after my wasp's nest was discovered, I was asked by Mr. and Mrs. Osborne, of Widcombe Lodge, Watford, to see another nest, apparently of the same species of wasp, which had been built in the pantry window between the glass and some lattice-work with a spray or two of ivy across it, the nest being attached to the glass on one side and to the lattice-work on the other. These wasps did not molest the inmates of the house, but Mrs. Osborne informed me that they were obliged to have them destroyed, as their neighbours complained that they would eat their fruit. In this I think that the neighbours were wrong, and I am somewhat at a loss to know what these wasps feed on, for, with an abundant crop of peaches, nectarines, and plums all around them, I never saw one of them on a fruit, while the ground-wasp is a voracious thief.—*Daniel Hill, Watford.*

Meteorology.

Read at Watford, 26th March, 1895.

Temperature and Rainfall at Hitchin, 1850–94.—The last five seasons show the temperature of the three winter months to have been lower than the average during the previous forty years, the mean minimum during those years being 15°·1, while for the forty-five years it stands at 14°·4, the mean maximum being unaltered.

Last February was the coldest month ever recorded here, its mean temperature being 26°·5. The nearest approach to it was in the Crimean winter of 1855, when the mean temperature of February was 27°·0; this was also the mean of December, 1890. The following are the instances of months showing a mean temperature below freezing point:—

		°			°			°			°
1855	Feb.	27·0	1874	Dec.	29·2	1880	Jan.	31·2	1890	Dec.	27·0
1861	Jan.	31·3	1878	Dec.	31·0	1881	Jan.	28·1	1891	Jan.	31·3
1870	Dec.	30·9	1879	Jan.	28·9	1886	Feb.	30·8	1895	Jan.	30·9
1871	Jan.	31·3	,,	Dec.	29·7	,,	Mar.	30·8	,,	Feb.	26·5

With regard to the rainfall, the mean of forty years was 24·80 inches; it is now, for forty-five years, 24·69 inches.

I am afraid we are forced to come to the conclusion that our seasons are becoming colder and drier.—*William Lucas, Hitchin.*

Supplementary Note on Temperature and Rainfall at Hitchin. —When giving, in our 'Transactions' (Vol. VI, pp. 72, 73), a summary of the observations of Mr. Lucas for the forty years, 1850–89, I stated that they did not show that the temperature or the rainfall in the north of Hertfordshire was undergoing any secular change, but that a connection could be traced between the temperature and the rainfall, cold periods being wet and warm periods being dry. The extended observations fully bear out these inferences, for if the forty-five years be divided into three equal periods of fifteen years each, it will be found that for the first period the mean temperature was 47°·1, the mean rainfall, 23°·75 ins.; for the second period the mean temperature was 46°·9, the mean rainfall, 25·78 ins.; and for the third period the mean temperature was, as in the first period, 47°·1, the mean rainfall, 24·54 ins., being very nearly the mean of the first two periods together. That wet periods are on the average cold, and dry periods warm, is shown more strikingly if the forty-five years be divided into five periods of nine years each, as follows:—

1850–58	Mean	Temperature	47°·1	Mean	Rainfall	24·42 ins.
1859–67	,,	,,	47°·3	,,	,,	24·27 ,,
1868–76	,,	,,	47°·1	,,	,,	24·18 ,,
1877–85	,,	,,	46°·9	,,	,,	26·27 ,,
1886–94	,,	,,	47°·7	,,	,,	23·31 ,,

It will be seen that both the temperature and the rainfall of the first three periods of nine years each were about the same in each period; that in the fourth period the temperature was very low and the rainfall very heavy; and that in the fifth and last period the temperature was rather high and the rainfall rather small.—*John Hopkinson, St. Albans.*

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APPENDIX.

LIST OF MEMBERS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB.

OCTOBER, 1896.

PAST PRESIDENTS.

1875–77.	SIR JOHN EVANS, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A.
1877–79.	ALFRED T. BRETT, M.D.
1879–81.	J. GWYN JEFFREYS, LL.D., F.R.S., F.L.S., F.G.S.
1881–83.	GEORGE ROOPER, F.Z.S.
1883–85.	RIGHT HON. THE EARL COWPER, K.G.
1885–87.	PROF. JOHN ATTFIELD, M.A., Ph.D., F.R.S., F.C.S.
1887–89.	F. MAULE CAMPBELL, F.L.S., F.Z.S., F.R.M.S.
1889–91.	RIGHT HON. THE EARL OF CLARENDON.
1891–93.	JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.
1893–95.	ARTHUR STRADLING, M.R.C.S., F.Z.S.
1895.	HENRY SEEBOHM, F.L.S., F.Z.S., Sec.R.G.S.

TRUSTEES.

JOHN HOPKINSON, F.L.S., F.G.S.
W. LEPARD SMITH.

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.*

1882 Cooke, M. C., M.A., LL.D., A.L.S., *Herbarium, Royal Gardens, Kew*; and 146, *Junction Road, London, N.*

1879 Etheridge, Robert, F.R.S., F.R.S.E., F.G.S., *British Museum (Natural History), South Kensington*; and 14, *Carlyle Square, Chelsea, London, S.W.*

1893 Flower, Sir William Henry, K.C.B., LL.D., F.R.S., F.R.C.S., F.L.S., F.G.S., Pres.Z.S., Director of the Natural History Department of the British Museum, *Cromwell Road, South Kensington, S.W.*; and 26, *Stanhope Gardens, London, S.W.*

1890 Geikie, Sir Archibald, Sc.D., LL.D., F.R.S., F.R.S.E., F.G.S., Director-General of the Geological Surveys of the United Kingdom, 28, *Jermyn Street, London, S.W.*

1875 Glaisher, James, F.R.S., F.R.A.S., F.R.M.S., F.R.Met.Soc., *The Shola, Heathfield Road, South Croydon.*

1879 Harting, James Edmund, F.L.S., F.Z.S., Mem. Brit. Orn. Union, *Linnean Society, Burlington House, London, W.*

1877 Henslow, Rev. George, M.A., F.L.S., F.G.S., F.R.H.S., Professor of Botany, Queen's College, London, *Drayton House, Ealing.*

1875 Hooker, Sir Joseph Dalton, R.N., K.C.S.I., C.B., M.D., D.C.L. (Oxon.), LL.D. (Cantab.), F.R.S., F.L.S., F.G.S., etc., *The Camp, Sunningdale, Berks.*

1886 Jackson, Benjamin Daydon, Sec.L.S., *Clevedon, Cautley Avenue, Clapham Common, London, S.W.*

1883 Jones, Thomas Rupert, F.R.S., F.G.S., ex-Professor of Geology at the Royal Military College, Sandhurst, 17, *Parson's Green, Fulham, London, S.W.*

1875 Lubbock, Rt. Hon. Sir John, Bart., P.C., M.P., D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., *High Elms, Farnborough, Kent*; and 15, *Lombard Street, London, E.C.*

1881 Ormerod, Eleanor A., F.R.Met.Soc., F.E.S., *Torrington House, St. Albans.*

1880 Sclater, Philip Lutley, M.A., Ph.D., F.R.S., F.L.S., F.G.S., Sec.Z.S., 3, *Hanover Square, London, W.*

1876 Symons, George James, F.R.S., Sec.R.Met.Soc., 62, *Camden Square, London, N.W.*

1896 Wallace, Alfred Russel, LL.D., F.R.S., F.L.S., *Parkstone, Dorset.*

1876 Whitaker, William, B.A. (Lond.), F.R.S., F.G.S., Assoc. Inst.C.E., *Freda, Campden Road, Croydon.*

CORRESPONDING MEMBERS.

1895 Massee, George, F.L.S., F.R.M.S., 1, *Kent Road, Kew.*

1896 Rudler, F. W., F.G.S., M.A.I., Curator of the Museum of Practical Geology, 28, *Jermyn Street, London, S.W.*

1894 Saunders, James, 49, *Rothesay Road, Luton.*

ORDINARY MEMBERS.

An asterisk before a name indicates a Life Member.

Elected

1894 Adams, Miss, *St. Peter's House, St. Albans.*

1887 André, R., *Melrose, Bushey Grove, Watford.*

1879 Andrews, R. Thornton, *Castle Street, Hertford.*

1892 Archer, Miss Janet, *St. George's Villa, Chalk Hill, Watford.*

1890 Ashdown, C. H., F.C.S., F.R.G.S., *Belmont, St. Albans.*

1883 *Attenborough, Mrs., *Haydon Hill, Bushey, Watford.*

1877 *Attfield, John, M.A., Ph.D., F.R.S., F.C.S., F.I.C., ex-Professor of Practical Chemistry to the Pharmaceutical Society of Great Britain, *Ashlands, Watford*; and 111, *Temple Chambers, London, E.C.*

1879 Austin, Vernon, *Blairgowrie, Bengeo, Hertford.*

1893 Ayres, Mrs., *High Croft, Watford.*

1893 Baldwin, W. Wallis, *Netherheys, Watford.*

1879 *Barclay, Robert, *High Leigh, Hoddesdon.*

1891 Barclay, Robert P., *High Leigh, Hoddesdon.*

1891 Barker, George, *Kettlewells, St. Albans.*

1887 Beck, Ernest, *Hoddesdon.*

1877 Benskin, Mrs. Joseph, *Chalk Hill, Watford.*

1892 Benskin, Thomas, *Glenthorne, Harrow Weald.*

1880 Berkeley, B. Comyns, *Collett Hall, Ware.*

1883 *Berry, F. Haycraft, M.D. (Lond.), *Wansford House, Watford.*

1883 *Bickersteth, John P., *Grove Mill House, Watford.*

1880 Bishop, Mrs., *The Platts, Watford.*

1892 Blackburn, H.

1885 Blathwayt, Arthur P., *Frogmore, Watford.*

1894 Braithwaite, Cecil, *Overbury, Watford.*
1887 Brown, Arthur M., M.A., *Beech Grove, Tring.*
1885 Burchell-Herne, Rev. H. F. H., *Bushey Grange, Watford.*
1884 Burr, E. T., *Oakley Lodge, Clarendon Road, Watford.*
1881 *Bushby, Lady Frances, *Wormley Bury, Hoddesdon.*
1880 Butcher, H. O. F., *High Street, Ware.*
1889 *Butler, Charles, F.S.A., *Warren Wood, Hatfield.*
1879 Buxton, Alfred Fowell, 32, *Great Cumberland Place, London, W.*
1894 Buxton, Dudley, M.D., 82, *Mortimer Street, Cavendish Square, London, W.*
1885 Buxton, John Henry, *Hunsdon Bury, Ware.*
1879 Buxton, Thomas Fowell, *Easneye Park, Ware.*

1879 Campbell, Frank Maule, F.L.S., F.Z.S., F.R.M.S., F.E.S., *Rose Hill, Hoddesdon.*
1875 *Carew, Mrs., *Carpenders Park, Watford.*
1879 *Carlile, James W., *Ashendene, Hertford.*
1896 Carter, W. R., B.A., Hon. Sec., *Amesbury, Malden Road, Watford.*
1891 Case, Henry, M.R.C.S., *Leavesden Asylum, Watford.*
1875 Chater, Edward M., *St. Alban's Road, Watford.*
1877 Clarendon, Right Honourable the Earl of, *Grove Park, Watford*; and 11, *Berkeley Square, London, W.*
1879 *Cowper, Right Honourable the Earl, K.G., *Panshanger, Hertford*; 5, *St. James' Square, London, S.W.*; and *Athenæum Club, S.W.*
1894 Cox, Alfred E., *Duffield, Upton Road, Watford.*
1876 *Croft, Richard Benyon, R.N., *Fanhams Hall, Ware.*
1878 *Croft, Mrs., *Fanhams Hall, Ware.*
1895 Crossman, Alan F., F.L.S., *St. Cuthberts, Berkhamsted.*
1894 Curry, Charles Albert, *Woodoaks, Rickmansworth.*

1888 Daw, S. J., *Ye Ingleside, Langley Park, Watford.*
1890 Downer, Frederick, *High Street, Watford.*
1894 Dudgeon, Arthur, *Northbank, Watford.*
1885 Durrant, John Hartley, F.E.S., Entomological Secretary to Lord Walsingham, *Merton Hall, Thetford.*

1893 Edmonds, Mrs., *Ardwick House, Queen's Road, Watford.*
1883 Ekins, Arthur Edward, F.C.S., *County Laboratory, St. Albans.*
1892 Essex, Right Honourable the Earl of, *Cassiobury, Watford.*

1875 *Evans, Sir John, K.C.B., D.C.L., LL.D., Sc.D., Treas. R.S., V.P.S.A., F.L.S., F.G.S., etc., *Nash Mills, Hemel Hempstead.*
1891 Evans, Lewis, F.S.A., *Barnes Lodge, King's Langley.*
1878 Ewing, Rev. J. A., M.A., *Westmill Rectory, Buntingford.*

1892 Fisk, William J., *Street Lodge, Watford.*
1875 *Fordham, H. George, *Odsey, Ashwell, Baldock.*
1895 Frome-Wilkinson, Rev. J., M.A., F.L.S, *Barley Rectory, Royston.*

1879 *Gibbs, Arthur E., F.L.S., F.E.S., Curator, *Avenue House, St. Albans.*
1891 Gibbs, Richard, *The Hollies, St. Albans.*
1875 Gibbs, Surgeon-Major J. G., *Riggendale Road, Streatham, London, S.W.*
1879 Gilbert, Sir Joseph Henry, Ph.D., LL.D., F.R.S., F.L.S., F.C.S., F.R.Met.Soc., *Harpenden.*
1894 Goodwin, J., *Langley Park House, Watford.*
1880 Grimthorpe, Right Honourable Baron, LL.D., Q.C., F.R.A.S., *Batch Wood, St. Albans*; and 33, *Queen Anne Street, London, W.*
1875 Groome, John Edward, *King's Langley.*
1891 Gruggen, W., L.R.C.P.E., 11, *Montpellier Road, Ealing.*

1875 *Halsey, Thomas F., M.P., *Gaddesden Place, Hemel Hempstead*; and 73, *Eaton Place, London, S.W.*
1894 Hardy, W. J., F.S.A., *Milton Cottage, St. Albans.*
1889 Harford, W. M., *Manor House, Bushey, Watford.*
1875 Harrison, Edward, *Upper Nascot, Watford.*
1890 Headley, F. W., M.A., *Haileybury College, Hertford.*
1894 Heaton, Noel, 9, *Fitzroy Street, Fitzroy Square, London, W.*
1887 Henty, Robert, *Langley House, Abbot's Langley.*
1885 Hill, Daniel, Librarian, *Herga, St. Andrew's, Watford.*
1881 Hill, William, F.G.S., *The Maples, Hitchin.*
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1875 Holland-Hibbert, Hon. A. H., *Munden House, Watford.*
1894 Holloway, William, *Arncot, Watford.*
1875 Hopkinson, Mrs. James, *Holly Bank, Watford.*
1875 *Hopkinson, John, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc., Hon. Sec. and Editor, *The Grange, St. Albans*; and *York Mansions, Cavendish Square, London, W.*
1875 *Hopkinson, Mrs. John, *The Grange, St. Albans.*

1883 *Hovell, T. Mark, F.R.C.S. (Edin.), *Boreham Holt, Elstree*; and 3, *Mansfield Street, Cavendish Square, London, W.*

1892 *Hudson, George Bickersteth, M.P., *Frogmore Hall, Hertford.*

1885 Hughes, T. McKenny, M.A., F.R.S., F.S.A., F.G.S., Professor of Geology in the University of Cambridge, *Trinity College, Cambridge.*

1895 Jackson, E. H., 5, *Lower Derby Road, Watford.*

1875 James, J. Henry, *Kingswood, Leavesden, Watford.*

1894 Janes, Clement, *Hunter's Farm, Leavesden, Watford.*

1877 Jeans, Mrs., *Eastleigh, Essex Road, Watford.*

1894 Johnson, Edmund L., *Heathdene, Watford.*

1890 Jones, Charles E., *Russell Farm, Watford.*

1893 Jourdain, Miss, *Corran, Watford.*

1893 Kember, Mrs., *Tregantle, Luton Road, Harpenden.*

1893 Kent, Harold, *Roseberry, Watford.*

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