THE

TRANSACTIONS

OF THE

LINCOLNSHIRE

Naturalists' Union.

EDITED BY

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GAINSBOROUGH.

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ADDRESS

TO

The Lincolnshire Naturalists' Union,

Delivered at Lincoln, May 24th, 1894,

BY

JOHN CORDEAUX, M.B.O.U.,

PRESIDENT (1893).

IN rising to address you on this occasion, I am not unmindful of the fact that I have been elected first President of the Lincolnshire Naturalists' Union, and I wish now, in the first place, to thank you for having placed me in so honourable a position. The object of our Society is intended to bring about a thorough and systematic investigation of the Natural History capabilities of the county, carried on year by year, a publication, if possible, from time to time, of the results, and an endeavour to create amongst all classes of the population an intelligent interest and correct appreciation of the various natural phenomena which surround them.

It is somewhat of a reflection on this great county that so little has been done hitherto for the cause of science; this indeed, becomes painfully apparent when we consider the excellent results shown by the enterprising naturalists in the two neighbouring counties of Norfolk and Yorkshire. In the former, the "Norfolk and Norwich Naturalists' Society" was formed in 1870, and published their first report; the number of members is now 250. The "Yorkshire Naturalists' Union" came into existence previous to 1883, and the number of its members is nearly 600. Both these, like our own, had small beginnings; they have, however, succeeded in extending the knowledge of local Natural History. In looking forward to the future I can see no reason whatever to think that our own Union will not be equally successful, and certainly in this great and diversified county it will never either lack material to work on or fall short in variety and interest of subjects.

So far, our efforts have been individual ones, and isolated and spasmodic : now, as a united band and numbering specialists in various branches, we shall become a representative body having a local habitation and name, and have much greater facilities for an exchange of opinion and for the proper collection and diffusion of facts. It must not, however, altogether be inferred that nothing has hitherto been done by the sons of Lincolnshire for the increase of physical science ; indeed, we have just cause of pride to see in our roll of honour such names as Isaac Newton, of Woolsthorpe; Matthew Flinders, of Donington; John Franklin, of Spilsby; Joseph Banks of Revesby Abbey; and more recently, Charles Anderson, of Lea. Of those now living, either within or without our boundaries, who are doing good work it would be invidious to make direct personal mention; sufficient is it to say that we include amongst ourselves all that is both necessary and capable for making this Union a great and a lasting success.

Lincolnshire is the second largest county in England, its total length being 75 miles by 48 in breadth, and containing 1,777,879 acres, 85 per cent. under cultivation. The surface presents a very considerable diversity of character, sea-coast, marsh, wold, moor, heath and fen, and some very considerable woodlands with much pleasant and typical scenery without anywhere rising into the grand and strikingly picturesque.

The county is not readily divided into what are called faunal areas—that is, districts more or less compact, with well-defined boundaries, between which—one or the other—faunal distinctions can be clearly established. In taking a general survey of the whole area it appears capable of being irregularly divided into at least six fairly marked districts, these are—

I.—The Marsh and Middle Marsh—which is the whole of the great alluvial flat which lies between the east coast and the foot of the chalk wolds, as far as Spilsby.

II.—The Fens—south of Spilsby and Wainfleet and east of Billinghay, Heckington, Bourn, and Market Deeping, with a branch extending westward of the Witham to Lincoln.

III.—The Chalk Wolds.

IV.—The Heath—an irregular district, partly on the oolite and partly on the lias, and not easily defined. In its more southern portion it is split into two arms by the Witham valley. It runs from S.E. to N.W., and includes the heaths near Woodall Spa, the moorland near Market Rasen and below Caistor, and the commons and rabbit-warrens between Gainsboro' and Frodingham, in the north-west of the county.

V.—A portion of Kesteven, south of Grantham and east of Belvoir, of which Corby is about the centre, well-wooded, picturesque, and highly cultivated, and containing noble parks and country seats.

VI.—The Isle of Axholme, formerly moor, bog and widely extending heath and low firwood, but now 50,000 acres of rich warp, and bounded to the north-west by the great level of Thorne waste in Yorkshire.

It must be clearly understood, however, that these divisions are only approximate, and that with our present knowledge no absolutely hard and fast lines can be laid down defining faunal areas, and that there are yet portions of the county which it is difficult to range under any of these divisions. I have endeavoured to define roughly six fairly marked districts within the boundaries of Lincolnshire, and I shall now briefly enter more fully into the physical peculiarities of each, and endeavour to show that, notwithstanding the great changes which have taken place, these still possess attractions for the naturalist. I would also mention those special matters which require more careful working out.

In the Marsh and Middle Marsh is included the whole of the low-lying plain between the foot of the chalk wolds and the sea, including the sea-coast itself and all its wide attractions. The chief interest of this district rests in its ornithology—more particularly in the spring and autumn—and in connection with the migration of birds. The total number of species which can fairly be admitted at the present time into the Lincolnshire avifauna is somewhat doubtful. In the Humber district up to this date I have been able to record 290. This compares favourably with the Norfolk list of 293, and Yorkshire with 310. With our present knowledge as to the frequency with which rare birds turn up during the period of migration, far out of their ordinary route, I think we should attach very little importance to the increase of any local or county list by the addition of mere wanderers. The record of such is interesting as showing how far some birds get driven out of their normal course. The chief additions to the Humber district in late years have come from Spurn, but there is no reason why equally good results should not be obtained from our own coast.

The flora of the marshes and the sea-coast is a very attractive and interesting one, and our knowledge of the same, as well as of Lincolnshire botany generally, has been greatly increased by the researches of the Rev. W. Fowler, of Liversedge; Dr. F. Arnold Lees, of Harrogate; the Rev. Adrian Woodruffe-Peacock; Mr. F. M. Burton; Mr. O. Thimbleby, of Spilsby, and others.

The collection of facts in connection with this district commenced as far back as 1590, and the great naturalists of former days—Gerarde, Ray, Dr. Martin Lister, and Sir Joseph Banks—have each in turn visited and investigated its floral treasures.

Before leaving this portion of the county, I should like to call attention to the marine mammalia, the seals, and various forms of whale, grampus, porpoise, and dolphin. Although in recent years considerable additions have been made to our local list, we still require much further knowledge and more scientific investigations. The capture of a seal or the stranding of a whale —and such occurrences are by no means unfrequent—should at once be noted, and an examination carried out on the spot, careful notes and measurements made, the skull, at least, preserved, and where possible a photograph taken before the carcase is removed. In this branch of zoology, as well as ornithology, the official representative of our Vertebrate Section, Mr. G. H. Caton Haigh, has done some excellent work. There is, so far as I know, no list of marine fish; the collection of facts in connection with these and with Marine Zoology generally, might well be taken up by those members who live near or have most frequent access to the coast. The Entomology, more particularly in this district the Aquatic-entomology, Conchology, and Micro-zoology and Botany, also present wide fields for close and careful study. In the former we have in the Rev. Canon W. W. Fowler, a member whose reputation as an entomologist is not only local and national, but world-wide. We must not fail to recognise, also, the good services rendered by Mr. H. W. Kew, formerly of Louth, and Mr. James Eardley Mason, of Alford.

There is no other faunal area in Lincolnshire where the old glories have so entirely vanished as in the fenland, formerly a vast level of peat-moor, morass and bog, with league beyond league of shallow mere, interspersed with a vast growth of reed and bull rush and various water-loving plants, and on the drier portion deep sedge and doubtless some rich pasturage, with thickets of sallow, willow, birch, and sweet-gale, which before the dawn of history had usurped the place of oak, Scotch fir, and yew. The whole of this vast level was a paradise for wild creatures, beast, bird, and fish, and predominate over all, upon the peat-stained waters of the shallow lagoons floated primitive man in a canoe dug out from a single tree, and using weapons tipped with fractured flint or fish-bone.

Of the natural treasures of the old fenland we have but scant record. Unfortunately our forefathers, when they did write, cared little for depicting their natural every-day surroundings, yet we must be thankful for the few precious records which have come down to us of those olden times, and enable us to form some idea of the extreme richness of the Fen fauna and flora, from the *Liber Eliensis;* the Chronicles of Crowland; and the writings of William of Malmsbury (1200); Thomas Fuller; Camden's Britannia (Gough's edition); and the naturalists Pennant, Ray, and Colonel Montagu; also the quaint verses left by Michael Drayton in the Polyolbion; and by "Antiquary Hall," of Llyn, in the doggerel rhymes depicting a fenman's daily life.

One aim of our Society should be the collection of any scrap, oral or written, in connection with physical-archæology, and any who have opportunities of inspecting old deeds, letters, and family account books, will do good service by extracting any small matter which directly or indirectly bears on this subject. Such entries were, no doubt, considered most trivial by the original writers, but in the light of the present day they are of much interest and importance. To cite one or two instances alone, how little historical record is left of the Great Bustard in Lincolnshire. The late Sir Charles Anderson, of Lea, in 1874, sent me extracts from an old account book kept by Charles Anderson, at Broughton, near Brigg, from 1669 to 1673 :—

"1670, September 26—To John Hall, brought curlew - 1s.
,, October 23—Item to Thos. Beckett for killing two bustards - - - - - - - 2s.

Then there is a letter from the great Dr. Johnson, dated January 9th, 1758, to his friend, Bennet Langton of Langton, acknowledging the receiving a parcel of game, amongst other things a bustard which he gave to Dr. Lawrence.

A letter written to myself by the Rev. Edward Elmhirst, November 29th, 1886, containing personal recollections of Lincolnshire ornithology, also his communication made to the *Field* newspaper, November 28th, 1886, concerning the former nesting of the Hen Harriers in the moors near Market Rasen, are amongst the most valuable contributions to the records of county natural history in recent years.

Of infinite interest also, as throwing light on the past, would be the account books and records of captures made in the duck-decoys at one period so common in the marsh and fen. We have never met with more than one decoy book, namely, the well-kept register of the Ashby Decoy, near Brigg, worked successfully for so many years by Captain Healey.

So marvellously abundant were wildfowl before the fens were drained that we are told a flock of wild duck has been observed passing along from the north and north-east into the east fen, in a continuous stream for eight hours together.

Our next faunal area is very distinct and well-marked—the Chalk Wolds—in its greatest length from Barton-on-Humber to Burgh, fifty-two miles, and the greatest breadth near Market Rasen, fourteen miles ; the highest point of the range, 549 ft., is near Normanby Clump, and this is the highest land in the county. Before the general enclosure at the commencement of the present century the wold was a wild and open region, a rolling upland, more or less intersected by deep valleys. These rounded hills were covered with heather and heaths, coarse rough grasses, like the barren brome, and *Aria cæspitosa* the tufted hair-grass, the most graceful if the most useless of all, with thousands of acres together of gorse, and ancient thorns in clumps and single. It was a district most admirably fitted to the habits of that noble bird the Great Bustard, and the Stone Curlew, the former probably becoming nearly extinct before the commencement of the century, and the latter still holding its own—a few pairs annually nesting, but not now on the wold.

During the last quarter of the century much good work has been done with Lincolnshire geology, the most important reports being in connection with the extension of the Rhœtic beds, near Gainsborough, by Mr. F. M. Burton, also his examination of these and the Keuper Sandstones in the same district ; Professor Judd's paper on the Neocomian strata ; Professor Morris on some Oolite sections ; Canon J. E. Cross on Lincolnshire Oolites and Lias ; also Mr. Clement Reid's work in connection with the New Geological Survey amongst the boulder-clays, inter-glacial beds, marine gravels, post glacial beds and alluvium of Northern Lincolnshire.

In connection with our Geological section I would suggest the appointment of a boulder committee, whose object will be to take observations relative to the erratic or ice-borne blocks of Lincolnshire, their character, position, size, origin and height above the sea. This to be carried out on the same lines generally as those adopted by the boulder committee of the British Association.

The two distinct ranges of chalk and oolite which run from south to north of the county form elevated tracts which in their original condition were heath and moorland, and almost destitute of timber trees. Along the flanks of these hills and in the intervening low country stretched the deep forests of Kesteven and Lindsey—the Bruneswald—oak, ash, elm, beech, fir, holly, yew, and hazel, sufficient remains existing in some of our oldest woodlands to recall the ancient glories of the land. No better "happy hunting grounds" remain to reward the naturalist than these comparatively undisturbed areas. Here in 1884 an example of the old British wild cat (*Felis catus*) was taken, and the pine marten, (*Martes abietum*) can scarcely yet be extinct; bones of red deer, *Bos longifrons*, wolf, wild boar, and beavers, have been found in the becks. We have as yet no list of Lincolnshire mammals, and I shall be greatly indebted to any of our members who will enable me to complete a list, which is already partially prepared, with notes from their respective districts.

The heath is another most charming faunal area, from the fact that some few scattered portions are still in their primitive condition, as in the neighbourhood of Woodhall Spa and the warrens and commons of Scotton, Manton, Twigmoor, Crosby and Brumby, in the north-east. The Ermin Street, that great military highway of the Romans, which passed through the gates of their chief fortress, Lincoln, followed the ridge of the oolite from south to north—to east and west of this was a wide, open and continuous stretch of elevated tableland, the road running through leagues of purple heather where the pink and purple shading of the common and cross-leaved heaths, intermingled with the yellow blooms of the petty whin and sheets of pale blue hairbell, and the darker blue gentian (*Gentiana pneumonanthe*). A glorious land it was to cross in those days, the long, lone, level line of a well-kept war path, stretching like a ribbon over the heath, and marked at short intervals with high stones or posts as a guiding line in fog or snow, in a solitude but rarely broken, except by the footfall of the legionaries and the dismal creakings of the baggage train and provision carts, while above under the blue heaven the lark carolled as it does now, and the plaint of the golden plover sounded sweet from off the moorlands.

The north-east corner of Lincolnshire, notwithstanding recent changes and trade encroachments, is still rich in animal and plant life, and presents a wide field for future research. Further westward, and beyond the Trent, lies the Isle of Axholme; some portion adjoining the great deer chase of Hatfield and Lindholme, in Yorkshire, was once the hunting-ground of English kings. We must turn to the pages of historians, such as Leland, De la Pryme, Dr. Stonehouse and others if we wish to learn its ancient condition before the enterprise of the Dutchman Vermuyden transformed its wastes and swamps and demon-haunted solitudes into fertile lands, and at the same time banished its indigenous flora and fauna. In fact, the entire district, including Thorne waste, beyond our border, and portions also east of Trent, resembled the "tundras" of Lapland and northern Asia, and, like these, were the breeding-homes of innumerable wildfowl and waders. Most suggestive of a not remote Arctic character are the lingering of such plants as *Selaginella selaginoides*, *Lycopodium alpinum*, recently discovered by the Rev. W. Fowler, also *Andromeda polifolia*, and *Empetrum nigrum*, on Thorne waste, *Myrica gale*, generally, and the impressions of leaves of some Arctic willow in the laminated silts and peaty alluviums.

Of our sixth district, that south of Grantham and east of Belvoir, I can tell you little, for excepting in passing through by rail, it is a *terra incognita* to me. The chief attraction is Grimsthorpe Park, which contains many fine oaks, hornbeams and hawthorns, and a small herd of red deer—interesting as the only one left in the county, and descendants of those indigenous deer which at one period wandered wild, free and unrestricted through the length and breadth of the land.

It is customary on these occasions briefly to notice the work done by the Union during the President's year of office. Two meetings have been held, the first at Mablethorpe, on June 12th, about thirty attending, and Professor L. C. Miall, F.R.S., of the Yorkshire College, presiding. The vertebrate section (ornithology) was, perhaps, the most successful. The full report of this very interesting meeting will be found in "The Naturalist" for August and September, this year.

The Rev. C. W. Whistler found the Natterjack toad (*Bufo calamita*) on the sand-hills. This is an interesting reptile and very different from the common toad. It is a light yellow colour, and never leaps nor does it crawl, its progression being more like a run. This toad was first discovered near Revesby Abbey, by Sir Joseph Banks, who made it known to the naturalist Pennant. Its distribution is somewhat remarkable, for it is found not only in England, but also in localities in Ireland, where the common species is unknown. All the Irish snakes and toads, as you know, were turned into stone by St. Patrick, but this seems to have escaped the wrath of the Saint. The inference is that the Natterjack succeeded in reaching Ireland before that distressful isle had become severed from Great Britain, which the common toad did not do, so we must consider the former is the older immigrant of the two, perhaps its particular mode of progress afforded better and more favourable facilities for getting over the ground.

In our investigation into the natural history of this county, we must remember that at no very distant period Lincolnshire was part of the mainland of Europe, and there was no North Sea as we know it now, and we must therefore expect to find close affinity between the fauna and flora on both sides of the water. Once, no doubt, a great central river, whose debouchure was over the Dogger Bank received the waters of the rivers from each side. The North Sea, if you will take the trouble to look at Mr. Olsen's map, is little more than a great plain covered by shallow water; off the north-east coast of England it is 20 fathoms, and as we go south even this depth is exceptional. The North Sea contains some remarkable depressions, one of which, the Silver Pit, is a narrow submarine valley 50 fathoms in depth, forty miles off the north-east coast of Lincolnshire. The intrusion of this great water, the North Sea, between ourselves and the continent may have been very rapid, for when the chalk barrier, which presumably at one time extended eastward from Flamboro' Head (cropping out again round Heligoland) was once breached and the central river taken in flank, there is no reason why the great level plain of intermediate Lincolnshire should not have been submerged in a period even of a few days.

The second meeting was at Woodhall Spa, on August 7th, with a very fair attendance of members, who were taken over the ground by the Rev. J. Conway Walter; the day was very hot, scarcely any birds were seen and very few insects taken; the botanical section, was, however, most successful, and several rare plants were fouud, the most interesting, perhaps, being the lovely dark blue gentian, in damp places on the moor. I must take this opportunity of publicly expressing the thanks of the Union to our Secretary, Mr. Walter F. Baker, whose untiring and intelligent exertions and great aptitude for organisation have done so much in setting us in motion and making the Union a success.

Before closing these remarks—as we are now engaged in rocking the cradle of the Union—I should like to say a few words as to the possibilities of a future, and the taking up of a useful position. There is no other county in England in which the fauna and flora have so greatly altered; large numbers of birds, insects and plants have been altogether destroyed, or in the former case, driven away by enclosure and drainage. It becomes therefore an imperative duty that we should use our best endeavours to preserve what is left and to take care that our scarcer mammals, nesting birds and surviving plants are not ruthlessly destroyed and unnecessarily banished. There is no sadder chapter to read than that on "Extermination," in Professor Newton's recently published Part I. of "A Dictionary of Birds;" it is a record of a destruction and waste of life in this fair world, brought about directly or indirectly by the ignorance, avarice, and greed of civilised man, assisted in late years by that rage for wearing feathers that now and again seizes civilised women.

Much might be accomplished if we could give our people an intelligent knowledge of their natural surroundings and an interest in their preservation. It would be a step in the right direction if object lessons were occasionally given in our village schools in connection with Natural History, illustrated from those easily accesssible raw materials of observation in the neighbourhood, which would best illustrate the every-day life of plants and animals.

I fear there is no class of men, who, considering the very favourable opportunities they have, are so proverbially ignorant of the economy of outdoor life as the gamekeepers, and so systematically destroy what it is often their best interest to preserve. Agriculturists, too, as a class, with but few exceptions, are deplorably indifferent to, and ignorant of, the most elementary principles of Natural Science. They care for none of these things. In looking back, however, I am proud to admit many genuine services rendered by agricultural labourers, who have walked miles to bring some curious object, or to tell of some strange beast or bird seen during their daily toil.

Unfortunately, in England, the inculcation of scientific knowledge is left almost entirely to private enterprise and in the hands of such societies as ours. This is not the case in foreign states, and notably so in America, where neither pains nor expense are spared in instructing the people. I have now before me a volume, most beautifully illustrated, recently published and issued by the American Government Department of Agriculture, on "The Hawks and Owls of the United States." This book has been scattered wholesale, as a free gift, over the land, and is intended to teach the American farmer the great usefulness of birds of prey, and the good which, as a rule, they confer upon him. Surely we have had object lessons sufficient to bring this matter forcibly home to us in that plague of field voles which has laid waste some of the great sheep farms beyond the border, and the plague of rats in Lincolnshire.

It is hoped that in time we shall get a museum in Lincoln. The want of this has been the the cause of our losing many art treasures, antiquities, and natural history specimens. We have lost the inimitable pictures of De Wint, the Franklin relics, and many other things which ought not to have left the county.

A word on our own individual and special duties as naturalists, and here I cannot do better than quote the words of a late Bishop of Oxford—the great Bishop Wilberforce. He says:—

"A good practical naturalist must be a good observer; and how many qualities are required to make up a good observer? Attention, patience, quickness to seize separate facts, discrimination to keep them unconfused, readiness to combine them, and rapidity and yet slowness of induction; above all, perfect fidelity, which can be seduced neither by the enticements of a favourite theory nor by the temptation to see a little more than actually happens in some passing drama."

In conclusion, it is gratifying to find that there is at least an awakening and uprising on these matters in Lincolnshire, and that the dry bones are moving. Let us trust that this union—a real Union of hearts—will inaugurate a new era. The most wonderful fact in connection with the last half century has been the progress of science. Everywhere amongst the educated and thoughtful there is a striving to search and probe downwards into the very sources and origin of all life—not alone that we may get a deeper insight into the workings of nature, but to find the key to our own position in connection with the life which is everywhere about us. Men of science are diligently engaged in painfully searching backwards into the infinity of the past, and, considering the results already attained, I think we can look forward with hope to the infinity of the future. Yet, I think, when science has spoken her last word, we shall still have to confess, in the words of Lincolnshire's noblest son, we are but

"An infant crying in the night:
An infant crying for the light:
And with no language but a cry."

Work for Lincolnshire Naturalists,

BY

L. C. MIALL, F.R.S.,

Professor of Biology, the Yorkshire College, Leeds.

I CANNOT refuse the request of your Secretary to put on paper some notions about more or less promising subjects for Natural History work, and yet there are reasons for shrinking from the task. To give advice which seriously conflicts with the opinions and practice of one's friends and neighbours is not a pleasant undertaking. It raises all manner of questions about one's competence to put other people right, and I have more than once made up my mind to let things slide, and go quietly on with my own work. But there are occasions when steady silence becomes cowardly and selfish. If your juniors, men zealous to do useful work, ask you what you think they ought to attempt, you are bound to give them the best you know, at all risk of seeming presumptuous.

We talk of investigating the Natural History of Lincolnshire. How shall we set about it? Many people, by their example, though not in so many words, give you to understand that it does not signify what you do. Write papers on Natural History, in which the names of Lincolnshire places occur frequently, and someone will be found ready to print it. Whether the observations tend to advance science, whether anyone will be the wiser for reading what you write, whether indeed anyone will read it at all, may be left undetermined. Of such writing the officers of the Lincolnshire Union can, I imagine, have as much as they please. I hope that they will have the courage to refuse it all.

We want *live* Natural History. Enumeration of the species of plants and insects in every parish is not at all the same thing. We study plants and insects mainly because they are, or have been *alive*. If you agree to sink that fact concerning them, and treat them as if they were milestones or remarkable boulders, you ignore the very thing which makes them particularly worth attending to.

Live Natural History cannot be worked out on a mechanical plan. Two indispensable conditions have to be brought together,—the living object and the thinking mind. You may treat the objects as if they were dead, and you may easily save yourself all trouble in thinking, but in either case you make your work of no effect.

Technical terms will not help you, if your observations have no human interest. The Latin and Greek may be all right, and exactly applied, but what does that signify if you have nothing to tell that we really want to know? Some Natural History lists, that are printed handsomely, are about as valuable as an auctioneer's catalogue. Both record facts, but they are facts that the human memory refuses to grasp.

What will the mechanical way of pursuing Natural History end in? There may be, for all that we know, some millions of species of plants and animals. Are we to have the parish history of every one? I should frankly admit that the names and technical descriptions, and records of distributions are, in some cases, an essential part of the scientific history; you cannot get at the best part of the story without attending to these things. But in the vast majority of cases the story has not been made out. The naturalist defines his species, and records its distribution, and there ends. It is not enough to tell us that these definitions and records are at times useful. Don't bring them out until you can show that they *are* useful. Envelopes may be useful to keep our correspondence safe; but what if we were to solemnly register and preserve empty addressed envelopes? That would be a fair parallel to a good deal that bears the name of Natural History.

In the present congested state of the literature of Natural History, which is being simply suffocated by unassimilated facts, we want no more of what some people call *materials*, isolated observations, which have no present worth, even though they may conceivably find a use some day. The records grow so voluminous that it will baffle our successors even to house them. As to reading them, I suppose that no one will ever try. It would be quicker to ascertain by immediate personal enquiry such facts of distribution, for instance, as are wanted for the solution of a really scientific question, than to analyse and compile the records. We have been for many years cataloguing in the belief that our catalogues will some day yield scientific fruit. If that hope has ever been realised in any appreciable degree, the evidence is not known to me.

Mechanical accumulation of facts, to be afterwards reduced and rendered fruitful by an inductive method, was the dream of Bacon. It has not been the practice of productive men of science, who have recognised that you must put mind into what you do, and have, therefore, from Newton to Darwin, given the inductive philosophy a wide berth.

" There is an attempt at induction going on, which has yielded little or no fruit, the observations made in the meteorological observatories. This attempt is carried on in a manner which would have caused Bacon to dance for joy; for he lived in times when Chancellors did dance. Russia, says M. Biot, is covered by an army of meteorographs, with generals, high officers, subalterns, and privates, with fixed and defined duties of observation. Other countries have also their systematic observations. And what has come of it? Nothing, says M. Biot, and nothing will ever come of it: the veteran mathematician and experimental philosopher declares, as does Mr. Ellis, that no single branch of science has ever been fruitfully explored in this way. There is no *special object*, he says."*

" *There is no special object!* "That is the secret of the failure, and all attempts to increase knowledge by labours without special object will fail too. It is mere laborious idleness. Let us not add to the pile of so-called scientific literature which has no special object, which amiably hopes that at some future time it may prove useful in a way that no one at present foresees. These things interest no human being because they have never in truth been warmed by lying in any human mind; they have been mechanically compiled, and they are dead and heavy as lead.

I am glad to leave the critical part of my theme, and that for more than one reason. For I have myself attempted this very

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* De Morgan, Budget of Paradoxes, p. 54.

task of mechanical compilation. I am bound to admit that I did it execrably, and the recollection is painful to me. I have repented for many years, and think that I can promise never again to offend in the same way.

But the young naturalist, in particular, eager for promising openings, in order that he too may be of use, and bring forth his faculties into the light of day (a most praiseworthy ambition !) will ask for more definite instructions. "If we are not to do what we see our neighbours on every hand doing with all their might, what are we to attempt ?"

I think that the young naturalist can hardly go wrong if he takes seriously to heart this one maxim : that he is to study plants and animals *as living things*. If he studies structure, let him incessantly recall that these tissues and parts are the organs of a living animal or a living plant. How are they meant to act—why are they found in this organism and not in that ? If he collects, let him try to find out why a particular aquatic insect, for example, is found in this stream and not in the next. Lists will not help him, he must bend his mind to the problem, and consider all the circumstances—presence or absence of food, of known enemies, and so on, and the causes of these in their turn. He need have no fear that the field is too well explored beforehand. Having been led, more or less accidentally, to interest myself of late years in aquatic insects, I find that their life-histories and their adaptations to environment have been, with rare exceptions, altogether neglected. We make a good beginning in Swammerdam ; Réaumur succeeds, and even improves upon his predecessor ; De Geer makes a good third. Then we come to the writers of little monographs and studies —deficient perhaps in grasp and fertility, but interesting and useful. A scattered and broken succession of these carries us down to the present day, leaving us with this result, that the structure and mode of life of the vast majority of common insects have never yet been investigated at all.

I suspect that the same holds true of other branches of Natural History also. Take any common aquatic plant, for instance, and ask why its leaves are of this particular shape. How does it face such and such an emergency ? How is it dispersed ? If you put these obvious questions, no one can answer. I have found it easy to make new observations on Duckweed, one of the most plentiful of green plants, and it would be the same with almost any other plant which happened to excite our curiosity. Going to live at Ilkley, on the Yorkshire moors, it immediately occurred to me that the moorland plants have been only slightly considered with respect to their particular external circumstances. Warming has made some good and suggestive observations upon them, but there is plenty more to be done. Leaf-buds again open out a wide field of almost untouched work. Let any young naturalist resolve to study nature with his whole mind, and to study only what interests him; I will venture to assure him that he is entering upon a boundless enquiry, and that he need never fear that the supply of good subjects will dry up.

It is a good rule to attend to the things that are close about you. If you are making out a life-history for the first time, you want an endless supply of specimens. Choose therefore something that is to be found in the next field, or in the pond at the bottom of the garden. Rarity is, for this purpose, a serious drawback.

Don't be in a hurry to print what you think you have discovered. The interpretation of natural contrivances, in particular, is always risky. Your first explanation is commonly wrong. Your well-considered explanation, pondered over for months, often turns out to be incomplete.

Lincolnshire has special tracts of its own—fens, and salt-marshes, and wide sands. Will not some one tell us all about the inhabitants of these wildernesses? Take the species one by one, and find out something like a full history of each. I should thank anyone who would tell us all about the insects of the sea-shore, of which I saw several during a short visit, but mere notes of occurrence are useless. We want to know what these insects feed upon, how they make their burrows, how they manage at high tides, what took them to the sea-shore, and so on. *Stratiotes*, which is commoner in Lincolnshire than in most counties, harbours multitudes of animals, insects and others. Why is it such a favourite? Can anyone give us some new observations upon the aquatic caterpillar which feeds upon *Stratiotes*? Of what use are the spines of *Stratiotes*?

There are many sides of nature, besides adaptation to environment, which are worth study. Human interest readily attaches to things that have had a history, if that history admits of being traced. The chalk hills, the raised beaches, the straths of sand

and mud,—how did they come to be what they are? If your curiosity is roused about anything, try to express it in the form of a question. What is it that you really want to know? The effort to solve a question that has been put into distinct words is seldom thrown away. The very statement of the question reveals whether it is worth answering or not.

I wish good luck to the Lincolnshire Naturalists' Union! The very best thing that it could possibly do, or help to do, would be to humanise Natural History.

Lincolnshire Geology,

BY

F. M. BURTON, F.L.S., F.G.S.

THE Geology of Lincolnshire is confined entirely to the great secondary period, with the exception of a narrow strip on the North Western border of the county at Gainsborough, where older strata, of Triassic age, are met with. These later deposits soon give place to the Rhœtic series, which form the passage beds of the Lias; and the latter again are replaced by the Oolites, and these further on by the Cretaceous measures reaching to the sea.

Pleistocene and recent deposits prevail to a great extent on the Eastern side of the county, where large tracts of land are covered up by Glacial drift, silt and peat.

The Northern half of the county has received considerable attention of late years from geologists, more so than the Southern portion, though the whole has been investigated by the Government Survey.

It will be interesting, in this the first volume of the transactions of the Lincolnshire Naturalists' Union, to give an account of what has already been done in the county by way of geological investigation, and the following list of papers and references is set down in the order of their publication.

1819.—MR. BOGG.—*On the Outlines of the Geology of the Lincolnshire Wolds.*—This paper, which is published in the transactions of the Geological Society, first series, gives an account of the succession of beds lying to the West of Louth. Mr. Bogg was one of those unfortunates who have, to their cost, so frequently mistaken appearances for facts in Geology; and, seeing bituminous shales exposed in the valley of the Bain, he spent and lost large sums of money in boring for coal.

1829.—PROFESSOR JNO. PHILLIPS, F.G.S.—*Geology of Yorkshire.*—In this work allusions are made to the beds at the base of the

Lincolnshire Wolds. The beds were examined by Professor Phillips as early as the year 1820, when he was assisting William Smith to complete the Geological Map of England. Such a record as this should stamp the strata in question as of more than ordinary interest.

1837.—W. H. Dikes & J. E. Lee.—*The Geology of Nettleton Hill.* (Mag. Nat. Hist., 2nd Series).

1853.—Professor Jno. Morris, F.G.S.—*On some Sections of the Oolitic District of Lincolnshire.* (Q.J.G.S.)—This veteran, and, to all who knew him, genial and kindhearted Geologist was the first to receive the Lyell medal, in 1876.

1857.—Professor Jno. Phillips, F.G.S.—*On some Comparative Sections of the Oolite and Ironstone Series of Yorkshire.* (Q.J.G.S.)—In this paper Sections of Lincolnshire Oolites at Harpswell Hill are noted and described.

1866.—F. M. Burton, F.G.S.—*On the Occurrence of the Rhætic Beds near Gainsborough, and the surrounding strata.*—Read at the British Association Meeting at Nottingham.

1867.—Professor J. W. Judd, F.R.S., F.G.S.—*On the Strata forming the base of the Lincolnshire Wolds.* (Q.J.G.S.)—This, like all Mr. Judd's papers, is a contribution of great value.

1867.—Professor R. Tate, F.G.S.—*On the Zone of Ammonites Angulatus at Marton near Gainsborough.* (Q.J.G.S.)

1867.—F. M. Burton, F.G.S.—*On the Rhætic Beds near Gainsborough.* (Q.J.G.S.)

1868.—Searles V. Wood, F.G.S., and the Rev. J. L. Rome, F.G.S.—*On the Glacial and Post-Glacial Structures of Lincolnshire and South East Yorkshire.* (Q.J.G.S.)

1869.—Professor Jno. Morris, F.G.S.—*Geological notes on Parts of Northampton-and Lincolnshires.* (Geol. Mag. vol. 6).

1870.—Professor J. W. Judd, F.R.S., F.G.S.—*Additional Observations on the Neocomian Strata of Yorkshire and Lincolnshire,* with notes of their relation to the beds of the same age throughout Northern Europe. (Q.J.G.S.)

1875.—The Rev. J. E. Cross, F.G.S.—*On the Geology of North*

West Lincolnshire. (Q.J.G.S.)—Canon Cross, though he investigated the junction of the Keuper and the Lias, yet failed to find any trace of the Rhœtic Beds in the district.

1875.—PROFESSOR THE REV. J. W. BLAKE, F.G.S.—*On the Kimmeridge Clay of England.* (Q.J.G.S.)—In this paper a very interesting account is given of this series in Lincolnshire, with an excellent sketch map.

1876.—PROFESSOR E. HULL, F.R.S., F.G.S.—*The Scarle Boring, Lincolnshire.* (Geol. Mag. vol. 3, N.S.)—This was another futile attempt to win coal; though the coal measures were reached at a depth of 1906 feet.

1876.—GEORGE DOVE, JUN.—*The Frodingham Iron Field, North Lincolnshire.* (Jl. Iron Steel Inst.)

1877.—S. B. J. SKERTCHLY, F.G.S.—*Geology of the Fen Land.* (Memoirs Geol. Survey.)

1877.—CAPT. MACDAKIN.—*On the Northampton Ironstone Beds in Lincolnshire.*—(Geol. Mag. vol. 4, N.S.)

1879.—A. J. JUKES-BROWNE, F.G.S. (of the Geological Survey) —*On the Extension of the Hessle Boulder Clay in Lincolnshire*, showing its continuation along the Fen-land border southwards. (Q.J.G.S.)

We are indebted to Mr. Jukes-Browne for several admirable papers in connection with the Geology of the county.

1879.—F. M. BURTON, F.G.S.—*On the Keuper Beds between Retford and Gainsborough. On a Northerly extension of the Rhætic Beds near Gainsborough.*—These two papers were read at the meeting of the British Association at Sheffield.

1881—T. HART.—*Flint Implements*, between Sleaford and Lincoln.—(Mid. Nat. vol 4.)

1881.—J. S. PADLEY.—*Fens and Floods of Mid-Lincolnshire* (with Plan), Lincoln.

1882.—H. KEEPING.—*On some Sections of Lincolnshire Neocomian.* (Q.J.G.S.)

1882.—SEARLES V. WOOD, F.G.S.—*On the newer Pliocene Period in England.* (Q.J.G.S.)

1883.—W. D. CARR.—*On the Lincoln Lias.*—(Geol. Mag. v. 10 N.S.)

1883.—A. J. JUKES-BROWNE, F.G.S.—*On the Relative Ages of certain River Valleys in Lincolnshire.* (Q.J.G.S.)—This is a most interesting paper, as touching on the Oolite gap at Lincoln on which the city stands, and on the present flow of the river Trent.

1884.—A. STRAHAN, F.G.S., (of the Geological Survey), and W. D. CARR.—*Excursion to Lincoln.* (Proc. Geol. Assoc. vol. 8.)

1884.—A. J. JUKES-BROWNE, F.G.S.—*On some Post-Glacial Ravines in the Chalk Wolds of Lincolnshire.* (Q.J.G.S.)

1885. SAME AUTHOR.—*On the Boulder Clays of Lincolnshire:* their geographical range and relative age. (Q.J.G.S.)

1885. SAME AUTHOR.—*The Geology of the South West part of Lincolnshire.* (Memoirs Geol. Survey.)

1886.—A. STRAHAN, F.G.S.—*On the Lincolnshire Carstone.* (Q.J.G.S.) A coarse ferruginous grit, lying immediately below the red chalk and resting on the Tealby beds.

1887.—A. J. JUKES-BROWNE, F.G.S.—*The Geology of part of East Lincolnshire.* (Memoirs of Geol. Survey.)

1888.—SAME AUTHOR.—*The Geology of part of East Lincolnshire.* Review of a Memoir of the Geological Survey. (Geol. Mag., Decade 3, vol. 5.)

1888.—W. HILL, F.G.S.—*On the Lower Beds of the Upper Cretaceous series in Lincolnshire and Yorkshire.* (Q.J.G.S.)

1889.—T. ROBERTS.—*On the Upper Jurassic Clays of Lincolnshire.* (Q.J.G.S.)

1890.—W. A. E. USSHER, F.G.S.—*The Geology of parts of North Lincolnshire and South Yorkshire.* (Memoirs Geol. Survey, 2 vols.)

1893.—A. J. JUKES-BROWNE, F.G.S.—*On some recent Borings through the Lower Cretaceous Strata in East Lincolnshire.* (Q.J.G.S.) To the unexpected and interesting result of one of these borings I alluded in my report, after the Mablethorpe excursion, in June last.

As a work of general reference see *The Geology of England and*

Wales, by H. B. Woodward, F.G.S. This book contains many valuable notes on Lincolnshire Geology.

See also *The Fenland Past and Present*, by S. H. Miller and S. B. J. Skertchly, F.G.S. This work, which is a supplement to *The Geology of the Fenland* by the latter Author, contains an admirable description and history of the Fens and their drainage, with records of animals and plants.

The above list, though it cannot pretend to be exhaustive, contains, so far as my means of search and memory serve, the principal papers that have been written on the Geology of Lincolnshire; and it will, I trust, be found useful to future investigators, who, in studying its surface and strata, will necessarily want to know what has already been done by workers in the past.

I wish again to draw attention to the want of any Lincolnshire Boulder Records; and, considering that so much Glacial drift exists in the county, this defect ought to be remedied. I can only repeat what I stated in my report after the meeting at Woodhall last August, that if any are willing to help in this work, and want information as to the mode of observing and recording Erratic Blocks, I will do my best to supply it.

Sporophytes or Cryptogams,

BY

MATTHEW B. SLATER, F.L.S.

THE Linnæan classification of the flowering plants was no doubt the best artificial arrangement ever produced. Linnæus adopted for his system the variations in the numbers and position of the stamens and pistils. These, being the reproductive organs of the plants, are most essential for their continued existence. By this method Linnæus arranged all the flowering plants then known to him into twenty-three classes. The twenty-fourth class he named Cryptogamia, in which he included all other vegetable organisms.

Since the time of Linnæus, by the aid of better optical instruments, the knowledge of the structure of plants, and more especially of the minute forms of vegetation, has been greatly advanced, and the natural arrangement of plants, based upon their structure and general physiographical characters, is now universally adopted.

Cryptogamic plants far exceed in number the flowering or Phanerogamic plants in the British Islands. By the modern method of research, these numerous forms of vegetable life have been divided into three main groups:—

1st Group, THALLOPHYTA.
2nd do. BRYOPHYTA.
3rd do. PTERIDOPHYTA.

Group 1.—The THALLOPHYTA includes the *Algæ*, *Lichens* (or Lichen-Fungi), and *Fungi*. The vegetable body in these plants is a Thallus, or simple growth of cellular structure, without any differentiation into stem, leaf, and root, or if at all, in a very rudimentary condition.

Algæ. The Algae are moisture-loving plants of very varied form and texture, growing in both fresh and salt water, the latter including the sea-weeds of our coasts, among which are some of the largest representatives of this section. The fresh water Algæ contain some of the most minute of vegetable organisms, requiring the help of a good microscope for their careful determination.

Lichens or *Lichen-Fungi.* The researches of Schwendener and others have shewn that Lichens, formerly considered as a separate tribe, must not only be included among the Fungi, but must be regarded as a section of particular divisions of them *(Asco-,Hymeno-*, and *Gastero-mycetes)*, and most modern students of this tribe have adopted this system.

The Lichen-Fungus consists of a *Fungus* and an *Alga*, living and growing together in intimate connection. They are very slow growing perennial plants, varying much in their form, appearance, and texture, constituting a thallus, crust, or frond, which frequently spreads horizontally upon soil, rocks, stones, the trunks of living trees, and upon dead wood. They are among the first plants which clothe the bare rocks and help to form a humus for others of a higher organization to live and flourish in.

In the fruticose Lichens the thallus grows erect, branching in a shrub-like manner.

In the foliaceous Lichens the thallus is flattened into a leaf-like expansion, and adheres to the substratum.

The margin of the thallus is usually lobed.

The thallus of the Crustaceous Lichens is usually indefinite in outline, and can hardly be distinguished from the substratum, the fructification alone being conspicuous.

Many species of crustaceous Lichens grow on the highest mountain peaks, and they contribute materially to the weathering of the rocks, and formation of a vegetable soil. Those that grow upon the trunks of living trees occur more especially upon those which have a smooth surface, much more rarely on rough-barked trees. Their growth is epiphytal, and they derive their sustenance almost entirely from the atmosphere. They prefer open exposed sites, and rarely grow in secluded shady places.

On the high exposed rocks of our hills, and in mountainous districts. the rock Lichens attain their highest development, always growing on sites most exposed to the storms of rain; and the frequent damp mists of the upland districts help to sustain these epiphytal vegetable organisms. Those that grow on the trunks of trees in lower districts prefer trees growing in hedge-rows, or exposed trees at the outskirts of plantations, always fixing themselves on the side most exposed to the prevailing rain storms of the district.

Lichens are very tenacious of life, and may be completely dried up without losing their vitality.

Fungi.—The greater number of the Fungi are parasitical (not epiphytal), deriving their support in a great measure from the host on which they grow. Some of the larger forms, in the family of Agarics, of which the well-known mushroom is a typical species, grow in humus, or soil, that contains decaying vegetable or animal matter. Some grow on the living bark of trees, their mycelium penetrating the tissues of the wood itself; and smaller forms of the Fungi grow on fallen leaves and decaying branches, assisting in the destruction of these.

A very large number of minute microscopical Fungi grow as true parasites upon living vegetable and animal organisms, and when atmospheric or other influences occur to assist their development, they become very destructive to the hosts upon which they grow. The potato disease, vine mildew, dry rot fungus, etc., etc., may be named as well-known results of their destructive parasitic growth on the organisms attacked. The ringworm on the human skin is also known to be the result of the growth of a minute parasitical fungus. The Fungi are very numerous, and are classified and arranged into many divisions, and far exceed in numbers the whole of the flowering or Phanerogamous plants in the British Islands. They require a microscope for their proper study, and we may refer students of them to the works of Berkeley, W. G. Smith, Dr. Cooke, G. Massee, and other British writers on them, Tulasne in France, De Bary in Germany, and many others who have by their researches much increased the knowledge of these vegetable parasites.

Recently students of the minute Fungi have been tracing out that several of them pass through different cycles of growth, assuming one form upon one host plant, and in their next stage of development, upon another host plant, differing so much that the two forms have been named and looked upon as distinct plants. By careful researches their life history is being traced out, and many are now known to be different forms of the same Fungus. We may refer students on this subject to the excellent monograph of the British Uredineæ and Ustilagineæ, by Dr. Charles H. Plowright, F.L.S., etc.

Group 2.—BRYOPHYTA (or Muscineæ).—The plants forming this group are the *Hepaticæ*, or Liverworts, and the *Muscineæ*, or Urn Mosses. All the plants in this group show simple cellular structure, though a higher stage of plant growth takes place. Some of the Hepaticæ have only a thallus or frond-like growth, whilst in the foliose Jungermaniæ true branches and leaves become developed, and in some genera of Hepaticæ both a thallus and stem with leaves are combined. It is among the Hepaticæ that the transition from a simple unbranching thallus to a more organised plant with stem and leaves becomes differentiated.

The sexual characters for spore reproduction may be discerned and traced out, although, like the previous more simple structured Algæ and Fungi, they are able to reproduce themselves by bud growth, for every cell of the plant is capable of growth, and thus materially assists to aid in their wide distribution.

Hooker's "British Jungermannia," a work published so long ago as 1820, first laid the foundation for the true knowledge of these plants. About eighty species were beautifully figured in this work, and accurately described. Since that period students of this tribe have not been very numerous. The few workers who have devoted themselves to their study have increased the number of Hepaticæ now known in Britain to more than 200.

No separate descriptive work, however, of the new species added to the "British Jungermannia" has yet been published. The new discoveries have been given in the *Journal of Botany*, and other botanical periodicals. Recently a Handbook of the British Hepaticæ has been issued by Dr. M. C. Cooke. It is, however, mainly a compilation from the works of others, and can only be considered as a synopsis.

Mr. W. H. Pearson, of Manchester, is engaged on a more comprehensive work on them, which is much needed for the assistance of British students.

By far the most important researches made in this tribe since the time of Hooker, have been done by the learned botanist and traveller, the late Dr. R. Spruce, who was a native of Yorkshire, and travelled for several years through the great valley of the Amazon in South America, and crossed over the Andine chain to the west Pacific coast, exploring botanically through the whole of his route.

Dr. Spruce discovered many new Cryptogamous plants, in the districts he explored, and contributed much to the botanical knowledge of the world. His grand book, "Hepaticæ Amazonicæ et Andinæ," will ever remain as a memorial of his great knowledge of these minute plants, and is acknowledged by all students to be one of the best works ever produced.

In the year 1882, Dr. R. Spruce issued a pamphlet of ninety-six pages (printed at Malton for the author) entitled "*On Cephalozia : Its Subgenera and some Allied Genera.*" In this work he has given the results of his great knowledge and careful studies, and has classified the Hepaticæ upon a more natural method, which students of this tribe, both on the Continent of Europe and in America, are now following. All students of this tribe should consult this brochure, which would greatly assist them to obtain a good knowledge of the Hepaticæ.

The leaves of the Hepaticæ have no nerve, and the capsule, when ripe, opens by four valves, from which the spores are distributed. The leaves of the Urn Mosses in many of them have distinct nerves, and the stems show rudimentary traces of vascular tissue, which is entirely absent in the Hepaticæ.

The urn-like capsule of the mosses opens by a lid or operculum at the top, which is thrown off when ripe for the dispersion of the spores by the peristome, which consists of a number of divisions or teeth, having cell structure very highly hygroscopic, which is acted upon by variations in moisture. The number of these divisions or teeth of the peristome is always four, or multiple thereof; thus some have four, eight, sixteen, thirty-two, and in one genus the number of the teeth round the mouth of the capsule is sixty-four.

In the British Islands 600 urn mosses and 200 liverworts, or scale mosses, are now enumerated, belonging to numerous genera. Many of them have a wide distribution in the temperate zone, for a great many of the North American and temperate European mosses are found to be identical with those of the British Islands, and even in the Southern Hemisphere, in New Zealand, some of the British mosses are found to grow.

Wilson's "Bryologia Britannica," published in 1855, is one of the best works on these plants. It is now a scarce book, as many copies of the edition were destroyed by fire in the publisher's office.

Hobkirk's synopsis of the "British Mosses," second edition, published in 1884, is a handy book, and gives a short description of all then known. Jameson's Illustrated Guide to British Mosses, 1893, contains an analysis of all the British species. A very comprehensive work on them is now in course of issue. Dr. R. Braithwaite's "British Moss Flora," has beautiful figures and magnified sectional drawings from nature of all the species, which are most essential for students of these plants.

The life history of the Muscineæ shows a regular and well-marked alternation of generations. The germinating spore does not at once give rise to what is known as the moss-plant, but produces an embryonic body, called the protonema, which consists generally of a branched filament, but occasionally of a flat layer of cells. The protonema is mostly inconspicuous and short-lived in the Hepaticæ, whilst in the mosses it is more amply developed, and sometimes persists from year to year.

The moss-plant is the adult sexual form, and on the adult shoot are produced the sexual organs, Antheridia and Archegonia. These organs are borne sometimes both on the same plant ; in other cases the Antheridia and Archegonia grow on separate distinct plants when it is dioicous, although both forms grow from the same protonema.

Group 3.—PTERIDOPHYTA (Vascular-Cryptogams).—This includes the *Filicinæ*, or Ferns ; *Equisetinæ*, or Horsetails ; and *Lycopodinæ*, or Club-mosses. The life history in this group presents a well-marked alternation of generations. The spore-producing form in the Ferns is the more conspicuous, constituting the well-known Fern-plant.

Filicinæ or Ferns. It is less than fifty years ago since the life-history of a Fern was worked out by the Polish Count Leszczyc Suminski, who fully investigated the subject, and gave the result in an illustrated memoir published in 1848. The spore produces from a cell in the first stage a cellular expansion of a growth called the prothallium, much resembling the thallus growth of a Marchantia or Liverwort. On the under surface of this prothallium the Antheridia and Archegonia grow from single cells. After the fertilisation of the Archegonia, the asexual generation or Fern-plant proper commences its growth, producing root and first leaf, and thus gradualy increases until the perfect Fern is formed, which becomes an independent plant, enduring for an indefinite number of years. Some of the Tree-Ferns of New Zealand and other tropical countries, as is well known, grow to a large size, and go on yearly producing an immense number or spores, in some cases for probably more than a century. This is one of the most wonderful and interesting developments of plant life, the true history of which has only been so recently made out.

Ferns prefer moist, shady places for their growth, and many of the species adorn secluded glens, more especially if a waterfall is near with its perpetual sprays of moisture. The total number of distinct species known in the British Islands is only about forty, including some seventeen genera. They are general favourites for the beauty of their frond foliage, and are much cultivated. Very many numerous varieties have been detected in their native habitats, and many other forms have been grown from the spores by enthusiastic cultivators of them, and a good many interesting works have been published about them.

Equisetinæ or Horsetails.—Some ten species of this genus are known in the British Islands. The stem grows a horizontal subterranean much-branched Rhizome, from which the subaerial shoots grow upright, mostly herbaceous, generally green in colour, and their surface is ribbed. They grow in moist, springy places, and some few of them may be met with by ditches and in wet places on the maritime cliffs.

Lycopodinæ or Club-Mosses are only represented in Britain by six species. They grow with slender much-branched erect or horizontal leafy stems, spreading on the surface of the ground. They are mostly natives of damp moors and hilly districts.

The Vascular Cryptogams are generally included in the works on the Phanerogamic or flowering plants. Hooker's "Student's Flora of the British Islands," Babington's "Manual of British Botany," and "Bentham's Handbook," are all reliable works that may be consulted with advantage by students.

J. W. GOULDING, PRINTER, 20, MERCER-ROW, LOUTH.

ADDRESS

TO THE

LINCOLNSHIRE NATURALISTS' UNION,

GRIMSBY, 1894,

BY

F. M. BURTON, F.L.S., F.G.S.,

PRESIDENT.

How the Land between Gainsborough and Lincoln was formed.

IN addressing you on a geological subject, as I am about to do, I do not forget that this is a Society of Naturalists; and as Geology, to those who have not studied it, may perhaps have an uninviting aspect, I intend to avoid technical details as far as possible, endeavouring at the same time to show that, in point of interest, Geology comes quite up to that of any other branch of natural science, and perhaps, I may say, exceeds most of them.

Geologists divide the Earth's strata, for convenience, into 3 great divisions,—Primary, Secondary, and Tertiary,—and as, in Lincolnshire, we have representatives of the entire Secondary series, from the strata above the Trias on the west to the chalk on the east, this fact alone must give to the Geology of the County a special interest and value. I am not, however, going to speak of so wide an area now, but intend to confine my address to the low flat land between Gainsborough and Lincoln,—a distance of some 15 miles,—alluding to the adjoining strata, only as they are necessary to explain the structure and present configuration of the district.

Now, as we stand on the high ground above Gainsborough and look over the Trent, we are on the oldest strata in the County,—the Upper Keuper beds as they are called,—at the top of the Trias or new red sand stone, the highest beds in the great Primary Division; and if we could be carried back to the time when these beds were laid down, we should see, instead of the present country, a vast lake, or inland sea, surrounded on all sides by land, which extended far out into the Atlantic on the west, and was connected with Europe on the south, and with Scandinavia, over what is now the North Sea or German Ocean, on the east.

This region had, for a very long period, been in a quiet, tranquil state; a great contrast to the stormy Permian age which preceded it, when the Alleghany mountains of America and the Pennine Chain of Derbyshire, the back bone of England, were thrown up.

This vast inland sea was a fresh water lake, which gradually became salt by the concentration of its waters,—like the salt lakes of North America,—and in which sand stones, grey and red marls, salt and gypsum were deposited.

It is to this inland sea, barren as it was, that we owe the rock salt and brine springs of Worcestershire, Cheshire, and Middlesborough. While, from its deposits of gypsum, or hydrated sulphate of lime, we get ornamental alabaster and plaster of Paris from which Parian and other cements are made.

In the Railway cutting, leading to Lincoln, bands of blue, red, and grey Keuper marls are seen, each resting on the other. They are the slow and quiet products of this great inland lake, and have no traces of life left in them. Suddenly, however, a wonderful change takes place; for, resting on the uppermost Keuper deposit, and at the same angle with it, appears a broad black band of rock, utterly different from the bed on which it lies.

The Keuper marls are, as I have said, devoid of fossil remains, but this new deposit abounds, nay literally swarms, with them; while, instead of marly deposits, the new strata consist of fissile slaty shales, full of iron pyrites the token of exuberant life, and narrow bands of sandstone glittering with mica: and, what adds to the wonder is, that, towards the base of this deposit, there lies a thin band of rock, not more than an inch in thickness, composed entirely of fish remains, bones, scales, teeth, and coprolites, pressed down into a hard solid mass; while a similar bed, scarcely as thick, occurs a little higher up. And how can all this have come about?

To understand it we must know something of the world we live on.

Originally a vast nebulous mass, which gradually condensed, it is now, (as generally accepted,) a thin crust, some 25 miles thick at the most, resting on a molten fluid substratum, under which, (as some think,) lies a solid rigid core. Now a thin crust over a fluid cannot be stable, and the surface therefore of our globe is for ever changing, rising here and sinking there, rising in parts where denudation makes it thinner, and sinking in regions where, through volcanic action, or the pouring on of the débris of large rivers, and other similar causes, matter is being piled up and the strata thickened.

And, in the region we are considering, action of this latter kind had taken place. The older strata had begun to sink, and, by degrees, the waters of a great ocean, coming up from the south over France, were let in upon them. The inland lake became an arm of the Liassic sea, and the Rhœtic beds were formed.

It must not be supposed, however, that all this took place suddenly. It was the result of no convulsion of nature, no rending of the rocks and inrush of the sea, but it came about quietly and imperceptibly, occupying as much time, probably, as would be necessary for so great a change in our own days. First, as the land continued to sink, would come the want of drainage, then the morass, then the tidal wash, and, last of all, the full open sea. It was the work of ages.

The Rhœtic beds,—which owe their name to the Alps of Lombardy, (the ancient Rhœtia,) the Grisons, and the Tyrol, where they attain a considerable thickness,—had not been found further to the north in England, in 1866, than at Coptheath near Birmingham, and at Abbots Bromley in Staffordshire; when, in that year, as the gradients of the line between Gainsborough and Lincoln were lowered, I had the satisfaction of meeting with them. Since that time they have been discovered, in a nearly continuous line, across England from north to south, wherever the junction of the Trias and Lias is exposed.

Some geologists place these beds at the top of the Trias, others at the base of the Lias, or Jurassic system. This, however, is a matter of small importance. They are the passage beds from one great system to another, from the deposits of the upper Keuper lake to those of the great Liassic sea; beds which go far to unlock the hidden story of the land we are considering.

About the origin of the bone beds referred to much speculation has taken place.

Mr. Jukes Browne, in his work on "the Building of the British Isles,"—to which I am indebted for several of the fact stated in my paper,—speaks of the irruption of the sea wate being prejudicial to the inhabitants of the Triassic lake, "s that most of them died, and their bones, scales and teeth wer drifted into layers on the sea floor;" but this I think coul hardly have been the case, as, apparently, the concentrated saltness of the lake had, to a great extent, prevented the possibility of life,—no trace of it, except in a few localities, being met with throughout the system,—and this view Mr. Jukes Browne himself bears out, when, in another part of his work, speaking of the Triassic lake, he says, "the sheet of water being apparently as salt, as clear, and heavy and as nearly lifeless as the modern waters of the Dead Sea, or of the great salt lake of Utah." May not these beds be rather due to the fishes, which the Liassic sea brought in, being killed by the salinity of the waters of the inland lake? or, perhaps, after life had developed through the change of water, the land temporarily rose again, or became stationary for a time, and, the salinity returning, the fishes, no longer able to sustain life, perished, and their remains sank, in a layer, on the sea floor.

There is another fact of interest connected with the Rhœtics, which must not be omitted before we leave them, and that is, that the earliest known British mammal, the Microlestes, a small insect eating animal, is found within its strata. The Rhœtic beds contain also remains of the huge Saurians which are so characteristic of the Lias and higher formations; and we are indebted to Mr. Montagu Browne, of the Leicester Museum, for an account of several new species, which he recorded at the recent meeting of the British Association at Oxford, as well as on two former occasions. Remains of Saurian life occur also in the Rhœtic strata at Lea, near Gainsborough.

AND now we pass on to the Lias, the lower beds of the Jurassic system, in which the ironstone bands of Frodingham and Appleby are found, and change to a deep sea; the remains of which, beginning a little way to the east of Gainsborough, extend right across to Lincoln, and form the material of the Cliff there, to within 20 feet of its summit.

This sea is one of great interest, it covered a great part of England with a portion of Ireland, and ran up far north into Scotland, having rivers to feed it from the adjoining lands around; while, to the south, it extended down towards the tropics. Its depth was considerable, and, as its strata show, its waters teemed with life. Fish, reptiles, molluscs of many kinds, echinoderms, insects, wood and corals, are met with in its layers. The insects,—which, according to Westwood, belong to no less than 24 families, and comprise both wood-eating and herb-devouring beetles, grass-hoppers, dragon-flies, and may-flies,—together with the wood, were, doubtless, brought down by the rivers which flowed into the sea; while the corals owe their presence to the extension of its waters southwards, enabling the products of warmer climes to push up towards the north.

Amongst the mollusca the Ammonites hold the first place. Chambered shells of great beauty, which have their counterpart in the Nautilus of the present day, they vary very much in shape, and are so distinct, that they have been used to designate zones of life in describing the Liassic strata, each zone having its distinct Ammonite as a characteristic feature; and, although this cannot altogether be relied on,—some Ammonites being found in more zones than one, and not always in the zones to which they give their name,—yet the fact of different species being found in succession, one above the other, as the higher beds appear, bears strong testimony to the vast period of time that must have elapsed during the formation of these strata. We have only to call to mind how slowly forms of molluscan life, (and we may say the same of life generally,) die out now, and are replaced by others, to appreciate this.

Taking an illustration near our own time, we find that, out of the shells in the Norwich Crag at the top of the Pliocene period in the Tertiary age, 85 per cent exist at the present day; and yet, between that period and our own, lies the whole of the Pleistocene and Glacial age, during which the Mammoth, the cave Bear and the Hyæna, the woolly Rhinoceros, the great Irish Elk, and other animals, appeared on the scene and passed away; hunted to death for the most part by man.

It is however in the Saurians that the great interest of this period centres. Huge fish-like lizards from 20 to 30 feet long,—Icthyosaurs, with eyes 14 inches in diameter, and Plesiosaurs, with long swan-like necks,—infested the shallower gulfs and bays; some swimming out in the open water and feeding on the fishes and Ammonites, others hiding themselves amongst the tangle and in the crevices of the rocks, and darting out at their passing prey,

> "Dragons of the prime
> That tare each other in their slime."

while Pterodactyls,—large, flying, bat-like lizards, which are principally found in the higher Jurassic strata,—pursued their victims in the air, and clung to the cliffs and rocks on shore. A strange weird life indeed was that which once filled the plain between Gainsborough and Lincoln, and, with other deposits of the same period elsewhere, it has well been called "the great dragon land."

This wonderful development of Saurian life began in the Triassic age, attained its greatest energy in the Lias, and finally died out, as a dominating power,. in the Chalk. The greater portion of it then passed, by the process of evolution, into birds; nearly every successive chain in the link having been now discovered, as Professor Huxley remarked at the late meeting of the British Association at Oxford.

And here, after ascending the Lincoln Cliff, and passing over the higher beds of the Lias on our way,—so well described by Mr. W. D. Carr, whose removal from Lincoln we all deplore as a real loss to our Society,—we reach the Oolite capping at the top, and stand on ground made famous by many a stirring event in history. Here Cæsar's Roman legions came and colonized. Here Norman William reared his fortress against the vain force of Hereward who lies, with his true forsaken wife, somewhere in Crowland's precints amid the fens he kept so well. *We*, from the same site, look down, immeasureably further back, over "the great dragon land," and picture again, in thought, the teeming life of the old Liassic sea.

AND now, having completed the building of the land between Gainsborough and Lincoln, I will, as briefly as possible, try to show how it attained its present shape.

To understand this, we must first glance a little further to the east; where, after passing over the limestones and clays of the higher Jurassic seas, we reach the chalk wolds.

In these cretaceous strata, we have the remains of beds which *must* have been laid down in great ocean depths; for there only are similar deposits being formed in our own day.

The Atlantic ooze, the modern equivalent of the chalk, is not deposited at a less depth than about 1000 feet, and usually, much deeper; and, as this ooze is laid down, according to the "Challenger" calculations, at the rate of a foot in a century at the most, the chalk, which is now some 1,300 feet thick,—and had, at one time, another 1,000 feet at the top of it, which has since been swept away,—the time occupied in the formation of these chalk beds must have been enormous. At the above rate of a foot of sediment in a century, the lost 1,000 feet alone would have taken 100,000 years to form.

Now, that the neighbourhood of such an ocean as this, which reached from Ireland, over Europe, to the Crimea, should have greatly affected the area we are considering, is not to be wondered at.

For a long period, during the existence of the Oolite and higher Jurassic seas,—when the land to the east of Lincoln, between it and the chalk wolds, was being formed,—the Triassic, Rhœtic and Lias beds on the west had become dry land; but, as the chalk sea grew, the weight of its deposits caused the land all round to sink, and, as this sea, at last, covered nearly the whole of England and Wales, the district between Gainsborough and Lincoln, with all the western land, was buried far beneath its waves.

Now the action of a sea is always that of a leveller, and as, in course of ages, the cretaceous ocean itself passed away, the land beneath it, as it rose again to the surface, presented a smooth plane of erosion, gradually sloping up to the higher lands around, which had, during this epoch, remained dry ground.

At this time,—a period when the Pyrenees were thrown up,—England, Scotland, and Ireland were, probably, as Mr. Jukes Browne tells us, bound together in one mass. Land lay far out into the Atlantic on the west, and land connected Scotland with Greenland, through the Faroes and Iceland, on the north, and with Scandinavia on the east.

How far, and to what extent, the area between Gainsborough and Lincoln was denuded, during this great erosion, we shall never know; but, as it rose higher and higher above the waves, the carving tools of nature were brought into play, and rain, frost, and other forces of the atmosphere began their ceaseless work.

Now rain may seem but a weak agent for forming hills, and scooping out valleys, but, with the help of frost and the corroding forces of the atmosphere, without doubt it effects the task.

Both hill and valley have one common origin, they are the remains of surfaces, once planed and levelled by the sea, (I am not here speaking of volcanic force), which, when raised above the waves, were carved and cut into shape by the rain; the harder parts, the most capable of resisting erosion, forming the hills, and the softer portions, the most easily denuded, forming the valleys.

Rising as vapour, mist, and cloud, and falling again on the earth, rain is the source of all our lakes, springs, and rivers; and, through rivers, the source of continents also, by the deposition of sediment on the floors of oceans and seas, and by the silting up of shallow bays and estuaries.

Its work never ceases, and, aided by frost and the chemical components of the air, it penetrates and dissolves the hardest rocks, and nothing is free from its action. Rivers can cut only narrow channels, and it is left to rain to widen them into valleys. No drop of rain runs an inch on the surface without setting some soil in motion towards a lower level.

The amount of erosion depends, of course, greatly on the soil on which the rain falls. On clays, like those of the Lias, it works far greater havoc than on sandy or gravelly soils; though, without due thought, the reverse might appear to be the case. Mr. W. Whitaker, of the Geological survey, in discussing the age of man at the recent British Association Meeting, well observed this, when he said, "When rain falls on gravel and sand, which are open and porous, they say 'Oh! come in, there's plenty of room,' and in it goes, and comes out again as a clear spring of water at the base; whereas, when it falls on clays and stiff soils, they say, 'We don't want you and we won't have you,' and the rain, in response, washes hundreds of tons away from the surface;" showing that resistance is not always the best policy.

A good illustration of this may be seen in the district I am speaking of, for, Hardwick Hill, which stands out, as a land mark, at the far end of Scotton Common, is mainly composed of gravel and sand, while the unyielding clays of the Lias are worn away to their present depth below the Lincoln Cliff.

For actions, such as I have described, unlimited time is, I need not say, required; but, that given, from the planed down surface of land emerging from the sea, we get the earth in its present form, with its infinite variety of mountain and valley, hill and dale.

Of course there are volcanic, and other forces, that aid in the construction of the earth's surface, but they lack the universality and ceaseless operation of rain, and there is no time to speak of them now.

It is to the eroding action of rain, that we owe, in the main, the present features of "the great dragon land."

ONE more phase, in the life history of the area we are considering, I have still to record.

After the chalk sea had disappeared, and the Tertiary age,—which may be called the latter days of geology,—had set in, the land underwent, for a great length of time, varying periods of elevation, subsidence, and rest; during which the North Sea appeared, and the principal physical features of our islands were developed: but, in the later Pleistocene epoch,—a period approaching our own days in a geological sense,—a great change took place. The Glacial conditions, which now prevail in the arctic regions, gradually invaded our land. The whole country sank to a considerable depth below its present level, and a great portion of Lincolnshire was covered with floating ice, which scored the rocks, and poured on its surface volumes of mud and clay, mixed with stones and boulders, which now pave the streets and market places of Gainsborough and Lincoln. And when, at last, all this had passed away, and the land had risen again to the surface, a period of subsidence once more set in. The North Sea,—which had come into existence prior to the invasion of the ice, but had, during this period, been filled up with its débris,—again resumed its sway. Our land, in course of time, became separated from the

Continent, and Great Britain. as it now is, appeared.

I should like to have spoken of a great river system, which cut through the Oolite and Lias on the south and west, and poured its waters into the Wash,—a system, the only remains of which are seen in the Lincoln Gap, through which the Trent once flowed, and where the Witham still finds its way,—but time will not permit of it.

I have drawn attention to the vast period of time that must have been consumed, during the events I have attempted to describe; and this is a point that I cannot too strongly impress on your memory.

I have dwelt on the structure and configuration of the land, as it appeared during the several ages my paper deals with ; for this is the goal that all geological investigation should aim at. The special study of strata, and their imbedded relics, valuable as it is, is nothing, if, out of it, we do not try to build up the framework of the world, as it appeared at the time these strata were deposited. I do not mean in any sense to under-estimate the value of such special studies. Those who labour at them are the patient seekers after facts, without whose labours it would be impossible to read the story the rocks are meant to teach. And here I must bring my paper to a close.

Elevations and subsidences are still going on, though we cannot see them. Attrition and denudation of the strata are still proceeding, though, in our short existence, we cannot trace them. Rains, frost, and rivers are still at work. The dragon land is slowly altering year by year; and the carving and modelling of the surface will last, as long as raindrops fall, and a vestige of land remains above the waves.

HYDROBIUS FUSCIPES;

NOTES ON ITS LIFE-HISTORY, LARVAL ANATOMY, &c.

WALTER F. BAKER, F.E.S.

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HYDROBIUS FUSCIPES;

NOTES ON ITS LIFE-HISTORY, LARVAL ANATOMY, ETC.

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The following is a brief account of the life-history of one of our common aquatic beetles, and is given, not only as a contribution to entomological literature, but also in the hope that it will induce others to pay more attention to the life-histories of the various creatures whose distribution they are studying. I have no intention of under-rating the work done by the systematist—far from it—for the facts of distribution are quite as important in their way as any other facts, and throw light upon many points that would otherwise be obscure; but my meaning is, that instead of naturalists devoting their *whole* time to enlarging their collections and studying the distribution of insects in their own particular neighbourhood, they should extend their researches into the equally attractive and less known study of life-histories. Another class of naturalists who might with advantage turn their attention to this branch, is the so-called microscopist, who, whilst possessing a good instrument and the usual accessories, yet contents himself with buying his slides, and is always ready at a microscopical conversazione to show the ever-present stock objects, such as 'wing of butterfly,' 'diatoms,' or the 'human flea.' Very little is known of the early stages of many of our commonest insects, and though it necessitates constant and careful watching, yet it is a comparatively easy branch of natural history, and will well repay the student.

This little beetle, *Hydrobius fuscipes* (Fig. 1), is one of the commonest, if not the most common, of our aquatic beetles. It varies very considerably in size. Down in the marshes of North Lincolnshire and Nottinghamshire I have often obtained specimens measuring as much as 8 mm. in length, but most of the specimens I have obtained in Yorkshire are not more than 6½ mm., and they are occasionally found less still. It is hardly possible that this is owing to climatic distinctions, as the difference is so slight, neither is it owing to scarcity of food, for though the fens of Lincolnshire may be a more ideal spot for it than the more thickly populated and less marshy county of York, yet there cannot be any real insufficiency of food, for it is not at all particular in this respect, and I have kept them alive for nearly a year by feeding them on nothing but duckweed. Whether they are entirely

Fig. 1.
Hydrobius fuscipes × 3

vegetarian in a state of nature I am unable to say, but on dissecting tank-reared specimens I have found small crustaceans, such as Cypris, inside their œsophagus; but it is hard to imagine how such lively little creatures as these can be obtained in any abundance by such, comparatively speaking, slow-moving insects as Hydrobius. Whatever the cause, however, it is an undisputable fact that the further north one gets, the smaller are the Hydrobii, and one specimen I got at Sledmere only measured barely 5 mm. in length.

In colour the beetle varies from light brown (in recently hatched specimens) up to a very dark brown or even black. This, however, is subject to variation, for many of the Hydrobii which inhabit ponds or ditches near to the coast show a tendency to a metallic blue tint. This I noticed more especially in the ponds on the banks of the Humber to the east of Hull, and also in a pond on the sand dunes near to Cleethorpes.

Generally speaking, it is a typically vegetarian beetle, and, wherever a weed-grown pond is found, there you may be sure to find our friend, generally accompanied by a companion of like habits, *Helophorus aquaticus.* No matter if the pond be covered with a continuous covering of duck-weed, stretching from bank to bank, a few minutes' search will, as a rule, discover one, if not both, of these creatures. In fact, it is in such ponds as these that they thrive best and occur in the greatest numbers, for their great enemies, the carnivorous aquatic beetles of the family Dytiscidæ do not, as a rule, frequent ponds in which there are no open spaces where they can easily come to the surface to breathe, and consequently they are not so much 'thinned.' Other enemies of theirs there are, however, in abundance, including all such birds as ducks, teal, and water-hens, and last, but not least, frogs and newts are responsible for numbers of them. Their sluggish habits and slow mode of locomotion place them in a very great measure at the mercy of these numerous enemies.

Their legs are formed more for climbing along the stems and leaves of water-plants than for swimming, but they can, by rapidly working their legs, proceed at a fair pace through the water. As a rule, they turn over on their backs when they wish to swim, for two reasons. In the first place, being lighter than water, their whole body is not immersed, and the smooth surface of the dorsal portion offers much less resistance to the water than the ventral surface, which is thickly clothed with hairs. The second reason is connected with their respiratory system. In most aquatic beetles the air necessary for the purpose of respiration is stored between the elytra and the dorsal surface of the abdomen, the beetle elevating the tips of the elytra above the surface of the water, slightly opening them until the air-supply is renewed, then closing them, thus imprisoning the air; but this beetle utilises the hairs on the under surface of its body, by their aid entangling a large bubble of air, almost continuous from the head to the anal segment, and from which the spiracles are supplied. This huge bubble naturally makes the ventral surface lighter than the dorsal, and consequently brings the former uppermost.

On the first approach of winter they bury themselves in the mud at the sides of the ponds or streams which they inhabit, and with rare exceptions, do not make their appearance again until the spring, unlike their carnivorous companions, which may be seen disporting themselves throughout the winter on any bright clear day, even when the surface of the water is covered by a coat of ice.

About the middle of March they emerge from their winter quarters, and about the second week in April the eggs are first laid. These are long and cyclindrical, being about $1\frac{1}{2}$ mm. in length by about $\frac{1}{2}$ mm. in diameter. They are enclosed in silken

Fig. 2.
Egg Cocoon on blade of grass. ×6.

Fig. 3.
Cocoon cut open, with the eggs in situ.

cocoons (Fig. 2), from nine to thirteen in each cocoon, and not placed in any regular way, but simply lying loose (Fig. 3). The cocoon itself is attached to the leaves of water-plants or to the blades of grass which hang into the water, and being partly filled with air floats on the surface of the water if, as often happens from one cause or another, it becomes detached. It is formed of closely woven threads, and is about 4 mm. by 3 mm., flattened and rounded at one end. The other end, the last one finished, terminates in an irregularly shaped flap, by which the cocoon is fastened to the blades of grass, etc. Sometimes this loose flap is an inch and a quarter in length, and often as many as three cocoons are attached to one blade of grass. Each beetle makes three or four cocoons, at intervals of about a fortnight. In a few days the larvæ (Fig. 4) emerge from the eggs, and biting through the top of the cocoon, which is thinner than the sides, climb on to the exposed portions of water-plants, and after resting there a short time enter the water, and suspending themselves by their peculiar anal processes to the surface film of the water, gyrate about after the style of a Chironomus, only always keeping the anal segment. with the spiracular openings, above the surface of the water. This anal segment is very flexible, and they can crawl sideways, horizontally, or vertically, without altering the exposed tip. These motions are evidently for the purpose of securing the small animals upon which they, at this early stage, feed. When not engaged in performing these 'figures of eight,' they rest upon the blades of grass or leaves of plants which lie upon the surface of the water. At this stage they are very transparent, and the internal organs, including their respiratory and circulatory systems, can be easily traced. As they grow older they get opaque, owing to the accumulation of fat. The larva, being heavier than water, quickly drowns, if by any accident it is entirely submerged, and there are no means by which it can crawl out. When first hatched its head is much wider than its body, but whereas the former grows but little, the latter soon begins to assume more equal proportions, and at the end of a week, at which time the diameter of the head and the body are about equal, they measure about 4½ mm. in length. After this, though their heads grow very little, their bodies increase both in width and length, until after about three months spent in the larval state, they attain a total length of about 12 mm., and are ready to pupate. They have at all times a most voracious appetite, and, if food is at all scarce, show very strong cannibalistic propensities, and frequently, after placing as many as a dozen together in one tank, have I found at the end of about a fortnight only one or two fine, well-fed ones and fragments of the

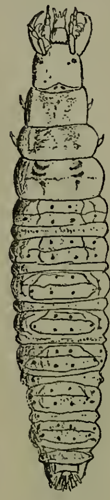

Fig. 4.
Larva. ×6.

remainder, who had served for nourishment for the survivors.

In colour these larvæ are a dirty white with the head and prothorax fuscous. The whole upper surface is densely covered with hairs and spines, and the under surface is covered in a similar manner, but not so thickly placed. In addition to these spines, which are evidently protective, each abdominal segment has about four tubercles, the functions of which I am unable to imagine. The head is small, but well armed; two sickle-shaped mandibles, each with three teeth in the centre, form their principal means of attack or defence. The maxillæ consist of a large basal joint, with four large spines pointing inwards, and isolated ones pointing in other directions. On the top of the joint are four much smaller ones, the one next to the basal having a small tubercle at the apex. The labial palpi are two in number, each consisting of a small basal and a long apical joint. A rudimentary third palp lies between the two. The labrum is serrated. The antennæ are three-jointed, the basal joint being as large as the other two together. The eyes are twelve in number, six on either side. The prothorax has the scutum entire, whereas in the meso- and meta-thorax the scuta are broken up, and lose the usual form entirely on the abdominal segments, being very much wrinkled and crossed by deep furrows. The eighth abdominal segment bears a sort of rosette of prominences which are capable of being shut up like a book (Fig. 4), or expanded at right angles to the body (Fig. 5); forming the means by which the larva is able to suspend itself on the surface film. In the centre of these are situated the two spiracular apertures. Air is conveyed from these two openings by means of two lateral tracheal trunks which give off smaller branches to the different parts of the body and head.

The nervous system (Fig. 6) consists of a fused mass in the head encircling the œsophagus and giving off from the sides separate nerves to each of the twelve eye spots. From the anterior margin nerves are given off to the antennæ, the maxillæ, and the labial palpi. Nerves

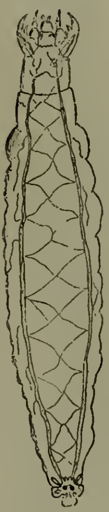

Fig. 5.
Respiratory system.
×6.

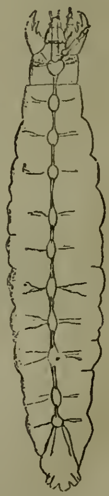

Fig. 6.
Nervous system.
×6.

are also supplied from the head to the œsophagus. The three thoracic ganglions are globular in shape and send off nerves to the legs as well as the segments. The abdominal ganglions, which are seven in number, are oval, with the exception of the last one. Nerves are supplied from each of these ganglia to the segment in which it is placed. All these ganglia are united to each other by a double cord. In the perfect insect the abdominal ganglia coalesce, and the optic nerves are not separate but form one nerve trunk to each of the two compound eyes; in other respects the structure of the nervous system is the same in larva and imago.

The alimentary canal (Fig. 7) consists of little more than a long tube running the whole length of the animal, and consisting of three divisions—the œsophagus, the stomach with its Malpighian tubules attached at each end, and a short intestine.

The circulatory system can be seen very plainly in a young larva. It consists of a long vessel, constricted at each segment, which pumps the circulatory fluid forward through the body, bathing all the organs.

When the larva is ready to pupate it crawls up the bank side, about six inches above the water, and there makes a circular burrow about a quarter of an inch below the surface (Fig. 8) but connected with the air by a small aperture. Here it remains for from three to six days and then turns into the pupa. The pupa is perfectly white and exhibits all the parts of the perfect insect in the usual shrouded form (Fig 9). Very long spines project from the prothorax, and the whole body of the pupa on the dorsal side is covered with spines

Fig. 7.
Alimentary canal. ×6.

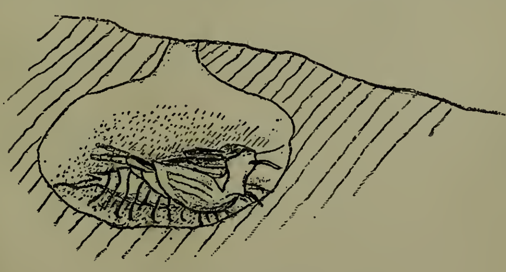

Fig. 8. Pupa in situ. ×2.

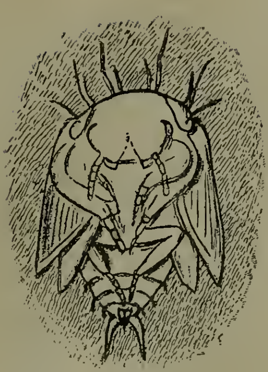
Fig. 9. Pupa, ventral aspect. ×2.

whose purpose is evidently to keep the body of the pupa from resting on the damp earth. The anus is terminated by two long sinuate circi similar to those of the pupa of Hydrocharis figured by Schiœdte. Although incapable of locomotion, the pupa is far from motionless, but wriggles about and moves its abdomen freely on being brought to the light or touched. After spending three weeks in this state the perfect insect emerges.

This beetle, unlike all other aquatic beetles I know of, is born with the sexual organs mature, and in three weeks' time the newly-hatched beetle forms a cocoon of eggs, and the process is repeated. Owing to this fact it is possible at the end of August to obtain all the stages of its life-history.

Important.

Omission

On page iii lines 13–15, the name of Revd Canon. W. W. Fowler. M. A., of Lincoln was accidentally omitted.

Since going to press, we have heard with much pleasure that an application has been made, on behalf of the Union to the Lindsey County Council to protect the coast area under the act of last year relating to birds eggs; and that the Council have agreed to it unanimously. The area, thus protected, extends from the Northern end of the coast down to Boston, and if the County Council of Holland follow suit, the whole of the coast area of Lincolnshire will be protected.