PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY

OF

EDINBURGH.

1874–78.

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ROYAL PHYSICAL SOCIETY.

ONE HUNDRED AND FOURTH SESSION, 1874-75.

Wednesday, 17*th November* 1874.—Dr JAMES M'BAIN, R.N., President, in the Chair.

In accordance with a recommendation of the Council, it was resolved to change the date of the Society's meetings from the fourth to the third Wednesday of each month, for this Session at least. It was also resolved that in future the Society's proceedings should be issued monthly.

Robert Gray, Esq., 13 Inverleith Row, was elected a Resident Member.

The following Donations to the Library were received, and thanks voted to the Donors:

1. Transactions of the Zoological Society of London, Vol. VIII., Parts 7 and 8.—From the Society. 2. Proceedings of the Geologists' Association, Vol. III., Nos. 6, 7, and 8.—From the Association. 3. Proceedings of the Royal Society, Vol. XXII., Part 154.—From the Society. 4. (1.) Proceedings of the Linnean Society, Session 1873–74. (2.) Journal of the Linnean Society (Botany), Vol. XIV., No. 77. (3.) Do. (Zoology), Vol. XII., No. 58.—From the Society. 5. Proceedings of the Royal Society of Edinburgh, Session 1872–73.—From the Society. 6. Transactions of the Edinburgh Geological Society, Vol. II., Part 3.—From the Society. 7. Proceedings of the Philosophical Society of Glasgow, 1873–74, Vol. IX., No. 1.—From the Society. 8. Journal of the Royal Institution of Cornwall, No. XV., April 1874.—From the Institute. 9. The Canadian Journal of Science, Literature, and History, Vol. XIV., Nos. 2 and 3.—From the Canadian Institute. 10. Porter and Coulter's Synopsis of the Flora of Colorado. 11. Proceedings of the American Academy of Arts and Sciences, 1868–1873. 12. Memoirs of the Boston Society of Natural History, Vol. II., Part 111, Nos. 1 and 2. 13. Bulletin de l'Academie Royale des Sciences, &c., de Belgique, 1873, 2 Vols.—From the Academy.

I. Dr M'BAIN, R.N., retiring President, then delivered the following address:

GENTLEMEN,—Eleven years have elapsed since I had the pleasure and privilege of addressing you from this chair.

We were then congratulating ourselves upon the satisfactory state of the Society—seeing that we had a goodly array of scientific contributors, the constant accession of new members, and a respectable balance at the command of the Treasurer. The papers then read at our meetings were published under the title of "Proceedings of the Royal Physical Society," and three volumes, extending over a period of twelve years, from 1854 to 1866, contain new and important facts in the various branches of science to which the Society has devoted itself, that will stand comparison with the contributions of other societies instituted for a similar purpose. But like the crust of our globe, societies are liable to depressions and elevations. Since 1866, we have had no further "Proceedings of the Royal Physical Society" published in an independent form, although the papers read at our meetings have been of equal interest and importance. Abstracts of these papers, indeed, have been published in the public journals; and it is now the most agreeable part of my duty on this occasion, to be able to state that arrangements have been made to resume the publication of our "Proceedings," or, at least, of abstracts of our "Proceedings," in a more suitable and permanent form. We are indebted to the zeal and able management of our excellent Treasurer for the financial state of the Society being now on a more secure and firm footing. We are out of debt, and have a small balance in hand, and every means have been adopted to lessen expense, and to secure the success, and to increase the prosperity of the Society.

Papers of the past Session.—Upwards of thirty contributions on various branches of the sciences which it is our privilege to study, were read at our meetings last Session. We had first a communication "On a Deposit of Magnetic Iron Ore on the Shores of Bute," by Dr James Middleton. This able and active naturalist is now engaged in the practice of his profession at Strathpeffer, in Ross-shire. He has succeeded in starting a Field Naturalists' Club in that locality, and there is every reason to anticipate useful and valuable additions to the natural history of that part of the country, from the united exertions of its members.

We had several interesting and important papers on Geology and Palæontology, communicated by our indefatigable Members, Mr Charles Peach, Dr James C. Howden, Mr David J. Brown, Dr Robert Brown; and a most original one "On Fused Stones showing Columnar Structure from a Pictish Tower," by the Rev. James M. Joass; and, as bearing on some of the unsolved problems in Geology, I would draw especial attention to the valuable and original series of "Experiments regarding the rate of Deposition of Sediment from Fresh and Salt Water," made by Mr David Robertson, Mr Joseph Somerville, and Mr William Durham. It is highly desirable that these experiments should be continued, as it is in this direction that more definite expressions in regard to geological time may be hopefully looked for. Two papers of considerable public interest were brought forward by Mr John Falconer King; the first, "On a New Method of estimating the amount of Colouring Matter in Water;" the second, "Recent Modes of determining the Impurity of Milk;" and we had an able resumé of our present knowledge of "Meteoric Chemistry," by Mr Andrew Taylor. Zoological papers of interest were communicated by Mr Charles Peach, Mr Archibald F. Grieve, Dr John A. Smith, Dr James C. Howden, Dr F. W. Lyon, and Dr James M'Bain.

It is thus evident that we are well supplied with working Members, and there is every reason to anticipate for the Royal Physical Society a long continued and useful career.

Obituary Notices.—A melancholy duty in connection with the President's address, is that of having to announce the deaths of Members of the Society, who have fallen from our ranks, and who, while in life, promoted its prosperity.

I cannot allow this opportunity to pass without a brief notice of the loss the Society has sustained by the death of two of our Ordinary Members, viz., Mr Robert M. Stark, and Mr Thomas Edmonston, of Buness, in Unst, the northernmost of the Zetland Islands.

Mr STARK was one of our old Members, who, some years ago, attended our meetings regularly; and whose kind, unassuming, and amiable character, endeared him to all his friends and associates. He was born on the 17th June 1815, at Dirleton, East Lothian, of which parish his father, the Rev. William Stark, was for thirty years the minister; and from whom he inherited a love of botanical pursuits, and, it may be added, his very retiring disposition. After finishing his education, Mr Stark entered the firm of Lawson & Sons, to learn the business of a nursery and seeds man. He then became a partner with Dickson & Sons; and ultimately having acquired a lease of the Dean Nursery, he set up in business on his own account, and was famed for his choice collection of rare herbaceous and Alpine plants, to the cultivation of which he more especially devoted his attention. A few years ago he gave up this business, and took up his residence at Trinity, where he still continued to cultivate his favourite plants in a small nursery there, to which he was constantly adding new and rare specimens.

In the summer and autumn of 1865, Mr Stark made a botanical excursion to Canada and the Northern States of America; the results of which he afterwards published in a series of papers of much botanical and horticultural interest, in the *Farmer's Journal.* The next summer he paid a visit to Switzerland, and brought home a large collection of Alpine plants, which were added to his select and valuable stock at Trinity. In the spring of 1870, Mr Stark removed to London, where he intended to carry on the business to which he had latterly restricted himself—that of the cultivation and disposal of rare Alpine and herbaceous plants. His health, however, about this time began to fail, and during the last three years of his life he was entirely laid aside from business, and from his favourite botanical excursions. He died in London on the 29th September 1873.

Mr Stark was twice married; his first wife was a daughter of the Rev. Dr David Landsborough, well known for his admirable writings on natural history. His second wife, Miss Henderson, belonged to London, and watched over him in his long and trying illness with the utmost care and devoted affection.

Mr Stark was a man of sincere and earnest purpose, and strictly honourable in all the relations of life. His habits were simple and unostentatious, and he was ardently fond of botanical pursuits. He paid particular attention to cryptogamic botany, and some years ago published a work "On Mosses." He also published a book "On Rock Plants," with the aim of popularising those interesting branches of botanical study. I may add, that there are few during the last generation who have done more to incite a popular taste for the culture of rare plants, and especially those of an Alpine character, than Mr Robert M. Stark; and hence he is justly and well entitled to a biographical notice in the annals of our Society.

Mr Thomas Edmonston was born on the 7th September 1825. He was the son of Mr Charles Edmonston, and was educated and passed the early years of his life in South Carolina, U.S.A. After a visit to the gold mines of California, he came to this country in 1854, and took up his residence in Zetland.

Mr Edmonston, by marriage with his cousin, became one of the landed proprietors in Zetland. He was a Commissioner of Supply and Justice of the Peace, and fulfilled his public duties with such remarkable zeal and ability, that a few months before his death he was appointed a Deputy Lord-Lieutenant. As a landlord he was greatly esteemed and respected by his tenantry, and he took a deep and warm interest in promoting the moral and social improvement of the people. He was famed for his hospitality and attention to strangers who visited the northern islands of Zetland, and especially to those who were engaged in the pursuit of science. To the latter he never failed to render the most friendly aid and assistance, and many warm and lasting friendships were made, the memory of which will not fail to be held and deeply cherished by the survivors. He was the author of "A Glossary of the Shetland and Orkney Dialect," published in 1866, which has proved highly acceptable and useful to those engaged in etymological studies. His constitution was injured by the hardships he endured in his visit to California, and since 1862 his health was most precarious. He died at his residence, Buness, in Unst, on the 1st of August (1874) this present year.

Mr Edmonston belonged to a family celebrated for their literary tastes and scientific attainments. He was nephew to Dr Arthur Edmonston, the author of "View of the Zetland Islands," published in two volumes, as far back as the year 1809. His predecessor and uncle, Mr Thomas Edmonston of Buness, was well known as a corresponding member and contributor to several of our scientific Societies and Journals; and as an excellent and an improving landlord. It was on his property that Dr Hibbert, when investigating the geological structure of the Zetland Islands in 1817, made the interesting and valuable discovery of chromate of iron, and of a rare mineral, the hydrate of magnesia, imbedded in the serpentine rocks of the island of Unst.

Dr Lawrence Edmonston has done much to promote the knowledge of the natural history of the Zetland Islands; and many of his contributions are to be found in the memoirs of the Wernerian Society.

His talented son, Mr Thomas Edmonston, and cousin to our deceased member, when only a student, by patient and well-directed labour, produced a "Flora of Shetland," so careful and exact, that only a few additions have been made to it, since it was published in 1846. This young and promising botanist, from whom so much good work was expected, met with an untimely death, by the accidental discharge of a gun, when serving in the capacity of naturalist, on board H.M.S. "Herald," employed on a survey of the Pacific coast of America. His "Flora of Shetland" will always be referred to by his successors, who may have occasion to labour in the same direction, and will serve to keep his name and memory in grateful remembrance.

Mr Thomas Edmonston of Buness was elected a Fellow of the Royal Physical Society in April 1870. The graphic and delightful description which he gave us at that meeting, of certain animals under domestication, as the seal, the sea otter, the tame Shetland pony, and sea gulls, under the title of "Our Pets in Unst," will be in the recollection of many here present. A cordial vote of thanks was awarded to him for his highly interesting communication, and it was remarked by Mr Scot-Skirving, that the thanks of all naturalists were justly due to Mr Edmonston, as the preserver on his estate in Shetland, of one of the few breeding places still remaining in Britain, of the skua gull or Bonxie, the *Cataractes vulgaris* of Fleming.

Early History of the Society.—The Royal Physical Society now enters on the 104th year of its existence. It was founded in 1771, under the auspices and with the aid of a number of celebrated men, many of whom were Professors in the University of Edinburgh, among which appear the distinguished names of Black, Cullen, Monro, Hope, Gregory, Home, etc.

The object of the Society was for the cultivation of the Natural and Physical Sciences, and to promote and inspire a taste for Natural History amongst the advanced students of the University, under whose fostering wing it continued to flourish for more than half-a-century. The number of members admitted during the first year appears to have been only eighteen, and the average number admitted during the next ten years about the same in each year. During the first decade many eminent men, Professors of home and foreign Universities, statesmen, and others (one name being more especially notable, viz., Benjamin Franklin), were elected honorary members. It seems, indeed, to have been the practice from time to time to inscribe on the honorary roll of membership the names of most men of the age who had especially devoted themselves to science. Thus, we have the names of Sir Joseph Banks, John Hunter, Lavoisier, Berthollet, Fourcroy, Zimmerman, Cline, Sir Astley Cooper, Spurzheim, Pallas, Thunberg, Earl of Bute, Earl of Buchan, Lord Gardenstone, Dawson Turner, Humphrey Davy, and many others. In 1782, the Society received an accession of strength by its union with the Chirurgo-Medical Society. On 5th of May 1778, a Royal Charter was obtained, which gave a status and importance to the Society most desirable and flattering to its members, and whose learning is therein lauded, the fame of which (says the Charter) extended over Europe and America.

In 1796, the American Physical Society cast in its lot with the newly chartered Society. Afterwards in 1799, it was also joined by the Hibernian Society, and in 1802, by the Chemical Society. The Natural History Society joined in 1812, and on this union, James Edward Smith (the father of English Botany), Henry Brougham (afterwards Lord Brougham), and James Macintosh (afterwards Sir James Macintosh), were elected honorary members of the Royal Physical, having been formerly ordinary of the Natural History Society. And it may be here mentioned that amongst the manuscript dissertations of the latter Society still extant, there will be found one or more of the juvenile performances of the late learned and versatile Lord Chancellor Brougham. Another amalgamation or rather absorption was with the Didactic Society in 1813, and the last took place with the Wernerian in 1858.

During the first half-century of its existence, the Society seems to have had a strong medical complexion, or rather constitution, its chair being filled exclusively by graduates in medicine, and its literary shelves loaded with medical treatises and theses. Thus constituted, the Society was in its membership always more of an erratic than of a local character, and every new session showed a remarkable succession of new faces and the absence of old and familiar ones. This is easily accounted for, because the members being mostly medical students, and who having finished their studies and taken their degrees or licences, as the case might be, left the metropolis for the provinces, or to go abroad, in order to prosecute the real business of life. After the year 1827, however, an improvement in every way more favourable to the best interests of the Society began to take place by the gradual introduction of resident members of cultivated and confirmed scientific tastes, and which is characteristic of its aspect at the present day.

For this interesting description of the origin and subsequent history of the Royal Physical Society, I am indebted to my esteemed friend, Mr David Grieve, who joined the Society in the year 1828, when a student attending the law and philosophy classes at the University of Edinburgh. In a MS. essay which he kindly placed at my disposal, he describes the hall in North Richmond Street belonging to the Society at that time, and the character of the meetings therein held, with graphic notices of its members. The essay deserves to be printed.

Zoology, its Rise and Progress.—The remaining part of this address will be occupied in tracing briefly the rise and progress of Zoological Science.

In the present day, when great unsolved problems are agitating the republic of the science, it may be a relief to glance back on the lives of some of those grand old pioneers who laid the foundation on which the vast superstructure now rests. The sketch must be brief, and therefore imperfect; but as the aim is retrospection, and not novelty, the imperfection will be of little importance.

Until the sixteenth century there are only two names whose writings on Zoology have been preserved to us from ancient times, and who deserve to be held in grateful remembrance.

Zoology dates from the time of Aristotle, and as a science lay buried with him for more than eighteen centuries. His "History of Animals" was written at a time when our country, with the greater part of modern Europe, was in a state of barbarism, and only emerging out of the stone age. There is not a name in all antiquity that stands more prominently in the foreground for science and learning than that of Aristotle. It has been said that Plato and Aristotle represent all the speculative philosophy and scientific knowledge of ancient Greece, and that whoever is acquainted with their writings knows all that Greece had to teach.

Plato was the teacher of Aristotle, and the restless and active disposition of the pupil was characterised by the master in the well-known epithet, "Aristotle is the mind of my school."

The rise of Zoology as a science dates from the time when Aristotle directed his attention to the animal kingdom, and it is chiefly in his capacity as the historian and interpreter of nature, that he claims our allegiance, gratitude, and admiration.

His " History of Animals " is the oldest and most celebrated contribution to zoological science that has come down to us from ancient times. The multitude of important and well-ascertained facts he relates are reduced to a systematic arrangement, and based on true physiological principles, that subsequent discoveries, with all the aid of modern science, have, with a few modifications, only tended to confirm.

His " History of Animals " consists of nine books. The opening chapter of the first book gives a general outline of the animal kingdom, and offers suggestions for a natural classification of animals, in accordance with their external form and manner of life. He compares animals among themselves, and enumerates with surprising accuracy the agreements, and differences, and analogies that prevail throughout their form and structure. He shows himself acquainted with the intimate relation that exists between the blood and the life of an animal, and he makes use of the colour of the blood for the primary division of the whole animal kingdom, which he divides into animals possessing warm and red blood, and those without blood-proper. This division is essentially founded upon physiological principles, and the positive and negative distinctions here indicated, under various forms and modifications, still constitute the foundation of all our scientific systems and classifications.

The only constant and formal terms of classification employed by Aristotle are species (*eidos*) and genus (*genus*); and he gives a remarkably clear and precise definition of species, which he says is " an assemblage of individuals, in which not only the whole form of any one resembles the whole form of any other, but each part in any one resembles the corresponding part in any other." His use of the term genus is more vague, and sometimes extends to what is now understood by tribe, family, order, or even class. With respect to animal life in general, he notices in Book VIII., that " nature passes so gradually from inanimate matter to animated beings, that from their continuity, their boundary, and the mean between them is indistinct. The race of plants succeeds immediately that of inanimate objects, and these differ from each other in the proportion of life in which they participate; for, compared with other bodies, plants appear to possess life, though, when compared with animals, they appear inanimate."

With the death of Aristotle, Natural History expired in the Grecian era. He left no worthy successors among his countrymen to follow in his footsteps, far less to add to the science he had done so much to establish; and it was not until after the lapse of nearly four hundred years that a solitary naturalist, the elder Pliny, again took up the study of Natural History.

Pliny is said to have written 160 volumes, of which, however, only thirty-seven books on Natural History have been preserved. Of this work, Cuvier says, " It is one of the most precious monuments that have come down to us from ancient times, and affords proof of an astonishing amount of erudition in one who was a warrior and a statesman." Other writers have compared Pliny to Aristotle, but beyond an ardent thirst for knowledge, they had few characteristics in common. Pliny made no attempt at a scientific mode of classification, further than commencing with the largest group, and ending with the smallest. His Natural History has been called the Encyclopædia of ancient knowledge, as it existed among the Romans, and the depository of all that was known in science and the arts from the earliest ages of the human race. He has been greatly extolled as a classical writer, and it has been remarked that had his writings perished, it would have been impossible to restore the language of Virgil and Tacitus. His romantic and heroic death, during an eruption of Mount Vesuvius in the year 79 of the Christian era, is touchingly told by his nephew in a letter to Tacitus.

After the death of Pliny, Natural History, as a science continued in the state in which he left it for upwards of *fourteen hundred* years. The writers during the " dark ages " were fettered by authority, and limited in their scientific inquiries, and amused themselves in building up what they imagined to be systems of the universe. Instead of seeking out by patient observation and original research, the facts of nature, and reasoning upon them, they occupied themselves in reducing to their own theories, every fact which seemed to contradict what they considered to be a law of nature. A notable instance of this prejudiced explanation has been often quoted in the theories advanced, to explain the existence of organic remains in the crust of the earth. Marine organisms, fishes, shells, corals, were found embedded in the rocks, far removed from the existing sea, and at considerable heights above its level. It was contrary to their theories to believe that the sea had ever occupied the position in which the marine fossils were found. If not, how came they to get there. The reply was a resolute denial, that the fossils were the relics of marine animals, and the phenomena were really explained by supposing a "plastic power" in nature, which exerted itself in moulding the living rock into mimic representations of plants and animals.

In the sixteenth century, with the revival of learning, a better era dawned upon the study of Natural History. This originated with Belon of Mans, who was born in 1517, and seems to have devoted himself to the study of birds, fishes, and botany, In the year 1554, two works on fishes appeared —one by Rondelet, Professor of Medicine at Montpellier, the other by Salviani, a physician at Rome. These were soon followed by two writers on General Zoology—Conrad Gesner, and Ulysses Aldrovandi, the former a physician at Zurich, the latter a Professor of Philosophy and Natural History in the University of Bologna. Gesner, in his history of animals, classifies them into two great divisions—those that reside on land, and those that live in the water. The viviparous quadrupeds are subdivided into six orders, into which families are disposed according to the accident of their being wild or tame. Aldrovandi adopts Plato's division of the animal kingdom, corresponding to the four elements of the ancients—viz., fire, air, earth, and water. He begins with birds, "that division," as he says, "seeming to offer itself first in order ; for as to those corresponding to fire," he observes, "I consider none such exist." There are many important anatomical and physiological details in the works of those authors. For example, Aldrovandi describes the process of incubation in the egg for each day, the "punctum saliens" having been seen on the third, with the "truncus venosus" arising from it.

The small band of active naturalists who flourished during the sixteenth century, deserve to be held in remembrance, and are entitled to our gratitude and esteem. It was by their labour and exertion that Natural History was enabled to emerge from the obscurity in which it was sunk, in common with every department of science, throughout the unillumined ages. After a long night of darkness the light of science had again sprang up, and was now above the horizon. The inductive method, so clearly indicated by Aristotle, was adopted and rigidly enforced in the writings of Bacon; and it was by its application that Galileo, Kepler, and Newton were enabled to achieve their immortal discoveries in Physical Science.

Men now appeared in various countries making observations for themselves in the Natural Sciences, collecting, appropriating, and verifying the knowledge which had been handed down in the writings of ancient authors. Facts were no longer tried by traditional authority, but tradition was subjected to the close scrutiny of newly observed facts.

Naturalists found that, so far from the Book of Nature being exhausted by the labour of their predecessors, Natural History was full to overflowing of rich and varied interest; and that notwithstanding the united efforts of human research for thousands of years, there was not a single department whose history could be said to be complete.

The first British zoological work appeared in 1634, under the title of "*Theatrum Insectorum*," by Dr Mouffet, physician to the Earl of Pembroke. The next original work was published in the year 1667, entitled, "*Pinax Rerum Naturalium Brittanicarum*," by Dr Christopher Merrett, and is deserving of notice as the first of our local faunas and floras, being entirely devoted to British plants and animals.

It was at this time that the illustrious names of Willoughby, Ray, Lister, and Sibbald, began to spread the fame of Great Britain. The vertebrate animals occupied the attention of Ray and Willoughby. The Cetacea captured in our seas, or thrown on our shores, were examined and described by Sibbald, and the results published in his "*Phalainologia Nova*" (Edin. 1692). The Mollusca were carefully investigated by Martin Lister, and great service rendered to this branch of

Natural History from the publication in 1685 of his "*Historia sive Synopsis Methodica Conchyliorum.*" The plates exceed a thousand in number, and are executed with great skill and accuracy. In the class *Arachnidæ,* the spiders had early attracted the attention of Lister; and his description of the species, as published in the first part of his "*Historia Animalium Angliæ,*" is still unrivalled. The "*Historia Insectorum*" of Ray (London 1710), to which Lister furnished a valuable contribution, is the work to which Entomology is chiefly indebted for its early success, and to the great popularity it still maintains among Naturalists.

The science of Insect Anatomy, however, is justly due to Swammerdam, whose great work entitled, "The Book of Nature," or "History of Insects," is a perfect treasury of original and important facts in the physiology and minute anatomical structure of this class of animals, and will always be referred to as one of the highest authorities that can be adduced on Entomological Science.

The true spirit of science had now sprung up in the study of Natural History. Anatomy and Physiology were henceforth to form the basis of the science, and aided by the application of the microscope, which had just been invented by a countryman of Swammerdam's, Natural History passed from simple observation and description to that of an experimental science. The works of Goedart on the Metamorphoses, and Redi, on the Generation of Insects; Leeuwenhoek's "Arcana Naturæ," the writings of Malpighi, Ruysch, Grew, and the immortal discovery of the circulation of the blood by Harvey, justify the proud appellation that has been conferred on the seventeenth century, as the physiological era or golden age of Natural History.

Time will only admit of the briefest allusion to Zoological Science in the eighteenth century. A few brilliant names stand out conspicuously,—those of Linnæus, John Ellis, John Hunter, Lamarck, and Cuvier. Ray's system of classification of animals, although based on physiological principles, was soon superseded by the more simple and effective one of Linnæus. As has been stated, the system of Linnæus was scarcely equal to that of Aristotle; but by the introduction of an exact and precise nomenclature, known as the "Binomial System," he contributed more perhaps than any other naturalist to give a general and popular taste for the study of the natural sciences.

It was when Linnæus had attained to the height of his fame, that the memorable discoveries and experiments of Trembly on fresh-water polyps, and those of Ellis on the marine corallines, established the animal nature of those organisms, and rescued a large assemblage of the lower forms of life from the doubtful position they had long occupied in Natural History.

Before their time, Zoophytes, as they had been named, were generally considered to belong to the vegetable kingdom, although some mineralogists were opposed to the vegetable theory of marine corals, and maintained that they were simply rocks and stones formed by a sub-marine deposit of calcareous and argillaceous sediment, moulded into representations of trees and mosses by the motion of the waves, by crystallisation, or by some inherent vegetative power in mineral matter. Ellis published his "Essay towards a Natural History of the Corallines, and other marine productions of a like kind, commonly found on the Coasts of Great Britain and Ireland," in 1755, a work that enriched science with a mass of important facts, entirely and absolutely new, and so complete and satisfactory in support of the animal nature of zoophytes and sponges, that although at first it met with considerable opposition, it soon came to be generally accepted, and the discoveries of Ellis form an epoch in the history of Zoological Science in the last century. The nullipore corallines only now remain in the vegetable kingdom.

Towards the end of the last and beginning of the present century, the science of Zoology is greatly indebted to the labours of Lamarck. The term "invertebrate animals" originated with Lamarck, and it expresses, as Cuvier remarks, perhaps the only circumstance in their organisation which is common to them all. They were previously known as white-blooded animals, a designation proved to be erroneous by the discovery of an entire class—the *Annelides*—possessing coloured blood. The work on which Lamarck's fame principally rests, and which has conferred a most important service to Zoology, is his "Natural History of the Invertebrate Animals, presenting the general and particular characters of these Animals, their Distribution, Classes, Families, Genera, and the principal Species referable thereto." It contains the most valuable system that has ever appeared of the invertebrate division of animals, and has formed the guide to most authors who have since written or occupied themselves in the study of this department of the animal kingdom.

The science of Comparative Anatomy in its higher and philosophical sense belongs to the eighteenth century. It was by the application of Comparative Anatomy that John Hunter was enabled to erect for himself a lasting monument in the magnificent museum which bears his name, and represents in no small degree the whole range of Zoological Science. Comparative Anatomy in the hands of Cuvier produced the "*Regne Animal*" and "*Ossemens Fossiles*," thus founding a new science—Palæontology—and an improved classification of the entire animal kingdom.

The small band of Naturalists that signalised the dawn of Natural History in the sixteenth century had now increased to a large army, and were still on the increase everywhere.

During the first half of the present century, there is no name more worthy to be associated with the increase and progress of Zoological Science in Great Britain than that of Fleming. His "Philosophy of Zoology" was published in 1822. Of this work the celebrated anatomist, Dr John Barclay, in a letter to Dr Fleming, dated 8th October 1822, says—"Your work is excellent, and will be of much advantage in conveying to naturalists not only interesting, but very comprehensive views. Your observations on the faculties of the mind are not only excellent, in my opinion, but in some particulars even superexcellent, especially on instinct and reason, on liberty and necessity, and the degrees of the intellectual powers possessed by the lower animals. The observations on these subjects, I think, are new, and, as you state them, so obviously just, that it is a matter of surprise how they have not occurred to some hundreds of zoologists before your time. But philosophers, like others, have a partiality for far-off fowls and fair feathers, and, like young fishers, are apt to cast their lines on the opposite side of the river, though most of the fish which they labour to catch be on the side next themselves. Men in general are too fond of dwelling on their own superiority over the lower animals. They have neither wings to fly, nor fins to swim; nay, in comparing themselves with insects and quadrupeds, they feel a pride in having only two feet to walk upon; and as for the reason of which they boast, it leads a few of them, it must be confessed, to a knowledge of God and to the cultivation of arts and sciences, but not a small number to poverty and wretchedness, to prison, exile, and the gibbet."

Fleming's "History of British Animals" was published in 1828, and its author was perhaps the only naturalist in Britain at that time capable of producing a work on Zoology, including almost every branch of the science. So rapid has been the progress of Zoological Science, however, in the present century, that the "History of British Animals," unlike the "*Systema Naturæ*" of Linnæus, which passed through thirteen editions in the lifetime of the author, has had no new edition. It has, however, formed the groundwork for many of the admirable monographs on British Zoology which the increase of the science imperatively demanded, and will ever be a monument of the patient research and of the great and varied scientific attainments of its highly-gifted author.

Conclusion.—Our work in the future, as it has been in the past, is to render still more perfect those splendid monographs, which confer lustre and honour on our country. As students of Nature, and guided by the same truthful spirit as those illustrious names so briefly and imperfectly alluded to, there are many highly important questions in science as yet undecided. The boundary line betwixt the vegetable and animal kingdom is as invisible to us as it was to Aristotle; and even the doctrine of spontaneous generation is held to be an open question in science.

Materials for ample investigation, however, lie nearer at hand. The remarkable transformations that occur in large groups among the lower forms of animal and vegetable life, demand further research and elucidation; and the recent and surprising discoveries of Darwin in the dimorphic and other unions, exhibited by means of insect agency in many of our common plants, have opened up new and apparently endless fields for investigation.

By the aid of Comparative Anatomy, the myriads of "organic forms" of past life, buried deep in the crust of the earth, have been brought within the domain of Natural History. And Chemistry, risen from Alchemy, by the discoveries of Lavoisier, Priestly, Black, Dalton, and others, resulting in the law of definite proportions, has connected the three great kingdoms of Nature, the mineral, vegetable, and animal, into one science, co-equal and interacting with Physical Science.

Compared with the solar and stellar systems, which occupy the student of Physical Science, the objects of Natural History may appear small and insignificant. But we must bear in mind that size and weight ought to have no place in our estimation of the great and the little in Nature, for they appear to have none in the plan of Nature. The same perfection and adaptation of structure and function to surrounding conditions is shown in the smallest animal or plant, as in that of the largest; and the same law that presides over the formation of a rain-drop, regulates not only that of our own world, but extends throughout the infinite regions of space.

Recent experiments on the light emitted from distant luminaries, show that their material constituents are similar to those of our own planet; and analogy would lead to the inference that life and organisation may co-exist with those materials in the solar and stellar systems; thus leading to the great generalisation that the whole system of the universe is governed by the same laws that manifest the wisdom and power of the Supreme Lawgiver, who planted the tree of life on our own globe, with all its marvellous forms, modes, and adaptations.

On the motion of the Rev. Professor Duns, D.D., a vote of thanks was unanimously passed to Dr M'Bain for his valuable address, and conduct in the chair during his term of office.

On the motion of the Secretary, it was agreed that the address be printed in full in the Proceedings.

II. Mr David Grieve contributed an interesting letter, descriptive of the Society's meetings between the years 1828-29 and 1836-37, in continuation of Dr M'Bain's remarks. The following are extracts: "In 1828 the meetings were held in the Society's Hall, North Richmond Street. It was a circular building of two stories or floors—the ground being occupied as the Library, with a Council Room and Housekeeper's apartments. The upper floor was entirely devoted to the public meetings. The Hall was large, fitted with backed and cushioned seats, and capable of accommodating 200 persons or so. In the centre of the room opposite the door of entrance was placed the President's throne or pulpit, on a raised dais, with a canopy surmounted by the royal arms richly gilt. In front of this was a large table, where sat the Secretary, and the member who had dissertations or communications to read. The room was carpeted, well lighted, and there were blazing fires always on meeting nights, lighted at each end of the room, so that altogether the apartment presented on winter nights a cheery, comfortable, and somewhat dignified appearance.* The building has been removed, and its site is now occupied by a United Presbyterian Church. While the Society occupied this building, the meetings were held weekly, commencing on the first Tuesday of November, and continuing till the last Tuesday of the July following. During this time the Society had a paid Secretary, a Janitor or Officer, and a Housekeeper. Mr Nicolson Bain, Librarian to the University, held the former office for many years, and was much esteemed for his urbanity, obliging character, and gentlemanly deportment. For several years prior to 1828, the Society was in a languid state, but an appeal having been made to the Members in session 1827-28 to beat up for recruits, the result was successful, and no less than 72 new members were added to the roll in the summer of 1828. In the course of the succeeding session, 68 gentlemen were also added to the Roll. This was about

* The Society had also at that time a good museum.

the time the writer of these memoranda entered the Society. He was much impressed with the liveliness and energy, not to say eloquence, of the debates, and although, as a youth, he relished this much, he is bound to admit that science was often forgotten in the struggle for victory, and much valuable time wasted. There were two parties, generally pitted against each other about this period—the one represented by Dr John Murray, Lecturer on Chemistry, the other by Henry Hulme Cheek. These two, with their respective backers, were generally opposed to each other, irrespective of the merits of the question at issue. In fact one would have supposed that they were disputing for fun, rather than to arrive at the truth, because jokes, repartees, and sarcasms were unsparingly, and to all appearances irrelevantly, bandied about. In fact at that time the Royal Physical was simply a debating Society. The writer has a distinct recollection of both Murray and Cheek. They generally took up positions facing each other at the opposite ends of the room, and standing with their backs to the fire. Here they would unintermittingly assail each other, talking against time, and often against sense. This, however, more frequently took place during the discussion of private business, which was often so prolonged as to cause occasionally visitors to retire from the waiting before the public business commenced. This sort of thing was found to be a nuisance, and was ultimately put down before the Society left its old hall. Cheek, notwithstanding the defects hinted at, was a man of considerable ability, and, in conjunction with William Ainsworth, edited in 1830 the 'Edinburgh Journal of Science,' a monthly periodical, which, however, did not live beyond the year. In this journal will be found many of the papers read before the Society, and which are a very fair sample of the dissertations and notices of this period." Mr Cheek afterwards received a medal from the Society. The rest of Mr Grieve's letter was occupied by a description of some of the more prominent members of the Society at that period, such as Kenneth Kemp, a rising chemist (who received one of the Society's medals), James Y. Simpson, who joined in 1829, Edward Forbes, who joined in 1831, and others. Kenneth Kemp was an accomplished chemist and electrician, and had he lived would doubtless have gained for himself a great name in science. In those days electrical science had not made the rapid advances it has since done, and accordingly great interest was excited in the minds of the members, by the brilliant experiments which Kemp week after week demonstrated before the Society. All of his discoveries were given to us before being published to the world. The Society most properly awarded to him a medal for his services to it, and to science generally. When Simpson joined the Society, he had just newly arrived from the country. His cheeks were ruddy with health, and his appearance rustic in the extreme, in comparison with the dandy *medicos,* who in those days monopolised the most prominent places in the Society. He was a rough diamond, which was afterwards to be polished and scintillate brightly in the world of science. His eye, always a marked feature in Sir James' face, was distinguished by that happy intelligent merry sparkle so noted in after-years. Edward Forbes was, as has been truly said, a "born naturalist," and early showed signs of his future greatness. The Royal Physical was his stronghold, and as soon as he became a member, he took an active part in the business of the Society, and showed himself in no way backward to impart his stores of knowledge. This was always done in a pleasant agreeable fashion, though in that peculiar drawling manner, so characteristic of the afterwards famous naturalist. One of the first papers he read to the Society, was on some shells from the Nor' Loch, now the site of the Princes Street Gardens, but at that time a vile, fetid swamp. When more than twenty years afterwards, he returned to Edinburgh, he again renewed his interest in the Society, and had not death cut him short, would doubtless have been our foremost member as of old. The leading members of the Society during that period seem from the minute-book to have been—James Chapman, president, D. Macaskell, J. Murray, David Grieve, Edward Forbes, James Haig, William Stanger, Robert J. Hay Cunningham, John W. Hay, and William Dick. Forbes, with Mr Grieve, who was in 1834 Secretary and unpaid Law Agent of the Society, together with William Oliphant, the late Professor Dick, the late

Professor John Reid, Donald Macaskell, and one or two others, may be said to have kept the Society afloat, and obtained for it an asylum in the University, when, owing to the foreclosing of a mortgage, it was (in 1834) turned out of doors. Owing to this financial calamity, the Society for some time had great trouble in weathering the storm, and could scarcely have done so had not our late President—Professor Dick—most generously given by way of loan, without bill or bond, timely pecuniary aid. In 1834-35, there was an excellent turn-out of members; and in 1837, when the writer left Edinburgh for England, the Society seemed to have acquired new life and vigour. Mr Grieve's diploma as President was signed by twenty-one regular attenders, including, among others (and they may be taken as types of the leading men in the Society about that period), the well-known names of "William B. Carpenter, John Hughes Bennett, John Reid, M.D., James Y. Simpson, M.D., and Edward Forbes."

III. Dr J. A. Smith exhibited the following rare birds: 1. *Circus æruginosus* (the marsh harrier), shot near Seacliff, East Lothian, by J. W. Laidlay, Esq., on the 7th October. 2. *Scolpax major* (the great or solitary snipe), shot by Mr M'Haffie, Torhousemuir, Wigtonshire, on the 5th September. 3. *Coracias garrula* (the garrulous roller), shot by Mr Dickson, gamekeeper at Dalhousie, near Edinburgh, on the 15th October. 4. *Anser leucopsis* (bernicle goose), shot near Gifford, Haddingtonshire, on the 15th October. Another was shot by Dr Crombie, near North Berwick, on the 29th September last. These birds were sent by Mr Small, taxidermist, George Street, who notes that *Lestris Richardsonii* (Richardson's skua) is apparently not uncommon in the Firth of Forth this autumn or early winter.

IV. Mr R. Scot-Skirving exhibited a specimen of the grey phalarope (*Tringa lobata*), which was floated in by the sea, dead, after the storm of the 21st October; and the shoveler duck (*Anas clypeata*), a young male, in immature plumage. Both birds were obtained by him at Gullane, and are, especially the last, among the rare visitants of Scotland.

Wednesday, 16th December 1874.—Robert Scot Skirving, Esq., President, in the Chair.

The following gentlemen were balloted for and elected Office-Bearers of the Society for the Session :

Presidents.—Robert Scot Skirving, Esq.; John Alexander Smith, M.D.; David Grieve, Esq.
Council.—J. Falconer King, Esq.; Principal Walley; E. W. Dallas, Esq.; A. B. Herbert, Esq.; Ramsay H. Traquair, M.D.; James M'Bain, M.D., R.N.
Secretary.—Dr Robert Brown.
Treasurer.—John Macdonald, Esq., S.S.C.
Assistant-Secretary.—John Gibson, Esq.
Honorary Librarian.—John Macdonald, Esq., S.S.C.
Library Committee.—James M'Bain, M.D.; Thomas Robertson, Esq.; R. F. Logan, Esq.; D. Grieve, Esq.; J. Falconer King, Esq.; William Durham, Esq.

The following gentlemen were balloted for and elected Resident Members:

William Ferguson, Esq. of Kinmundy, 1 Charlotte Square, Edinburgh; Robert Thomson, Esq., LL.B., Rutland Square; John Hunter, Esq., City Analyst's Laboratory; D. R. Murray, Esq., Eastwood, Ferry Road; John Walcot, Esq., 20 Drummond Place.

The following donations were laid on the table, and thanks voted to the donors:

1. Proceedings of the Literary and Philosophical Society of Manchester, 1874 (pp. 35-50).—From the Society. 2. Transactions of the Berwickshire Naturalists' Club, 1873.—From the Club. 3. Annuaire de l'Academie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique, 1874.—From the Academy. 4. Proceedings of the Royal Society of London, Nos. 145, 149, 152, 153.—From the Society. 5. Transactions of the Royal Society of Edinburgh, 1873-74.—From the Society. 6. Fifty-fourth Annual Report of the Board of Public Education of the First School District of Pennsylvania for 1872.—From the Board. 7. Jubilee Chronicon of the Medico-Chirurgical Society of Edinburgh, 1874.—From Dr Handyside.

The following communications were read:

I. *On Dr Hall's New Theory of Chemistry.* By Andrew Taylor, Esq.

Mr Taylor gave a synopsis of Dr Hall's theory, referring the curious to "The Sun and the Earth," published by Trübner & Co.

1. The main factor in terrene Chemistry is the sun diffusing heat everywhere on our globe.

2. The individual actions of the chemical elements are dominated and modified by a like action from the earth itself; which, on this theory, is held to have unique properties like a chemical element.

3. Dr Hall postulates every chemical element to have the power of conducting or making heat "latent" within definite numerical limits. This power of thus taking and giving heat

either from adjoining elements, whether simple or in combination, or from the sun, is just chemical affinity and combination.

4. The forms and states of matter thus depend on this action.

The sun is thus striving to force or keep matter in the gaseous and liquid form. So those elements found only in such conditions have the most receptivity for sun-heat. The earth's action is to contract and solidify gaseous and liquid matter. A whole group of elements will thus be specified.

The behaviour of oxygen, carbon, and gold, under this hypothesis will serve to illustrate it.

The first two typify elements of low atomic weight, which, therefore, readily take heat from the sun, and consequently prefer the gaseous form, when nearly isolated. So soon, however, as they are influenced by metals, or the unique power of the earth (both of which have a greater capacity for taking heat from such elements though not from the sun, neither do they retain it), liquid or solid compounds, such as some of the acids or metallic oxides, may be formed.

Carbon assumes the gaseous or liquid form only when united with the sun-heat loving oxygen; as the diamond, graphite, or charcoal, it is solid; in company with oxygen it becomes gaseous as carbonic oxide or di-oxide.

Gold is heavy, non-heat capacious, and has thus an almost neutral force to the antagonistic heat forces. It forms few compounds, and is an inactive element. So, too, of the allied heavy metals.

In tabular form, this theory stands thus:

Sun, source of positive electricity, gaseity, latent heat, capacity, mechanical motion; has affinity to elements with small atomicity, and of gaseous or liquid form.	Earth, source of negative electricity; resistance to mechanical motion; solidity; contraction; latent coldness; has affinity to heavy metallic elements or compounds.

Mr Taylor objected to the theory, because it contradicted the new dynamical theory of heat, it confounded mechanical attraction or cohesion with chemical affinity, and no solid basis of experimental proof had been given for it. Sir Isaac Newton and James Watt had both anticipated the idea of an element deriving essential properties from some external source.

II. *On some Nematode Worms from a Chicken, with Remarks on the Causes of recent Epizootic Parasitic Diseases (with Exhibition of Specimens).* By Principal WALLEY, Veterinary College.

Professor Walley exhibited (microscopically) specimens of a nematode worm removed by him from the cæcum and colon of several chickens, amongst a number of which, at Trinity, a verminous enzootic had made its appearance during the past summer. The female worms measured from one-fourth to one-half of an inch, the males from one-fourth to one-third, and were found, some free in the bowel, others buried partially or wholly in the mucous membrane of the cæcum or colon. The symptoms induced by these entozoa, were lassitude, prostration, loss of appetite, emaciation, drooping of head and wings, and fetid diarrhœa; the *post-mortem* revealed diffuse inflammation of the intestinal mucous membrane, and in each case the contents of the cæcum were pasty in consistence, and of a very fetid odour. The treatment adopted, which was successful in curing some cases, and preventing the spread of the enzootic, was the administration of purgations followed by vermifuges, as sulphate of iron, and an entire change of food. One remarkable circumstance in connection with this attack lay in the fact that a number of young turkeys, which were associated with the chickens, enjoyed perfect immunity from the visits of the unwelcome guests.

Professor Walley attributed the increase of verminous diseases to the mild winters and wet springs which have been experienced within the last few years, and stated that great as had been the loss amongst the ponies of the Welsh hills during the past year, it was nothing in comparison with that which had taken place, and which had come under his own notice, in a different class of the same animals. As to preventative measures, Professor Walley observed that all animals should be kept in as perfect a state of health as possible, avoiding debilitating influences; that pastures should not be fouled by overstocking, and where practicable should be broken up, drained, manured with such agents as salt, lime, soot, and sulphate of iron, and stocked for upwards of two years with animals of a different species; and that "feg" or rough grass should be destroyed by burning.

III. *Process for the Estimation of Colour in Water.* By J. Falconer King, Esq., City Analyst, Edinburgh.

During the later months of the year 1873 and the spring of 1874, I had occasion to examine and report upon many samples of water, chiefly in connection with the water supply of Edinburgh.

As is well known, there were several schemes proposed for the supply of the city, and samples of water from most of them were submitted to me for examination.

The analyses, as usually performed, showed all these waters to be very much alike, because the main and almost only difference between them was the extent to which they were coloured. By the ordinary mode of analysis hitherto in general use, this most important feature would either not have been described at all, or would have been described in language so vague as to be totally unintelligible. We find, for instance, in many reports of analyses of water, the colour stated as being much or little, or by some meaningless or incomparable terms, as yellowish or brownish, which are altogether without significance, as no one can tell with precision what is wished to be indicated by such vague expressions, and which preclude the possibility of comparison, or of the character of the water being accurately recorded, as that tint which one observer would consider as fairly characterised by one name, might quite possibly, and would indeed most probably, be in the opinion of another, deserving of quite a different appellation. In addition, therefore, to the usual details set forth in reports of water analyses, I found that in order to permit of the merits and demerits of these different waters being properly discussed, compared, and recorded, it would be necessary to have the depth of colour of each exactly and definitely stated. To enable me to do this, I elaborated a process for the estimation of colour in water, which I will now have the pleasure of describing to the Society, and which, I may add, has lately been employed both by myself and others, and has been found in every way satisfactory.

The process, which is extremely simple, consists in adding to a known quantity of pure distilled water contained in a glass tube, an aqueous solution of caramel, of a certain strength, from a burette, until the tint communicated to the distilled water is found to equal that of the water under examination.

The tubes I employ are made of glass as free from colour as possible; they should be 15 inches long, and of such diameter that when filled to within 3 inches of the top, they will contain 8 ounces of water exactly.

Preparing the standard solution of caramel is the only part of the operation attended with any difficulty. It is done by adding caramel to distilled water until the proper depth of tint has been attained. The depth of colour which it should possess is ascertained as follows: To 8 ounces of *pure* water, perfectly free from ammonia, contained in a glass tube, and forming a column 12 inches long, add 10 grains by volume of solution of ammonium chloride, containing 3·17 grains of the salt in 10,000 grains of water (or 0·0001 grain of ammonia in 1 grain of solution). To this mixture, after proper agitation, add 25 grains by volume of Nessler's solution, of the usual strength; allow this, after mixing, to repose for 10 minutes, at a temperature of 60° F., when the colour produced will equal 30° degrees on my scale. That is, 300 grains by volume, or 30° (a degree being equal to 10 grains by volume) of caramel solution, if of proper strength, will produce exactly the same depth of colour when added to the same amount of distilled water (8 ounces) in a column 12 inches long.

The caramel solution, which I should state can be kept unchanged for a considerable length of time, being thus prepared, all that is necessary to do to estimate the colour of a water, is to fill two tubes, of the dimensions stated above, to within 3 inches of the top, one with distilled water, and the other with the water to be tested; and having placed them side by side on a white slab, in a good light, to add the caramel solution from a burette to the distilled water, until that is found to equal in colour the water contained in the other tube. The burette being graduated in grains, every 10 grains consumed will represent one degree of colour. The intensity of the colour is ascertained by looking down through the length of the column.

This process I have found very efficacious, which fact, with its extreme simplicity, will, I believe, recommend it to all who, like myself, have occasion to examine numerous samples of water.

IV. Principal WALLEY exhibited a specimen of a membrano-ossific cyst. This cyst, which was obtained from a mare (having formed an obstruction to parturition, and being attached by an elastic pedicle to the internal surface of the uterus), he looked upon as an instance of a perverted ovum, inasmuch as the mare did not become pregnant until she had been allowed the horse for two successive seasons, the cyst thus being the result of the first impregnation.

V. Dr ROBERT BROWN exhibited specimens of ferruginous sand from the shores of Lochfyne. The iron was magnetic, and similar to the specimens shown last session by Dr James Middleton, only much less rich in iron. Similar sands are found in various portions of the world, including many spots on the Scottish shores. Dr Middleton's specimens were obtained from Bogamy Point, at the entrance to Rothesay Bay, where it forms a very considerable deposit. It also occurs at Kilmichael in the Kyles of Bute, and there seems to be a deposit of a similar kind at Ettrick Bay. An interesting circumstance, probably connected with this deposit, is that captains of small coasters in the neighbourhood say that they have noticed a divergence of the compass near the point where the principal deposit lies. The physical properties of magnetic iron ore are that it is not only attracted by the magnet, but possesses magnetic properties itself. In the case of the deposits on the Scottish shores, it might be applied to economic purposes.

Wednesday, 20th January 1875.—Dr John Alexander Smith, President, in the Chair.

The following gentlemen were balloted for and elected Members:

As Corresponding Member—Millen Coughtrey, M.B., Professor of Anatomy and Physiology in the University of Otago, New Zealand. As Resident Member—James Bennie, Esq., Geological Survey of Scotland.

The following donations were laid on the table, and thanks voted to the donors:

1. Proceedings of the Royal Society, Vol. XXIII., No. 156.—From the Society. 2. Transactions, etc., of the Edinburgh Botanical Society, Vol. XII., Part I.—From the Society. 3. Annuaire de L'Académie Royale des Sciences, etc., de Belgique, 1874.—From the Academy. 4. Geological Notes on the Noursoak Peninsula and Disco Island, North Greenland, 1875, by Dr Robert Brown.—From the Author.

The following communications were read:

I.—*Recent Modes of Water Analysis, with special reference to the examination of Water as to suitability for Domestic purposes.* By J. Falconer King, Esq., City Analyst, Edinburgh.

Table A.—Analysis of Water.

Carbonate of Lime,	10·42
Carbonate of Magnesia,	2·32
Sulphate of Lime,	5·63
Sulphate of Magnesia,	2·43
Chloride of Magnesium,	1·26
Chloride of Sodium,	4·28
Chloride of Potassium,	1·32
Silica,	0·20
Organic matter,	2·02

Table B.—Analysis of Water.

Total residue,	20·00
Comprising Volatile residue,	2·10
And Fixed residue,	17·90
Consisting mainly of Lime and Magnesia Salts.	
Albuminoid Ammonia,	0·004
Saline Ammonia,	0·002
Nitric Acid,	1·30
Chlorine,	4·60
Iron,	None.
Lead,	None.
Hardness,	15°
Colour,	20°

One of the most important, if not the most important application of Chemistry to technical purposes is in the examination of articles of food and drink, to which subject, it is pleasing to notice, there has been a considerable amount of attention given in late years, resulting, as was highly necessary in many cases, in greatly improved methods of analysis. As might have been expected, water being an article in common use, and being very liable to contamination, has received at least a fair amount of attention, the modes of analysis in the last few years having been very much altered and improved. Formerly, either from mistaken ideas as to the nature of the substances which influenced the character of waters intended for domestic use, or from inability to estimate correctly certain ingredients, the presence or absence of these peculiar constituents, which are by far the most potent causes of bad water, was seldom or never determined.

The results of an analysis of water, as reported by chemists a few years ago, and even by some chemists still, show with great minuteness the amounts of the different salts present, a matter the determination of which is a tedious, a troublesome, and withal a totally useless operation. Besides this, there was introduced at the end of the statement of analysis an undefined and undefinable something known as organic matter, which, however, whatever it was, was certainly not organic matter, as it simply showed the loss after certain allowances and corrections which the water residue suffered on being exposed to a red heat. There could not be a greater fallacy than reckoning this loss as organic matter, and it would be difficult to make a greater mistake than to rely upon this, even if it did show the amount of organic matter, as an indication of the suitability or unsuitability of a water for domestic use. In the accompanying table (A) I show the mode in general use in former years, and still used in some instances in reporting results of an analysis of water. Before referring further to this table, I should remind the meeting that in this paper I am referring to analysis of water intended for domestic use alone, and not for trade purposes, as brewing, distilling, tanning, and the like. From this table it will be seen that in the analysis pursued in eliciting these results, the whole, or the greater part by far of the analyst's care has been lavished in ascertaining the precise number of grains of carbonate of lime, etc., which the water contained—an exceedingly futile operation,—while the item with which he should have been almost solely concerned is pushed in at the end; as if he was ashamed of it, he puts it as a sort of addendum, its peculiar position indicating but too truly the amount of consideration it has received. Now every one knows that it is in no way a desirable thing to swallow daily in the water one drinks, large quantities of carbonate of lime or other earthy salt; but what difference does it make whether the water we use contains four or six grains to the gallon of carbonate of lime or chloride of sodium? and yet this is really the main, I had almost said the only, information we have from such an analysis as this. The item known as organic matter, and obtained in the way I have already indicated, is nothing short of a burlesque. It is absurd, in the first place, as it does not show in any way whatever the amount of organic matter present. A great many changes other than simply driving off organic matter, it is quite well known, may, and almost invariably do, take place when a water residue is exposed to a red heat. In the second place, it is absurd, because even if this was a correct measurement of, or if it even was an approximation to, the real amount of organic matter, it tells nothing whatever of the *nature* of the organic matter, it takes cognisance of quantity only, and says nothing of quality. Now we are well aware that certain kinds of organic matter are perfectly harmless, while others, there is not the slightest doubt, are exceedingly pernicious. For example, one water, let us suppose, is mixed to a slight extent with some starch or gum, and another is contaminated with some deleterious decomposing animal matter: by this mode of analysis, both these things would be described as organic matter, and if the former water contained twice as much as the latter, it would be described as the worst; whereas exactly the reverse of this would be true, as water containing even very small quantities of certain animal contaminations is known to be very prejudicial to health, which is what could not be said of a water containing small quantities (as a half or quarter of a grain per gallon) of such things as gum or starch.

The peculiarity of the mode of water analysis which I have adopted is, that while it gives a sufficiently correct indication of the quantity and quality of the saline matter present, it has for its special object the determination of the nature and amount of deleterious organic matter with which a water may be contaminated. It is not my wish nor do I attempt to show in an analysis of water the total amount of organic matter present; what I give my almost undivided attention to is, the determination of the amount of deleterious organic matter together with other objectionable constituents, as nitric acid, iron, lead, copper, arsenic, etc.

My analysis when finished is reported in the form indicated in table B. There it will be seen I set forth the total amount of solid matter which the water contains, and that is divided into (1.) Volatile Residue, and (2.) Fixed or Saline Residue, which latter is generally examined to ascertain which salt or salts it is mainly composed of. Then I estimate by means of the beautiful process, first proposed I believe by Wanklyn, the amount of ammonia existing as such in the water, which, together with the amount of ammonia obtainable from organic sources by the action of an alkaline solution of potassium permanganate at a boiling heat, gives a very correct indication along with other things of the amount of *deleterious* organic matter present, and therefore a good basis for the foundation of an opinion as to the suitability of the water for dietetic purposes.

The next ingredient mentioned in the table, viz., nitric acid, I test for with great care, as I believe this is a good guide so far as to the purity of water. Nitric acid, it is well known, arises from the decomposition of peculiar kinds of organic matter under certain circumstances, and as nitrates are very soluble, they generally find their way into the water along with part of the organic matter from which they have arisen, and so their presence becomes an indication of contamination. As water, however, may contain nitric acid and yet be perfectly free from organic contamination, I do not place implicit reliance on this test. The next ingredient is chlorine; this substance is found in considerable quantity in water which has been contaminated with sewage. As it may, however, and indeed often does, occur in considerable quantity in water which is quite free from sewage, it must not by itself be taken as an indication of impurity. Iron and lead are the constituents next mentioned. The former of these rarely, and the latter never, occurs in natural water. They are both, however, liable to be communicated to certain waters during passage or storage in leaden or iron pipes and cisterns, and as they are both, especially the former, objectionable ingredients in potable waters, they should always in an analysis be carefully searched for. We then come to the property known as "hardness." The amount of this may to a certain extent be inferred from the amount of saline matter present; but as we have a very ready and reliable method of determining its amount, it should always be accurately ascertained. The peculiar properties and disadvantages of a hard water are so well known that I need not take up time enlarging upon the subject, further than stating that these degrees of hardness simply express grains of carbonate of lime. If we say, for example, that a water has 10° hardness, we mean that it has the same power of destroying soap as would be possessed by a water containing ten grains of carbonate of lime in the gallon, or at all events lime and magnesia salts equal to that. Of the next ingredient, the colour, I require to say very little. At the last meeting of the Society I read a note on my process for determining the amount of this, which will be found printed at length in the Proceedings (p. 26).

Having thus considered, though somewhat imperfectly, I am afraid, the different ingredients which I think should be estimated in making an analysis of a potable water, it remains for me to illustrate by a very few examples how I have found this process to serve the purpose required of it. One of the best examples I can give is one drawn from our own city.

Not very long ago a sample of water was sent to me for examination. It was, I may remark, stated to be Crawley water obtained from an ordinary cistern; it was all right to look at, and if it had been analysed in the ordinary way it would have showed little or none of the so-called organic matter, and would therefore have been reported as pure. By the mode of working which I have adopted, however, I found it to be very bad; it was in fact one of the worst samples of water I have had occasion to examine. I accordingly, though not without a little suspicion that some trick had been tried, reported the water as being very bad and quite unfit for use. On making inquiries some days afterwards as to where such a specimen of water could have come from, I was informed that a small leak had been discovered in the soil pipe leading from the water-closet situated above the cistern from which this sample was drawn, and that the various matters which should have been removed by that pipe were soaking through the flooring, and draining into the water intended for the supply of the house immediately beneath. Besides numerous other samples of water from the city, I have been called upon to examine many waters from country towns. Which waters, as they were generally bright and sparkling, were believed and maintained by many people in the habit of using them to be perfectly good and wholesome, although disease was prevalent of such a nature as, together with other circumstances, pointed most undoubtedly to impure water supply.

These waters contained in many cases the ordinary saline ingredients, in the same proportions as are found in good wholesome waters, and the so-called organic matter was sometimes high, but frequently, even in very bad waters, was exceedingly low. Nor is this at all to be wondered at, when we remember what this organic matter is, or rather what it is not, and how its amount is ascertained.

I have quite recently finished a very extensive investigation into the quality of the water supplied to an important town in Ayrshire, and I have found, in one case at least, that the water, though really very bad, did not contain by any means a large amount of "organic matter," while one or two other specimens, much purer, contained far more. I am at present engaged in a series of water analysis for another town in the west, and these samples, so far as the analyses have been proceeded with, show similar results to those last named. I have also had lately the water supply of a town in Kirkcudbrightshire to investigate, and some interesting results were obtained in the course of that examination. The soil upon which the town is built is very light and sandy, and as far as I could learn, the system of drainage is by no means perfect. The town being supplied with water from wells situated in the streets, often in close proximity, I imagine, to the sewers, there was every reason to suspect bad water, as in point of fact most of the samples proved to be. They almost all showed, on being properly analysed, distinct signs of being most seriously contaminated, and still some of them might have been considered as ordinary good waters, by any one who in examining them confined his attention solely to the estimation of the saline matter, and the amount of "organic matter," as ascertained by noting the loss suffered by the residue on ignition. I might cite many more instances from my own experience, giving further proof of what I have said, but I think those I have given are sufficient. I pass over some very curious and well marked cases of water pollution which I had in a town in Aberdeenshire, where in the light open soil on which the town was built, the wells for the supply of water for domestic purposes, and the cesspools containing all the refuse and sewage matter, seemed to be placed pretty frequently in the most favourable circumstances for an interchange of contents; also one from Wigtonshire where a like arrangement seemed to have prevailed; to mention specially, and in conclusion, a case which occurred in Fife, where the water of a well which had been used for years, had suddenly been suspected of being bad. This water I analysed, and finding signs of serious contamination, I reported that it was impure. I was told, however, with tolerable plainness, that I must be wrong, as the water had been used for many years, and had never been found wanting, and, moreover, that it was beautiful water, and had not been changed nor interfered with in any way whatever. On making inquiry, I found that the conclusion I had come to was perfectly correct, for though the water had for long been of excellent quality, and even then exhibited outwardly no appearance of being contaminated, I found that a small dungstead had been erected, a considerable distance from the pump whence the water was procured, but nearly or directly over the well, and the drainings from which heap filtering down, clear and bright enough, into the water accounted at once for its bad qualities, and the results of my analysis, although it is quite possible that if it had been tested by the other process I have indicated, it would have been in all probability reported as being excellent water.

II.—*Notice of an Account of the Great Eruption of Mount Vesuvius, of April* 1872. By W. T. Black, Esq.

Mr W. T. Black contributed a communication of an account of the great eruption of Vesuvius of April 26th, 1872, compiled from the journal of his brother, then staying at Naples, and from information collected from letters in the journals of the time.

It was illustrated by numerous photographs and views obtained by his brother, and by a collection of volcanic minerals, by charts and diagrams of the mountain, drafted from original sources, showing the course of the streams of lava, the formation of the crater, and the structure of the pillar of cloud.

This eruption is called a paroxysmal one, in contradistinction to ordinary ones, because it was accompanied by all the three physical manifestations, viz., by the pillar of cloud, the showers of ashes, and the streams of lava, with their concomitant phenomena.

Ordinary eruptions, on the other hand, may have only the steam cloud, and this may have either ash showers with it alone, or lava streams alone coincident with it.

Date and Duration.—The eruption began on Tuesday, April 23d, 1872, reached its climax on Friday the 26th, and ceased about Thursday, May 2d, thus lasting about a week.

Lava Streams.—These began to flow from the top of the cone on Tuesday the 23d, and did not cease before Saturday 27th. There were two great streams of lava that flowed down from the cone; one smaller on the south side towards Camaldoli, about two miles long, which did not cause much mischief to life or property. The larger one, on the north side, flowed out of the great fissure of the cone, filled up the

Atrio del Cavallo, and then overflowed its basin, and divided into two streams; the north-western one ran through the Fossa Vetrana to the villages of Massa di Somma and Sebastiano, and overwhelmed them, and passed on towards Circola and Ponticelli, and was about four miles long, and stopped on Saturday the 27th. The other branch, smaller, flowed down the Fossa Grande, and filled up the ravine, for about a mile, in the direction of Resina, but did not do any damage.

Showers of Ashes.—This phenomenon was of as great importance as that of the streams of lava, on account of the darkness occasioned for several days, and submersion of the country by their fall like that of snow, for several square miles round Vesuvius, including Naples itself. They began to fall about Friday the 26th, reached their maximum of density on Sunday the 28th, and did not finally cease before Friday, May 3d.

Their composition was found to be chiefly silicates of the alkalies and earths, with soluble chlorides of sodium and iron, and they were collected for use as mortar for buildings, and for tooth powder.

Pillar of Cloud.—This sight was the grandest and most enchanting of the phenomena of the eruption, and consisted of a large cauliflower-shaped cloud of white vapour, shining brilliantly white in the clear blue sky in the daytime, and illuminated with a gorgeous red tint at night.

Its dimensions were vast, 16,000 to 20,000 feet in height, or four to five miles (as high as Gay Lussac rose in his balloon), with a capping four to five miles in diameter, or twice as long when floating out before the wind, the borders of which were in perpetual gyration in the regions of perpetual frost.

It began imperceptibly on Monday the 22d, reached its grandest on Friday the 26th, and Saturday the 27th, and its glories finally paled as the dust clouds began to prevail more and more.

Dust Clouds.—These began after Friday the 26th, and soiled and overpowered the fleecy pillar of vapour, but scarcely reached half its height, and extended themselves all over the country, darkened the sky, shed down rain mixed with dust, and did not end before May 3d.

Observatory.—This is situated on Monte Canteroni, which divided the two streams of the northern lava, and was consequently exposed the whole time to the scorching heat and mephitic vapours of the slag running red-hot past it on each side, as well as to the showers of ashes and scoria on its roof, which also rattled with the fall of the bombs and splinters of rock.

Professor Palmieri and his assistant were therefore entitled to every meed of praise for their heroic resolution to abide by their instruments, and watch the progress of one of nature's grandest exhibitions.

Vegetation.—Everything organic was of course destroyed under the huge banks of the lava streams, but much more serious and more extensive destruction to agriculture and horticulture was effected by the dust showers.

Most of the vineyards and market gardens round Vesuvius for several miles were buried, and immolated by the acrid dust, especially when the rains came and washed it down afterwards into mud.

Cone and Crater.—The Great Cone was split open all along its north side from the top to the bottom, and let out of the fissure the great flood of lava into the Atrio del Cavallo, and was likewise cracked on the south side, to let out the south stream of lava.

The Crater was wholly altered from what it had been before, and was now converted into a pit 600 feet deep, divided into two halves, east and west, by a wall of rock, that had fallen across during the throes of the volcano.

A new crater was formed in the Atrio del Cavallo, and poured out extra supplies of ashes and vapours between the cliffs of Monte Somma, and Monte Canteroni.

Meteorological Phenomena.—The weather, prior to and during the first half of the eruption, was fine and clear, but subsequently thunderstorms and showers of rain prevailed uninterruptedly for several days.

These rains washed the country all round of the deposit of ashes, cleansed the streets and houses of Naples, and the roads and trees in the country, but occasioned damage in low lying parts from the accumulation of *débris.*

There was a splendid display of *electric flashes* in the pillar of cloud and in the dust clouds, besides the lightning of the thunderstorms, and it was beautifully seen at night and was of a very dazzling description.

Sea.—The Bay of Naples continued calm throughout the whole period of the eruption, though the ships in the harbour were somewhat affected by the inland earthquakes.

Acoustic Phenomena.—These were of the most extraordinary and violent description, and frightened the inhabitants, and were called the roaring and bellowing of the volcano, and were most terrible during Saturday 27th, Sunday 28th, and Monday 29th, and must be distinguished altogether from the thunder of the storm-cloud.

Property and Life.—Two very distressing events happened to the populations—one was the appalling loss of life to excursionists from Naples on Friday morning 26th, when the floor of the Atrio burst open, and a deluge of lava overwhelmed and destroyed them; the other was the destruction and submergence of the villages of Massa di Somma and Sebastiano on Friday by the north-west stream of lava, and these were really towns of several thousand inhabitants each, and had good houses.

General Flight of the Population.—All the towns round the base of Vèsuvius were early deserted by their inhabitants, who fled in thousands into Naples and to the further country, and left their property unprotected—such was the intensity of the panic.

Products of the Eruption.—The chemical products distilled and sublimated from the volcano this time were steam, muriatic acid, sulphur, chlorides of sodium, iron, copper, and ammonium, which became afterwards condensed on the sides and lavas of the mountain.

The quantity and character of the solid projectiles were very remarkable, and consisted of bombs or globular masses, great pieces of rock and fragments of scoria, and many of these were seen red-hot in the pillar of vapour, and were projected the height of a mile above the crater itself frequently.

Earthquakes.—Local ones occurred in isolated spots round the base of the volcano, and were especially noticed by the inhabitants of the various villages, whose houses experienced their topical effects, chiefly on the north side of the mountain.

III.—*Zoological Notes.* By Professor Duns.

(1.) *On Aphrodite hystrix.*—The specimen shown was dredged in Oban Bay, August 1874, at a depth of four fathoms. The attention of the Society was specially called to the fact that, when touched, the animal threw out several of its sharp spines, which stuck firmly in the hand, causing pain and slight inflammation. Dr Duns had been stung by *Aphrodite aculeata*, but this species did not shoot its spines free from the body. When removed from its sheath the spine of *A. hystrix* presents the appearance of an exquisitely shaped spear, sharp at the point and armed at the side with five, not four, as often stated, barbs—one straight, four recurved, the one farthest from the point being the largest and most bent. The barbs are placed on small cushions in a groove immediately below the upper edge. MM. Audouin and Milne Edwards in their work on the "Shores of France," regard these barbed spines as weapons of offence. Mr Gosse, remarking on this opinion, says he "thinks they are in error, misled by the resemblance which they bear to weapons of human construction." But the experience in the instance now noticed leaves no doubt as to their being formidable weapons of offence.

(2.) *On Phyllodice laminosa.*—The magnificent specimen of this beautiful annelid, exhibited by Dr Duns, was taken in the Firth of Forth, and sent to the New College Museum by the Rev. Walter Wood, Elie, Fife. It is 2 feet 4 inches in length. Its girth, a few inches from the head, exclusive of its lateral appendages, is 2 inches. The flattened styles of the tail—the homotypes of the leaf paddles—are awanting, and the end of the posterior part of the body has a truncated appearance, a considerable portion having been broken off. At three different places the rings are imperfect and unsymmetrical, as if at these truncation and subsequent renewal had occurred. The number of segments is about two hundred—the first, or neck, being twice the breadth of the others. The lateral paddles are leaf-like and irregularly heart-shaped, placed on a cushion, and associated with two bundles of bristles on the same ring. The head is small, with two pairs of minute terminal antennæ, behind which, at the edge of the first ring, are four pairs of well marked tentacular cirrhi. A deep groove runs from the head along the middle of the ventral surface of the body.

(3.) *On the spawning of the Hermit Crab* (*Pagurus Bernhardus*).—Three specimens were exhibited, one 6½ inches long, another 6 inches, and a third not more than $\frac{9}{16}$ths of an inch in length. All have layers of light brown round eggs attached to the left side of the soft abdomen. The tiny specimen when taken was clinging to the under surface of one of the mature forms. Its slenderness and size seem to indicate that it could not long have completed the stages of its metamorphosis—a curious example of sexual maturity in a comparatively high invertebrate at a very early age, the parent continuing to live, unlike some insecta by which ova are produced at an equally early period. It is generally stated that April is the spawning time of the hermit crab, but these specimens, with their egg-clusters attached, were taken in Oban Bay, August 1874. Many more were captured in the same condition, and in every case the egg-bearing forms came up in the dredge uncovered, having left their borrowed shells before getting entangled in the dredge, as no empty shells fitted to lodge them were found in it.

(4.) *On a species of Phasma* (*Palophus centaurus*, Westw.) —This large and finely preserved specimen was forwarded by Dr Robertson, Old Calabar, to the New College Museum. It differs both in size and in some of its markings from a specimen from the same locality, described by Westwood in the British Museum Catalogue of *Phasmidæ.* The length of the body is 10½ inches, and the wing-expanse 7 inches, as compared with Westwood's specimen, which is 9 inches long, and the wing-expanse 5¾ inches. There is a corresponding increase of size in the various parts of the body. The central oblong tubercle on the *tegmina*, or winglet covers, is rough above and smooth below. Four dark spots, irregular in size and position, occur on the thorax.

(5.) *Empusa gougyloides* (Fabr.).—This Mantis was recently received, along with many other *Orthoptera,* from India. Ceylon is the habitat usually assigned to it. The peculiarities of its form, compared with that of *Mantis religiosa,* were pointed out, and specimens of *Blepharis mendica, Harpax ocellaria,* and *Mantis bicornis,* were associated with it to show the gradual differentiations of the flattened projections on the body and limbs of these forms.

(6.) *Tryxalis nasuta* (Fabr.).—Two beautiful specimens of this wide spread species were shown. They had been received a few days ago from Alexander Fraser, Esq., Batavia. This being another locality added to the list of places mentioned as habitats of this graceful locust. The position of the eyes, the contrast between the depressed ensiform antennæ of this genus and the antennæ of most other *Orthoptera,* etc., were pointed out.

(7.) *Teratodes monticollis* (India)—Was shown with the view of pointing out the specialisations of the thorax in the *Locustidæ.*

(8.) *Schizodactylus monstrosus* (Brullé) (India).—The length of this specimen is about 1½ inches, while its antennæ are more than 4 inches long, with 240 joints on each. The structure of the tarsi, the form of the mouth organs, and the beautiful spiral folding of the wing covers and wings, when the insect is at rest, were pointed to as outstanding features in this remarkable looking grasshopper.

(9.) *Kallima inachis* (India).—Four specimens of the so-called withered leaf butterfly, were shown with the view of indicating the perfect character of the disguise possessed by these insects. The prevailing tint of the under side of the wings is a light ash-brown, having the very closest resemblance to withered leaves. The midrib and venation of the decaying leaf are also closely imitated. In one of the specimens the wing has been broken at the edge, but the rupture has taken place after a fashion characteristic of the break in many leaves. It is not clean, but consists of a saw-like irregular edge, which, as it lies on the dark part of the upper surface, forms a perfect resemblance to a broken leaf lying on a bit of bark, or on another leaf not so far gone in decay. The markings on the wings, as round or irregular dots, ragged streaks, and yellowish, greenish, or black patches, are just such as our own *microfungi* make on withered leaves.

(10.) *A small Lizard* (*Tachydromus sex-lineatus*) *from Batavia.*—The specimen was recently forwarded to the New College Museum, by Alexander Fraser, Esq. This pretty little lizard is noted for the great length of its verticillate tail, compared with the length of the body, which is not more than $1\frac{1}{16}$ inch from the back of the head to the vent, while the tail is $8\frac{1}{2}$ inches long. The head is acute, measuring $\frac{6}{16}$ths of an inch. The body scales are carinate, largest on the back. The palate is destitute of teeth. Toes long and slender, terminated by a minute claw. Two of the toes of the hind feet very long, comparatively; the first, second, and fifth moderate; the other two $\frac{6}{16}$ths of an inch.

IV. Professor Duns exhibited—(1.) A Cream-coloured variety of the Skylark (*Alauda arvensis*), shot some time ago near Stranraer, and forwarded to him by the Rev. George Wilson, Glenluce. (2.) Specimens of the Surmullet (*Mullus surmuletus*), and the Norway Haddock (*Serranus Norvegicus*, Flem.), taken on the Wigtonshire coast. The fact that the Wigtonshire fishermen by whom they were taken, regarded them as rare fishes, shows that they are not of frequent occurrence on their coast. They are not mentioned by Parnell in his list of the Fishes of the Forth. Fleming gives one instance of the occurrence of *S. Norvegicus* on the Aberdeen coast, and says, "In Zetland, where I have found it, it is termed Bergylt, or Norway Haddock."

V. Mr Robert Gray sent a note on living specimens of *Loligo media*, which he had found while walking along the shore of the Firth of Forth, between Granton and the Quarry. "The first one met with measured about 1 foot 8 inches in length from the caudal extremity to the tip of the longest arms. It was of a deep purplish red, the outer skin being finely grained. On touching it with my walking-cane, I observed that this outer skin peeled off readily, leaving white patches, or narrow lines just as the point of the cane was applied. The suckers were very tenacious, and instead of relaxing their hold on being forcibly pulled, they came away adhering to the point of the cane. On placing the animal in a pool of water, it discharged the contents of its inkbag, and I left it completely obscured.

"About half-a-mile farther west, I encountered a much larger specimen, measuring 2 feet 4 inches in length, also cast up by the receding tide. It, too, was alive, but in a dying state, and in colour it was precisely the same as the smaller specimen.

"On referring to Fleming's 'British Animals,' I find that he speaks of this species as being rare. I have never myself seen it but on one occasion—a specimen much smaller than the least of the two whose occurrence I now record—having been cast on shore, three or four years ago, in the Kyles of Bute, on the west coast.

"A characteristic figure of this animal, under the name of *Octopodia media*, is given in Pennant's 'British Zoology,' edition 1812, and it may not be out of place to quote here the following short description which that author gives:

"' . . . . long, slender cylindric body; tail finned, pointed, and carinated on each side; two long *tentacula;* the body almost transparent; green, but convertible into a dirty brown, confirming the remark of Pliny that they change their colour through fear, adapting it, chameleon like, to that of the place they are in. The eyes are large and smaragdine.'

"Dr Fleming's later description is as follows: '*L. media.*—Body long, fins elliptical, tail pointed. . . . Rare. . . . Body slender, almost transparent, cylindrical; arms with a double row of suckers. Eyes large, blue.' No dimensions are given by either of these writers. The discrepancy in describing the colour of the eyes may be accounted for by assuming that after death the emerald green changes to blue; indeed in the two specimens found by myself I observed that after an hour's interval the eyes had acquired a dark bluish green tint, which is probably more noticeable and of a deeper hue in preserved specimens.

"Compared with the common calamary (*L. vulgaris*), this species has a longer and more strictly cylindrical body, and a more pointed tail, the fins attached to which are elliptical in place of being rhomboidal in shape."

Wednesday, 17th February 1875.—DAVID GRIEVE, Esq., President, in the Chair.

The following gentleman was balloted for and elected a Resident Member: John Goldie, Esq., H.M. Register House.

The following donations were laid on the table, and thanks voted to the donors:

1. Proceedings of the Royal Society, Vol. XXIII., No. 157.—From the Society. 2. Proceedings of the Linnean Society, Vol. XIV., No. 78.—From the Society. 3. Proceedings of the Geologists' Association, Vol. II., No. 1. —From the Association. 4. Transactions of the Manchester Geological Society, Vol. XIII., Parts 6 and 7.—From the Society.

The following communications were read:

I.—*On the Guelph Limestones of North America, and their Organic Remains.* By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E., Professor of Biology in the Durham University College of Physical Science, Newcastle-on-Tyne, Corresponding Member.

In this communication the author described the deposits which form the uppermost portion of the Niagara Formation (Wenlock Series) of North America. The deposits in question are typically developed in western Ontario, where they are known as the "Guelph Formation," from their occurrence in full force near the little town of Guelph. Lithologically, the Guelph Formation consists of magnesian limestones, usually of a buff or yellow colour, sometimes highly crystalline, but very commonly of an exceedingly porous texture, owing partly to the existence of drusy cavities, and partly to the numerous vacant spaces left by the weathering out of organic remains. In the State of Ohio, all the limestones of the Niagara Formation, with the exception of the celebrated "Dayton Stone," are magnesian, and the Guelph limestones are therefore not marked off from the lower beds by any distinctive peculiarity of a lithological nature. The summit of the Niagara Formation in Ohio is, however, formed by a group of dolomites, which can be unhesitatingly identified with the Guelph Formation of Canada, not only by the precise similarity in mineral characters, but also by the identity of organic remains. The Ohio geologists term these beds the

"Cedarville Limestone," or "Pentamerus Limestone." Dolomites of the same age, and containing the same fossils, have also been described as occurring at Leclaire in Iowa, at Port Byron and near Chicago in Illinois, and at Racine in Wisconsin.

The remainder of the paper was occupied with a general account of the organic remains of the Guelph limestones. Fossils are numerous in the beds of this formation, but are poorly preserved, and are for the most part in the form of casts. The most highly characteristic forms are the *Trimerellidæ* and *Pentameri* amongst the *Brachiopoda*, the *Megalomi* amongst the *Lamellibranchiata*, and the numerous species of *Murchisonia*, *Pleurotomaria*, and *Holopea* amongst the *Gasteropoda*. Upon the whole, it may be concluded that the Guelph dolomites constitute a distinct series of deposits, which, however, clearly are to be regarded as merely a subordinate stage in the great Niagara Formation.

II.—*Suspension of Clay in Water.* By WILLIAM DURHAM, Esq., F.R.S.E.

On January 28, 1874, I read a paper on this subject before this Society. This paper was afterwards published in the *Chemical News* of August 7, vol. xxx., No. 767. The following were the results then noted:

(1.) The clay rapidly separated into two portions; the greater part quickly settling down to the bottom of the jars, the lesser part remaining suspended in the liquid considerably longer.

(2.) The power which water possesses of sustaining clay is *gradually destroyed* by the addition of an acid or salt.

(3.) In solutions of sulphuric acid and sodium chloride, of varying strengths, the greater part of the clay sunk to the bottom of the jar, and the liquid became clear *in the order of the specific gravities* of the solution, so that the *densest* liquid *settled* and *cleared last.* This effect was more decided in the acid than in the salt solutions.

(4.) In solutions of sodium carbonate of varying strengths (and most probably in all alkaline solutions) the greater part of the clay sunk to the bottom, and the liquid cleared in the *inverse order of the specific gravities* of the solutions, so that the *densest* liquid *settled* and *cleared first.*

(5.) The power which water possesses of sustaining clay is *gradually increased* by the addition of *small* quantities of the alkalies or their carbonates and lime.

(6.) Water, whose power of sustaining clay had been destroyed by an acid, had this power restored in great measure to it, by the addition of any of the alkalies. The following examples will make the foregoing clear:

	Density.	Time of Clearing. Hours.	Minutes.
Water only,	1000	36	0
,, with two drops Sulphuric Acid,	1000	0	30
,, with Acid,	1024	1	30
,, ,,	1048	2	0
,, ,,	1093	5	0
,, ,,	1440	36	0
,, with 1 gr. Sodium Carbonate,		96	0
,, 5 ,, ,,		112	0
,, 9 ,, ,,		93	0
,, 20 ,, ,,		46	0
,, 30 ,, ,,		22	0
,, 200 ,, ,,		4	0

Curiously enough, about three weeks after I read the foregoing paper, Dr Sterry Hunt, read a paper on the same subject, before the Society of Natural History, Boston, U.S.

His results are much the same as mine, only he did not notice the peculiar action of small quantities of alkalies. He thinks an explanation is to be found in the researches of Guthrie on the formation of drops. Studying the size of drops of water, falling from a small sphere of ivory, he found that the cohesion of the water was diminished when it held saline matter in solution, as was shown by the smaller size of the drops.

I have since made a variety of experiments, to find out if possible the true cause, as Dr Hunt's explanation does not seem to me satisfactory. The probable explanation that I gave in the paper referred to above, was, that the clay in falling through the liquid developed frictional electricity, the quantity and duration of which determined the time the clay was held in suspension. Before proceeding, however, to consider this question, I will mention two or three experiments interesting in themselves.

(1.) *Sea Water.*—I obtained from the end of Leith Pier, a sample of water; its density was 1009, showing it was considerably mixed with the Water of Leith. On shaking it up with clay, in the usual manner, I found it just about the best mixture that could be made to precipitate quickly. It cleared in about two hours. This fact throws considerable light on the silting up of harbours, etc., at the mouths of rivers. Through the kindness of Mr Brown, I got a specimen of strong sea water from Dunbar, and found that it took about twelve hours to clear, but on mixing it with an equal bulk of rain water, it cleared in six hours. I next tried the effect of lime carbonate in place of clay, and found that both rain water and strong sea water cleared in about the same time, viz., two to three hours, and this too although I put four times the weight in, to bring up the opacity of the liquid to the same point.

(2.) In order to test the sensitiveness of the clay to anything held in solution by the water, I took four glass bottles (light green glass), and filled them with rain water. To one I added a few pieces of lead, to another some copper filings, and to a third a few pieces of zinc, while the fourth remained with water only. In that state they remained for a week, when clay was added to each, and shaken up as usual. The result was

Water only took	96	hours	to clear.
,, with copper,	72	,,	,,
,, ,, zinc,	72	,,	,,
,, ,, lead,	42	,,	,,

It appeared to me that the water had acted on the glass in the first case, and extracted a little soda. With the lead the action was evident. With the copper and zinc the action was doubtful; but possibly there might have been a little oxide dissolved by the water; but this experiment shows the sensitiveness of the reaction.

It occurred to me that possibly there might be some connection between these phenomena, and the solubility of the salts, etc. used, so I made several experiments for the purpose of testing this idea. Taking quantities of the salts proportional to their solubilities to see if they cleared in equal times, and equal quantities of salt, to see if they cleared in times bearing any relation to their solubilities; but I could not trace any relation whatever between the two phenomena. As an example, I may mention Barium Nitrate, and Potassium Sulphate, which, at the temperature of the experiment, are equally soluble. With equal quantities of the salts

Barium Nitrate	cleared in	2 hours	45 minutes.
Potassium Sulphate,	,,	16 ,,	,,

I now turned to my original idea of electricity. I cannot say that I have been successful, as yet, in proving this to be the true cause of the phenomena; but will state my experiments on the subject so far as they have gone. Through the kindness of Professor Tait, I have been enabled to make some experiments in his laboratory (in conjunction with his assistant, Mr Scott Lang), on the electric conductivity of saline solutions of various strength.

We used distilled water, which I find much more sensitive than rain water to the action of salts in precipitating the clay. We have as yet only made a few experiments on common salt, and find that the electric resistance (which of course is inversely as the conductivity) diminishes in a very rapid manner with each addition of small quantity of salt. Thus, suppose with the hundredth part of a grain of salt, the resistance is about 30,000 B A Units; with the fiftieth part the resistance will be, say 20,000 B A Units. I am not at present giving strictly accurate results, but only general. This rapid diminution of resistance agrees very well with my experiments of the rapid diminution of the time of clearing with addition of salt. The turning point, however, that is the point when the liquid began to take longer to clear, is very soon reached, although the resistance is still diminishing. This may be accounted for by the increase of specific gravity.

I got from Professor Tait the results of some former experiments by two of his students on the electric resistance of Zinc Sulphate, Copper Sulphate, and Potassium Sulphate.

Unfortunately, the solutions experimented on were too strong for my experiments. I did try, however, if there was any general agreement between the conductivity of the solution and their power of sustaining clay. Potassium Sulphate was the *best* conductor, but it turned out, contrary to my expectation, that it kept the clay up longest. This may be explained by the fact that the action of the Potassium as an alkali to support the clay was scarcely overcome by the Sulphuric Acid. Zinc Sulphate and Copper Sulphate may be supposed a fairer comparison. Copper Sulphate is the better conductor of the two, and I found it also cleared faster and very nearly in the same proportion as its conductive power. In the whole three, the rate of diminution of time of clearing corresponds pretty well with the rate of increase of conductivity.

These experiments, though very general and far from conclusive, still point hopefully in the direction I have indicated for a solution of the problem.

III.—*Note on Fossil Corals from the Conglomerate of Habbie's Howe, Pentland Hills.* By ROBERT ETHERIDGE, Esq., Jun., F.G.S. Communicated by CHARLES W. PEACH, Esq., A.L.S.

At a meeting of the Edinburgh Geological Society during the last session, Mr John Henderson* read a paper on some fossils obtained by Mr D. J. Brown and himself from the conglomerate of Habbie's Howe. They consisted of a few Brachiopoda and some fragmentary specimens of Corals, from the rounded and semiangular limestone boulders and pebbles contained in the upper part of the bed.

The conglomerate unconformably overlies the Silurian rocks of the Pentland hills, and is considered by Professor Geikie to be of Old Red Sandstone age.

The pebbles enclosing the specimens consist of a dark-coloured limestone, with numerous fragments of small encrinite stems. The Corals, with one exception, belong to the *Tabulata*, the exception being a portion of a small *Rugose* Coral, in too fragmentary a condition to be determined with certainty.

* *Transactions*, II., pt. 3, p. 389.

(1.) The first specimen is that of a species of the Silurian genus *Halysites,* with smaller and more circular corallites and intercalicular spaces than either of the two British forms *H. catenularia,* Linn., and *H. escharoides,* Lam. The tabulæ are very regular and apparently more concave than in the foregoing species. So far as we can judge from the number of specimens collected by Messrs Henderson and Brown, this is the commonest but one of the Corals in the conglomerate.

(2.) The next specimen to which I would draw your attention, is a single fragment of a small and fine species, apparently of the genus *Heliolites,* allied to the Silurian species *H. interstincta,* Linn.; but with smaller calices, and a less developed cœnenchyma.

(3.) The third Coral is perhaps the most interesting of all, from the very fine nature of its structure. It occurs as numerous pink or flesh-coloured irregular fragments scattered through the pebbles, and presenting to the naked eye a perfectly dense and homogeneous appearance. When thin sections are prepared, which has been accomplished by my friend, Mr C. W. Peach,* the most minute and beautiful coral structure is perceptible, but which unfortunately will not bear the application of any but a very low power lens. I am under the impression that this is a species of *Alveolites;* but a further set of microscopic sections are necessary before this point can be settled. If it is an *Alveolite,* it is even finer in texture than the very fine Carboniferous species, *A. depressa,* Fleming.

(4.) The fourth and last specimen appears to be the remains of a Coral of the genus *Favosites,* nearly related to the Silurian form, *F. Gothlandica,* Linn. I have not succeeded in detecting the nature of the mural pores, and do not therefore care to speak positively on this point.

I hope to be able, on some future occasion, to return to this subject, and to offer more detailed notes on the Corals of the Habbie's Howe Conglomerate, than can be done from the few specimens at present known. Whence the limestone pebbles and blocks containing the corals were derived, is a

* Mr C. W. Peach was the first to detect the minute coral structure of these specimens.

question still open to discussion. The species appear to be distinct from any yet described from British rocks. I am indebted to the kindness of Mr Brown and Mr Henderson, for the loan of the specimens exhibited.

IV. Mr JOHN GIBSON exhibited specimens of the Colorado or potato beetle (*Doryphora decemlineata*), from Ontario, Canada.

V. Professor DUNS exhibited two heads of roe deer (*Cervus capreolus*), whose horns present striking divergences from the normal form. One of them, killed at Airds, Argyleshire, has the left beam shaped like a highly-developed second year's "pricket," while the right resembles the regular antler of the third year. At the root of the left a second beam or "pricket" has sprung up a little behind the large one; and another, more to the front, rises at the side of the right beam. But these are not mere tynes. They have an independent place on the frontals, and possess well-developed "burrs." The chief "burrs" are unusually large—one of them even partially shading the eye. In the second the horns, instead of rising perpendicularly from the head, are divergent, like those of the fallow deer (*Cervus dama*) and the red deer (*Cervus elaphus*). Some remarks were made by Professor Duns on the physiological explanation of such abnormal forms of horns among the *Cervidæ*. The normal conditions of growth were contrasted with the highly marked variations in the specimens exhibited. The horns of the roe spring at once upward from the frontals. They have no curved forward direction, as in the Airds specimen, and no lateral divergence, as in the other. The fawn is hornless during the first year; in the second, simple stems, or "prickets," appear; in the third, the first tyne is formed extending to the front; the fourth is marked by the growth of another tyne standing to the back. The antlers are not fully developed till the sixth year.

Wednesday, 17th March 1875.—ROBERT SCOT SKIRVING, Esq., President, in the Chair.

The following gentleman was balloted for and elected a Resident Member: Dr Robert Saundby, Saughtonhall.

The following donations were laid on the table, and thanks voted to the donors:

1. Transactions of the Royal Society of Edinburgh, Vol. XXVII., Pt. 11, Session 1873-74. 2. Proceedings of the Royal Society of Edinburgh, Session 1873-74.—From the Society. 3. Proceedings of the Literary and Philosophical Society of Liverpool, Session 1873-74, Vol. XXVIII.—From the Society. 4. Nova Acta Regiæ Societatis Scientiarum Upsaliensis, ser. tertia, Vol. IX., Fasc. 1, 1874.—From the Society. 5. Bulletin Metereologique Mensuel de L'Observatoire de L'Université D'Upsal, Nos. 7-13, Juin—Decembre 1873.—From the University.

The following communications were read:

I.—*Notes on Mimicry and Protective Resemblances among Animals.* By JOHN GIBSON, Esq.

In this communication the author stated that, although the term "mimicry," in so far as it implied a theory, was objectionable; still, premising that its adoption did not commit one to the "conscious volition" implied in the usual acceptation of the term, it was the single word in our language which came nearest to describing the phenomena under consideration.

This subject was first brought into notice by Mr Bates, in a paper read before the Linnean Society, shortly after the publication of Darwin's "Origin of Species." Since that time cases of mimicry have been observed in all quarters of the globe, by such travellers as Bates, Wallace, and Belt; and notices of these are to be found scattered throughout books of travel and scientific journals. These the author had collected, and now brought before the Society arranged in three groups:

(1.) Mimicry of Backgrounds generally.

(2.) Particular Mimicry of the Vegetable Kingdom.

(3.) Particular Mimicry of the Animal Kingdom.

Among instances of the latter, he referred to the following as probable cases of mimicry, but which had not hitherto been noticed as such:

(1.) The cobra (*Naja tripudians*) is the most deadly of

Indian snakes, and being comparatively abundant, its markings and attitudes are well known, yet there is an innocuous colubrine snake—*Tropidonotus macrophthalmus*—found side by side with the cobra, which is frequently mistaken for it. It has the neck dilatable, as in the cobra—a feature almost peculiar to the latter; while the arrangement of the scales is nearly similar in both.

(2.) The *Ophiophagus elaps* is an exceedingly poisonous Indian snake. Major Beddome says the young of *O. elaps* is very like the *Dipsas dendrophila,* an innocent snake—so like that it may very well be mistaken for it. Next to the cobra, the krait (*Bungarus cœruleus*) is the snake that kills most people in India. "The krait," Dr Fayrer says, "may be mistaken for *Lycodon aulicus,* an innocent snake, the colouring and general appearance being in many cases very similar. The least examination of the mouth would detect the difference, but at first sight they are very much alike, and are often mistaken; the lycodon suffering for its resemblance to its poisonous *fac-simile.*" The injury, however, which it suffers in this way must be much more than compensated for in the immunity from the attacks of snake-eating animals which it no doubt shares with its poisonous model.

The author, in conclusion, criticised the theories advanced by Murray, Bates, and A. W. Bennett, to explain the phenomena of mimicry.

II.—*On some Fishes and Reptiles from Old Calabar.* By Professor Duns, D.D.

The specimens on the table, and several others, were sent more than a year ago to the New College Museum, by Dr Robertson, Old Calabar. They were received in a weak solution of carbolic acid, and are in a perfect state of preservation. The colours are fresh and bright. Various shades of green, blue, brown, and yellow, are unaltered from their natural tints. When the specimens were removed from the carbolic acid, they were freely washed, and then put into methylated spirit, sixty-one over proof, in which they have been for two months without any change having taken place in the tints.

Dr Duns pointed out the advantages of using carbolic acid for the preservation of specimens. In its crystallized form it is much more portable than methylated spirit, and not more than about one-fifth of the price. An ounce will saturate two gallons of water at least, rendering it strong enough for this purpose.

Among the fishes were two large specimens of *Calamoichthys Calabaricus*, originally described by the Society's president, Dr J. A. Smith. They are larger, and in a better state of preservation than those characterised by Dr Smith.

Dr Duns exhibited three specimens of the West African electric fish (*Malapterurus Beninensis*) one of the Siluridæ; and pointed out a characteristic mark of age in these forms. The first, which is large and full grown, has lost the black blotches, usually held to belong to this species. The second, which is not mature, is marked by these; and, in addition to them, has a band of dim white passing round the extremity, between the dorsal and caudal fins. The third, a young specimen, has the band of a pure and distinctly marked white, and the black spots not so well marked as in the second.

Two large and beautiful specimens of the new boa (*Calabaria fusca*) were shown to the Society, and described. This form was first characterised by Dr J. E. Gray, in 1858. Having noticed the form of the labial, rostral, and frontal shields, Dr Gray says that the three pairs of frontals are followed by a band-like shield from side to side, that is, between the eyes. He afterwards adds, "I think it is probable, when some other specimens have been examined, that the band-like shield, extending across from the upper edge of each eye, will be found to be composed of three shields, like the band behind it" (Proc. Zool. Soc., 1858, p. 154). He afterwards adds, in a note, that he had found a young specimen of this boa, in which the number and order of the shields were as he had anticipated. In the largest specimen shown to the Society, the shields have most distinctly this form; but this specimen has all the appearance of age about it. It is nearly a foot larger than that originally described by Dr Gray. It is 3 feet 9 inches in length, and 7 inches in girth. In the other specimen, which is manifestly immature, the band consists of two shields—one small, the other twice its length; looking from the back of the head, it is seen reaching across the crown to the margin of the right eye.

Clotho nasicornis was the next specimen noticed. It was stated that this differed so much from those described by Dumeril and Bibron, Shaw, Reinhardt of Copenhagen, Wagler, and Hallowell, that it was thought to be a new species, but Dr Günther had informed Dr Duns that it is the species now named. It corresponds with *Vipera hexacera* of the French erpetologists, *Coluber nasicornis* of Shaw, *Vipera nasicornis* of Reinhardt, *Cerastes nasicornis* of Wagler, and *Echidua Gaboonica* of Hallowell. In all these cases there is considerable difference as regards subordinate marks. That now exhibited differs even more widely from these than they do among themselves. In length it is 1 foot 10 inches; tail 1½ inch. The head is comparatively flat; twice as broad behind as at the muzzle; gape wide; fangs large, recurved; eyes round and prominent. In colour the difference is even more marked. A leaf-like mass of light brown covers the muzzle up to the eyes, where it narrows, passes between them, then gradually widens, till it reaches the hind head. Here it narrows again, by a sharp curve, and terminates in a point about an inch down the neck. A row of black circular dots mark the scales on its edge behind the eyes, and at a little distance from the edge at its widest part; on the hind head an irregular black blotch occurs at each side. From the front of the eyes to the angles of the gape, the edge of the upper lips is dark brown, divided at each side by a narrow band of white passing diagonally from the under part of the eyes to the edge of the lips. A rich dark brown line, like the midrib of a leaf, passes up the centre of the head, from between the prominent nostrils to the termination of the light brown mark on the neck. The dark brown upper labial band is formed of thick quadrangular scales (shields); the light brown covering of the head and part of the neck consists of scales distinctly keeled, convex at the outer edge, and closely imbricated. Those on the under side of the head present a thickened, rounded appearance; colour, dirty white mottled with brown. A deep zigzag white line, commencing at the back of the head, runs down each side, enclosing between them the soft amber brown of the back, on which occur, about half an inch apart, sharply-defined oblong white patches, of different sizes, connected by two narrow lines of the same colour, in the form of a St Andrew's cross. The whole ornamentation of this specimen is exceedingly pretty. This is one of the most deadly of poisonous snakes.

A fine example of *Dendraspis angusticeps* was next referred to; and along with it a rodent, about the size of a small rat (*Rhinomus soricoides*, Proc. Roy. Phys. Soc., 1859, p. 159), which had been taken from its stomach in a perfect state of preservation.

Dr Duns then called the attention of the Society to three specimens of a beautiful species of lizard, not identified, from the same locality, with the view of pointing out the abnormal character of the tail in two of the specimens, which were contrasted with the other, in which the tail is in its normal condition—rounded; white spotted; indistinctly marked by light brown rings, and 6½ inches in length; the whole length of the lizard being 13½ inches. Of the other two, one has had the tail twice broken. The wounds have afterwards healed, and growth to the extent of 3½ inches has taken place. In the second abnormal specimen, the tail has been broken off close to the body, and two sprouts have been put out, which have grown about 2 inches. The one is placed above the other, but distinct from it, forming a bifurcated tail. The forks are rounded, thickest at the base, and gradually tapering to a point, and presenting a perfectly symmetrical appearance.

III.—*Note relative to the Bed of the South Esk River at Newbattle, in connection with Fossils found there.* By DAVID GRIEVE, Esq., F.R.S.E.

The South Esk river, the second of the same name in Scotland (the first being in Forfarshire), rises in the county of Peebles, and runs a sinuous course till it joins its sister river, the North Esk, in the grounds of Dalkeith Palace, whence they unitedly flow to the sea at Musselburgh. After entering the county of Edinburgh its meanderings are very beautiful and romantic, particularly where it passes through the grounds of Arniston, Dalhousie, Newbattle, and Dalkeith. It skirts and intersects the chief coal measures of the county, and its bed—at least in the locality I am about to indicate—is rich in fossiliferous deposits of the Lower Carboniferous formation, and which crop up in many places very near the surface. The portion of the river to which I recently directed my attention, and which has led to this notice, extends only a short way, barely half a mile, viz., between Newbattle and Lothian bridges, and which being within the enclosed grounds of Newbattle Abbey is not accessible, without permission, to the public.

Except where it cuts through walls of red sandstone, the bed of the river is here composed of a micaceous sandstone of various degrees of grain (and which probably alternates with fire-clay), lying horizontally and being generally of a more or less schistose character. In this sandstone the ferns after enumerated are mostly found and *in situ.* Some of the other plants are not so, but are found in carbonaceous rolled masses, rectangular or approaching that shape, and of a few inches in thickness. Many of these have no doubt been carried down from a higher portion of the fluvial bed.

I was led to investigate this part of the river bed from information kindly given to me by Mr Blackie, the intelligent Clerk of Works on the Newbattle Estate, who mentioned to me that some time ago while making a cutting for a mill lade near the bank of the river at Newbattle Bridge, the workmen, at about five or six feet from the surface, came upon quantities of sandstone (barrow loads in fact) covered, or rather, I should say, intermixed, with fine impressions of ferns of various kinds, but which stones had now all got scattered, except one large slab placed in a niche of the screen wall of Newbattle Abbey. An inspection of this slab led me greatly to regret that I had not been present at the scattering of such a splendid find of fossil treasure.

Lord Lothian, on being made aware of the interest I took in geological research, kindly offered me, through Mr Blackie, a piece of the slab mentioned; an offer I should have hesitated to accept in case of injuring the specimen, but on examination I found that the stone could be split with advantage rather than otherwise to the remanent part; and so it happens that this separated portion, with its beautifully preserved foliage, comes to be exhibited to the Society this evening. It would be wrong should I not take this opportunity of thanking the noble Marquis for his kind and considerate gift in the interest of Science.

To return to the bed of the river, the specimens of fossils in the following list have been either gathered by me while exploring it in the very dry weather of last summer, or obtained in the manner above mentioned:

Asterophyllites longifolia; Antholithes Pitcairnii (*Cardiocarpon* of Carruthers); *Calamites nodosus; Calamites* (species not identified); *Cordaites* (Flabellaria) *borrassifolia; Lepidodendron* (Knorria condition); *Lepidodendron* (species not identified); *Neuropteris* (species not identified); *Pecopteris Serlii; P. nervosa; P. marginata; Poacites* (with numerous stems of ferns); *Sigillaria flexuosa; Sphenopteris Hibberti; Sporangia* (spores or seeds in great variety); *Stigmaria; Strobilus* (under which head I place a small fruit or cone with well marked scales).

I may remark that in the specimens of Flabellaria the beautiful fan-like leaves so characteristic of this plant occur in great abundance.

The chief interest in the specimens exhibited, however, centres in the size and beauty of the *Pecopteris Serlii* on the large slab, and which is not very unlike the familiar living fern *Polypodium vulgare.* It is very rarely that this species is found in this country except in a very fragmentary condition. M. Ad. Brogniart, in his description of the species represented in his tableaux, mentions in regard to this one, that it is chiefly found in America, and there only in a similar incomplete condition, rarely with well developed fronds.

The only representative of fossil mollusca I met with in the Esk bed was a very fine specimen of *Lingula squamiformis.*

In conclusion, I beg to express my best acknowledgments to my friends Messrs Peach and Etheridge, for kind assistance rendered to me in the identification of species.

IV. Mr Peach exhibited drawings of twenty-six species of the animals of mollusks, dredged in 1864 by Mr Jeffreys off Shetland. He shortly commented on them, but more fully described *Stilifer Turtoni*, a pair having been got in deep water living amongst the spines of *Echinus neglectus* of Forbes, on which they had deposited about forty clusters of spawn. Large drawings were shown of them and their spawn on the *Echinus* and of the fry. Some of the ova were taken out of one of the masses, from these they escaped and immediately whirled about by the long cilia on the three lobes protruding from the nautiloid shells they were contained in. They were very much like the young of the Nudibranchiæ. Although this interesting shell is far from common, it is pretty generally found in our seas. He also mentioned *Trochus helicinus* for its beauty, the animal having long, slender, flexible, and contractile ciliated tentacles, six appendages on each side all ciliated, its lobed mouth, two pairs of eyes, and minute, pretty formed shell, as making it altogether a beautiful object for the microscope. He added to the interest of the exhibition by introducing two species of *Dentalium* like shells, both new to the British seas, which Mr Jeffreys had dredged off Shetland, viz., *Siphonodentalium Lofotense* and *Cadulus subfusiforme.* Both were previously known in Norway.

V. Mr Thomas Hope exhibited a female specimen of the Iceland gull (*Larus Islandicus*), shot between Leith and Portobello, on March 1, 1875.

Wednesday, 21st April 1875.—David Grieve, Esq., President, in the Chair.

The following donations were laid on the table, and thanks voted to the donors:

1. Proceedings of the Royal Society, No. 159, Vol. XXIII.—From the Society. 2. Annual Report of the Geologists' Association, 1874.—From the Association. 3. Eighth Annual Report of the Perthshire Society of Natural Science.—From the Society. 4. Report of the St Petersburg Botanic Garden (in Russian).—From the Director.

The following Committees were appointed for the summer:

Entomology: Messrs George Logan, W.S., R. Scot-Skirving, Andrew Wilson, J. Gibson, and Dr F. W. Lyon; *Convener:* Mr R. F. Logan. *Marine Zoology:* Dr M'Bain, R.N., Professor Turner, Dr Traquair, the Rev. Professor Duns, D.D., Dr Strethill-Wright, Dr Lyon, and Messrs R. F. Logan, A. Wilson, C. W. Peach, James Anderson, Andrew S. Melville, and Robert Gray; *Convener:* Dr Robert Brown. *Geology:* Dr M'Bain, R.N., Professor Duns, Dr R. Brown, and Messrs David Grieve and Andrew Taylor; *Convener:* Mr C. W. Peach; *Vice-Convener:* Mr D. J. Brown.

The following communications were made:

I. *Notes on the Analysis of Feeding Stuffs, with special reference to an improvement upon the Method in general use for Separation of Indigestible (or Woody) Fibre.* By John Hunter, Esq., City Analyst's Laboratory.

In these notes which I now lay before the Society, I will first briefly describe the process I use for the estimation of woody or indigestible fibre; after which I will give a few of the reasons which have actuated me in so doing.

The process which, so far as I am aware, has been commonly adopted for this purpose, consists in alternately treating a known quantity of the substance being examined, with sodium or potassium hydrate, and sulphuric acid (with, of course, the requisite washings after each), first in a cold solution, and next in a warm solution, necessitating in all at least twelve different digestions and washings. The obstinacy attending the subsidation of the undissolved matter (subsidation and decantation being of course the means adopted for the removal of the dissolved matter) was so great in most cases as to render it impossible to obtain anything like a correct result within a week. In the analysis of feeding material, one of the most important operations is the determination of the amount of oil present; and it is in the taking advantage of this operation that my improvement consists, *i.e.*, that portion of the substance under examination from which the oil has been removed in its estimation, I at once treat with a hot solution of sodium or potassium hydrate, and then with hot sulphuric acid (with the necessary washings after each), thus obviating entirely the digestion in the cold, which, as will be easily understood with a material containing considerable proportions of oil and albumen, was a tedious operation indeed.

By this process the determination of oil and fibre in a linseed or cotton cake, or any such substance, can be easily accomplished in one day, and, as I have already said, it was wont to occupy at least six; thus a great saving of time is effected, and, what is of still greater value, more trustworthy results are, in my opinion, obtainable.

The following observations are made in the hope that they may be brought under the notice of some of our agriculturists, because there are a few points in regard to feeding stuffs on which many farmers are at present misled. It is not uncommon for some chemists to "slump together" in their reports starch, sugar, woody fibre, etc., which is a very convenient mode indeed; but why not indicate by name merely *all* of the supposed constituents, and then state the 100? Such a system is simply absurd, and ought not to be tolerated. If all the constituents of a feeding cake are in normal proportion, all is well; but if, on the other hand, the woody fibre present be excessive, then, however rich the material may otherwise be, the feeding and fattening ingredients are more than neutralised by the indigestible matter. I might give numerous instances in proof of this statement, but suffice it to say I have known of death resulting to young cattle from their having been fed upon a material such as I have indicated.

I came in contact recently with an agriculturist (a man of considerable intelligence), who, in common with many others, had been taught to believe that in forming an opinion of a feeding stuff from an analysis (such as he until recently was accustomed seeing), the only things of importance to be observed were the percentages of oil and albuminous compounds. Whether it be the getting over the woody-fibre difficulty, or one still less excusable, there is not the least doubt that there are some establishments where analyses have been manufactured wholesale without any apparent regard for accuracy save in the mechanical operation of writing the report. But great as has been the extent to which these conditions have obtained, they have at last received a check, not perhaps so much from any great strides chemical science may have recently made, as, I believe, from the higher education of the rising generation of farmers.

II. Mr Robert Etheridge, Jun., F.G.S., Paleontologist to the Geological Survey of Scotland, exhibited specimens of bitumen from the Bathgate limestone at Galabraes Quarry, near Bathgate, consisting of—(1.) Fragments of white limestone, containing small cavities filled with bitumen; (2.) Specimens of the carboniferous coral (*Lithostrotion basaltiforme*, Con. and Phil.), showing the various cavities of the coral filled with a bituminous substance. The specimens were collected by Mr James Bennie.

III. Mr Peach exhibited bitumen enclosed in shattered masses of rock, from a quarry of old red sandstone, near Thurso East, Caithness, N.B. He remarked that the fissure in the specimen was six inches in length, two and a half in depth, and one inch across, and completely filled with bitumen, which had cemented the shattered pieces together, and looked like dirty pitch. It burns freely, and gives out black smoke, with heavy, unpleasant fish-like smell. He also stated that although bitumen was far from rare in Caithness rocks, he had never before seen it in such abundance as at Thurso East.

IV. Dr Robert Brown, Secretary, concluded the business of the session with some remarks on the scientific aims of the new Arctic Expedition, which is expected to sail from Portsmouth towards the end of May. Its main scientific aims were not merely to discover that point of the globe known as the North Pole—a spot in no way differing from the world of waters or the dreary wastes around, and only remarkable in so far that it is here that the sun's altitude is equal to its declination. What the expedition will endeavour to accomplish is the exploration of part of the nearly $2\frac{1}{2}$ millions of square miles of unknown lands and waters surrounding the Pole, and to add to our knowledge of the animals, plants, geology, and meteorological, magnetical, and other physical phenomena of that unexplored region of the Northern Seas. Some particulars were given regarding the blanks in our knowledge, which the researches of the scientific men attached to the expedition might be expected to fill up. We could not, however, be too careful to moderate our expectations of the greatness of these results; for though everything would be done that skill, courage, and forethought could devise, yet the best arranged plans were checked and controlled by a thousand circumstances which could not be foreseen or provided against in seas so unknown, and where navigation was so much at the beck of the ice-floes. In the Arctic regions the navigator learned, by the schooling of many disappointments, how most truly "On earth there is nothing certain unless that nothing is certain." On the motion of Professor Duns, the meeting recorded its thanks to Dr Brown for his address; and after a few observations by the President on the work of the past session, the Society adjourned to the third Wednesday in November.

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

ONE HUNDRED AND FIFTH SESSION, 1875-76.

Wednesday, 17th November 1875.—Dr JOHN ALEX. SMITH, President, in the Chair.

The following donations to the Library were received, and thanks voted to the donors :

1. Transactions of the Zoological Society of London, Vol. IX., Parts 1, 2, 3, and 4. 2. Proceedings of the Zoological Society of London, 1874, 1875. 3. Revised List of the Animals in the Gardens of the Zoological Society, 1875. —From the Society. 4. Proceedings of the Royal Society of London, Nos. 160, 161, 162, and 163.—From the Society. 5. Journal of the Linnean Society : Botany, Vol. XV., Nos. 77, 80, and 81 ; Zoology, Vol. XII., No. 64.—From the Society. 6. Proceedings of the Philosophical Society of Glasgow, 1874-1875.—From the Society. 7. Transactions of the Manchester Geological Society, Vol. XIII., Parts 9 and 10. 8. Catalogue of the Library of the Society.—From the Society. 9. Memoirs of the Boston Society of Natural History, Nos. 1, 3, 4, and 5. 10. Proceedings of the Boston Society of Natural History, Vol. XV., Parts 1 and 2. 11. Jeffries Wyman Memorial Meeting.—From the Society. 12. Proceedings of the Academy of the Philadelphia Academy of Natural Sciences, Parts 1, 2, and 3. 13. United States Geological and Geographical Survey of Colorado, 1873.—From Professor Hayden. 14. Report of the United States Geological Survey of the Territories, Vol. VI.—From Professor Hayden. 15. Smithsonian Institution Report for 1873.—From the Institution. 16. Verhandlungen der K. K. Zool.-bot. Gesellschaft in Wien Band, XXIV., 1874.—From the Society. 17. Oversigt over det Kongl. Danske Vidensk. Selskab., 1874, No. 2.—From the Academy. 18. Verhand. der Verein für Erdkunde zu Dresden, 1875.—From the Society. 19. Canadian Journal, Vol. XIV., No. 5.—From the Canadian Institute. 20. La Spia Sismica, 1875.—From the Author (Jacopo Mensini). 21. Proceedings of the Geologists' Association, Vol. IV., Nos. 2 and 3.—From the Association. 22. Report of the Visitors to the Royal Observatory, Edinburgh. —From Professor Piazzi Smyth. 23. Sixty-fourth Report of the Swedenborgian Society, 1875.—From the Society. 24. "Since I was a Student," by Charles Scott, Advocate, 1875.—From the Author ; various Natural History Book Catalogues from the Publishers.

I. Dr ROBERT BROWN, in the absence of Mr SCOT-SKIRVING, the retiring President, then gave an address on the Arctic

Explorations of the past summer, explaining by maps and diagrams: (1.) The Course of Proceedings of the "Alert" and "Discovery," up to the last news received from the ships; (2.) The Voyage of H.M.S. "Valorous;" (3.) The Voyage of Captain Allen Young's yacht "Pandora;" (4.) The Voyage of the Swedish Expedition in the "Pröven," under the command of M. Nordenskjöld, to the Yenesei River; (5.) The Cruises of some of the Walrus Hunters in the Spitzbergen and Kara Seas; (6.) The Route of the English Whalers.

On the motion of the President, the thanks of the Meeting were awarded to Dr Brown for his address.

II. Dr J. A. Smith exhibited, in illustration of Dr Brown's address, a number of rocks (sandstone, syenite, basalt, etc.) from the Arctic regions, and minerals (mica slate, with garnets, felspar and quartz crystals, white zeolite, aptatite, Healandite, amber-coloured carbonate of lime, etc.), brought in 1866, from Godhavn, Disco Island, North Greenland, by Dr T. Graham Kerr, now of Ballarat, Australia.

III.—*Ornithological Notes.* By John Alex. Smith, M.D.

(specimens exhibited.)

1. *Pernis apivorus*—Honey Buzzard.—A fine specimen of an old male, shot at Kilberry, Argyleshire, on the 20th September. The proventriculus and stomach contained a number of wasps, not the larvæ, but the perfect insect. This season has been especially a fine one in the West Highlands, fruit abundant, and wasps have indeed been abundant everywhere. In this old bird shows the lighter tints of the head, and especially of the neck (which is light buff), are very distinct. The young birds are darker in colour. Mr J. Keddie informs me he had once an opportunity of examining some young birds almost from the nest, and they were of a nearly uniform dark-brown colour. The bird is one of our well-known, rather rare, occasional summer or autumn visitors.

2. *Buteo lagopus*—Rough-legged Buzzard.—This bird is also one of our occasional autumn or winter visitors, occurring, however, much more frequently than the Honey

Buzzard. This autumn, numerous specimens have been taken in the eastern districts of Scotland. Through the kindness of Mr Sanderson, bird-stuffer, who has also sent the Honey Buzzard, I am able to exhibit a fine specimen of a male bird, shot at Coldingham on the 29th October, the property of Mr Mason; and also an old female, which is always slightly larger than the male, the property of the Earl of Strathmore, shot near Glammis Castle on the 1st November. The male bird is rather lighter in colour than the female, the white at the root of the tail being brighter in plumage than in the female; each of course have the dark-brown abdomen.

Mr Small, bird-stuffer, has kindly sent, at my request, several specimens of the Rough-legged Buzzard—a fine male killed near Largo, on the 27th October; a female got near Selkirk, also on the 27th October; a female taken near Haddington, on the 8th November, the property of Lord Walden, and another, a male also, killed on the 9th November, near Lockerbie. Three specimens of the Rough-legged Buzzard were also taken about the same time, in the Pentland range of hills, and other two were stated to have been seen in the same district, but were not captured.

Mr D. Carfrae has sent a Rough-legged Buzzard, shot about the 29th October, by Mr Cochrane, gamekeeper at Ludgate, near Stow, Edinburghshire. I am sorry to say many of these birds were taken in traps baited with rabbits.

We have thus had a most unusual abundance of this bird this season, due, I believe, to the prevalence of easterly gales at the time of their southerly migration on the Continent, carrying the birds over to our eastern shores.

Mr M. Sanderson sends for comparison, a fine specimen of the *Buteo vulgaris*, the Common Buzzard, killed in the island of Mull, in the middle of October, and Mr M. S. Keddie has, at my request, sent the bones of the sternum of each of these three different Buzzards, which are interesting for comparison, and show the differences between the species.

3. *Falco peregrinus*—Peregrine Falcon.—Mr Small has also sent a very fine specimen of this beautiful bird, a female, recently killed near Inveraray.

4. *Otus brachyotus*—Short-eared Owl.—From a similar cause,

I believe, the prevalence of easterly gales, we have also had an unusual number of captures of the Short-eared Owl.

It is one of our resident birds, but a great addition to its numbers occasionally takes place in autumn, and this year especially so. Mr Small tells me he has had no fewer than fifteen specimens recently sent to him, both males and females, in the month of October and the beginning of November. Two were from North Berwick, one from near Heriot, another from Liberton, one from Humbie, and others from Saughton-mains, near Edinburgh, Lasswade and Stranraer: these are a few of the instances, to show the localities where they were got. Mr Small exhibits one or two specimens. Messrs Sanderson and J. Keddie also send a pair of these owls, a male shot near Musselburgh on the 6th October, and a female near Edinburgh on the 21st October. These birds show well the general lighter colour of the old male, and the darker and more yellow colour of the larger female bird.

Mr D. Carfrae tells me he has also had some four specimens of these Short-eared Owls from this neighbourhood in the end of October and beginning of November.

6. *Podiceps auritus*—The Eared Grebe.—The last birds I have to notice are a pair of the Eared Grebes, sent for inspection by Mr D. Carfrae. They were shot by Mr Taylor, in Donnibristle Bay on the Firth, in the beginning of last December. These birds have been generally considered very rare in this neighbourhood—Mr Macgillivray indeed in his "British Birds," says, he has very seldom met with it in Scotland. I had the pleasure of exhibiting to the Society one got near Cramond some thirteen years ago, and I find our esteemed member, Mr Robert Gray, in his very valuable work on the "Birds of the West of Scotland"—which, however, includes a great deal of important information on the birds of the whole of Scotland—has pointed out that this bird is not so very uncommon a visitant on the shores of East Lothian.

It has been overlooked by collectors, who have not noticed the difference between it and the other small species of Grebe; though it is easily distinguished by its small size, and the upturned character of its bill.

Wednesday, 15th December 1875.—DAVID GRIEVE, Esq., President, in the Chair.

The following gentlemen were balloted for, and elected Office-Bearers of the Society, the names in *Italics* being those of the Office-Bearers elected in room of those who retire this Session:

Presidents.—John Alexander Smith, M.D.; David Grieve, Esq.; *John Falconer King, Esq.*

Council.—A. B. Herbert, Esq.; Ramsay H. Traquair, M.D.; Jas. M'Bain, M.D., R.N.; *Wm. Durham, Esq.; Professor Duns, D.D.; R. Scot-Skirving, Esq.*

Treasurer.—E. W. Dallas, Esq.

Assistant-Secretary.—John Gibson, Esq.

Library Committee.—James M'Bain, M.D.; Thomas Robertson, Esq.; R. F. Logan, Esq.; *Robert Gray, Esq.; F. W. Lyon, M.D.; James Anderson, Esq.*

The following gentlemen were balloted for, and elected Members of the Society:

Resident Members.—Dr Andrew Wilson, Lecturer on Zoology in the School of Arts, and in the Extra-Academical Medical School; and James Pryde, Esq., Lecturer on Mathematics, in the School of Arts. *Corresponding Member.*—John Macdonald, Esq., S.S.C., H.M. Register House.

The following donations were laid on the table, and thanks voted to the donors:

1. Proceedings of the Linnean Society, for Session 1874-75. 2. Presidential Address of the Linnean Society, and Obituary Notices. 3. List of the Linnean Society, 1875. 4. Additions to the Library of the Linnean Society, from 20th June 1874 to 19th June 1875.—From the Society. 5. Transactions of the Royal Scottish Society of Arts, Vol. VIII., Part V., Vol. IX., Parts I. and II.—From the Society. 6. Proceedings of the Literary and Philosophical Society of Liverpool, Session 1874-75, No. XXIX.—From the Society.

The following communications were read:

I.—*The Natural History of Islay.* By R. SCOT-SKIRVING, Esq.

In the commencement of his paper, which was the address he proposed to have delivered at last meeting, as retiring President, could he have been present, Mr Scot-Skirving began by remarking that the first thing that struck a stranger on landing in Islay, in spring or early summer, was its extreme greenness, and that, even more than Ireland, it might merit the appellation of the "Emerald Isle." It was only, he said, after people had travelled in warmer countries that they learned fully to appreciate the charm of the bright, green, fresh turf of the British Isles. Many persons held erroneous ideas as to the nature of the climate of Islay and other members of the Hebridean group, as they attributed the excessive rainfall of some of them to the whole. They thought that as

Glasgow was wetter than Edinburgh, and that unfortunate place Greenock was worse off than Glasgow, things got worse and worse, till they reached a climax in the Hebrides. But the fact was they counted too much on longitude and latitude, and too little on the topographical configuration of the ground, and thus it was that while some portions of Skye, for example, were deluged by a rainfall of no less than 148 inches, another island (Tyree) had only 36 inches of rain. As regarded Islay, the rainfall on an average of eight years was 48½ inches, which was 14 inches less than Greenock. But this gave no idea of the dryness of Islay during midsummer, as in June there was only 1·86 inches of rain, against 2·49 in Edinburgh. October, however, was a bad month in Islay, the equinoctial gales being strong and the rainfall excessive. After giving a general sketch of the geological structure of Islay, which consisted chiefly of gneiss, micaceous schists, trap, and mica-slate, traversed by several very remarkable greenstone dykes, Mr Skirving, in touching on the botany of the island, recommended a large increase of plantation, as the existing trees proved that it was quite possible to grow timber.

Speaking of plants and shrubs, he showed that several of these, both wild and cultivated, attained extraordinary dimensions. As regards the former, the common whin, the honeysuckle, and the blackberry were developed in a manner unknown on the mainland, the whin having burst into brilliant bloom in October, and was only checked by a sharp frost on the 9th November. In the gardens, all evergreens attained stately proportions, especially the rhododendron and the hydrangea—the great blossoms of the latter remaining in full beauty till the frost of 9th November. The fuchsia also was gigantic, one plant being 66 feet in circumference and 18 feet high. This plant was covered with blossom, which quite withstood the November frost. Among ferns, which were numerous, the Royal (*Osmunda regalis*) attracts chief notice.

Taking man as the foremost of the animals, Mr Skirving said he saw no cause to join in the jeremiads that were constantly raised by sentimental persons on account of the depopulation of the Western Highlands. Islay once contained

20,000 inhabitants; it now contains only 8000; while everywhere one sees the traces of tillage where the plough has now given place to the sheep-walk. But if corn could be got cheaper from our own colonies, why should it not be brought from thence? The people, on going to our towns at home, or colonies abroad, at once rise in the social scale. At home, they lived in dark, dismal, ruinous hovels, standing in the midst of lakes of sewage and filth unutterable. They seemed lazy, listless, hopeless, and helpless in their native sties—for he could not call them houses—but transplant them, and teach them to speak a civilised language, and they quickly showed they were every whit as good in sinew and brain as any of their fellow-subjects. Let sentimentalists say what they liked, the Gaelic language was mainly responsible for this state of matters, and its extinction as a spoken tongue was a consummation devoutly to be wished. With all deference to Professor Blackie, and without any reference to the establishment of a Celtic chair, as an aid to philological research, we had here a people speaking nothing but Gaelic, and whom we could not instruct, because we could not speak their language.

As regarded animals in general, there were naturally few species in a small island, and the fox, badger, wild-cat, martin, polecat, hedgehog, mole, and squirrel were all wanting. Neither were there any weasels, which was the more remarkable as the stoat was only too abundant. Most of the other quadrupeds of Britain were present in Islay.

As regarded birds, all the varieties of game were plentiful except the capercailzie and the ptarmigan. It had been said that the pheasant could not really exist in a thoroughly wild state in Scotland, as it required grain in continued winter storms; but in Islay the pheasant throve without grain, and was found on the wildest moors and mosses, living on wild seeds and insects. There had never been grouse disease in Islay, and it was to be remarked that the heather, which forms almost the entire food of the grouse, is also most healthy and vigorous. The birds were very tame and not given to packing; they are also rarely seen in stubble. Mr Skirving ridiculed as absurd the idea that grouse disease had been caused by overstocking. Mr Skirving next noticed as a remarkable fact the absence of several species of birds, though the soil and climate seemed peculiarly adapted for them, which was proved by their congeners, the rest of the families, being abundantly present. Thus, every variety of the thrush was found in extraordinary numbers, with the single exception of the ring ouzel (*Turdus torquatus*), which was totally absent. The common sparrow and green linnet were also scarce. The merlin and kestrel occur, the former being somewhat plentiful, and the latter scarce. The hen-harrier, a rare hawk on the mainland, came in considerable numbers to Islay in August as a migrant—the males appearing in August, and the females in September. Mr Skirving believed that the hen-harrier, like most hawks, preferred small birds, rats, and mice, to game; he had seen it hunt over stubbles that were dotted with black-game, pheasants, and partridges, and take not the slightest notice of any of them. Among other Islay birds which occasionally occur were the snowy owl (*Surnia nyctea*), osprey (*Pandion haliæetus*), and the bittern (*Botaurus stellaris*). The sparrow-hawk is resident. The chough is still found in some numbers, though subjected to much persecution on account of an increasing demand for the skins by dealers in natural history specimens. The rook is also a common permanent resident. The hooded crow is migratory. The house swallow is common. The land-rail is very common. White-fronted geese, bernicle and brent geese, are abundant; of wild swans 7 to 70 having been seen in separate flocks during the present winter; teal ducks (resident and breeding), etc., are also to be classed in the Islay avi-fauna. Mr Robert Gray, to whom the author acknowledged his obligations for notes on the birds not observed by him, also remarked that eagles were still occasionally seen in Islay, and that among other interesting birds the Greenland falcon has occurred in the island.

Professor BLACKIE made some remarks, in which he vigorously defended the Highlanders from the strictures of Mr Scot-Skirving, attributing their present condition chiefly to—(1.) The geographical remoteness of the Gaelic-speaking countries; (2.) The badness of their climate; and (3.) The want of social and economic wisdom in the upper and middle classes, the former owners of the soil, and their immediate dependants; and not to the Gaelic language, the possession of the latter tongue in addition to English being, in his opinion, to the advantage rather than otherwise of the people.

The thanks of the Society were, on the motion of Professor Duns, awarded to Mr Scot-Skirving for his able and suggestive address, and for his services during the term he had occupied the office of President.

II.—*Note on the Nesting of the Tufted Duck* (Fuligula cristata) *in Scotland.* By A. B. Herbert, Esq.

(specimen exhibited.)

On the 29th May last a duck's nest was discovered by some Members of this Society on a rocky island in an inland lake in Fifeshire. It contained ten eggs, and the duck was seen rising from the nest as the party approached the island. The eggs and nest, the latter composed of coarse grass, were brought to me the same evening, and I immediately placed them under a hen. From the fact of the nest containing very little down, and the eggs being of a dirty cream colour, I at once concluded that the nest was not that of a common wild duck (*Anas boschas*). The young birds were hatched in exactly twenty-one days, and were almost black. Every care was taken of the brood, but the weather at the time being cold and wet, five of the ducklings died very soon. The remaining five lived, and were strong and healthy. They were fed chiefly upon greaves and soaked bread, which, however, they would only take when thrown into the water. In about three weeks they were able to devour worms which I occasionally gave them; they then became exceedingly tame, came to my call, and followed me about the garden when they saw me with a spade. Their progress was watched with much interest by Dr M'Bain and myself; and as they acquired their plumage we were soon able to identify them as Tufted Ducks.

Of the five reared, two were drakes and three were ducks; one of the five died when about three months old, and the others gradually acquired the use of their wings, and would fly after me along the garden when called, until one stormy day two of them rose in the air and were, I believe, carried out to sea, as I saw them no more. Another, a drake, afterwards wandered away and was lost; and the only remaining one, a female, I now exhibit alive to the Society. I much regret the loss of the drake, as I hoped to have had them to breed in confinement, and I have a strong impression that they might be perfectly domesticated. I am now endeavouring to procure from the London dealers a live drake, if possible. Some years ago I reared wild ducks from eggs, and the third generation were as tame as ordinary ducks; they would occasionally take a long flight, but always retained the *animus revertendi* and well knew their home.

Bewick, in speaking of the Tufted Duck, states that the female has no crest, and that the flesh is excellent as an article of food. Yarrell, on the contrary, states, that he has seen an old female having some elongation of the occipital feathers, but from the specimen before us, you see that Yarrell is right, as the tuft is quite apparent, though not much developed.

Yarrell also remarks that they have bred in the Zoological Gardens, London. Our late member, Dr Saxby, says, that in Shetland they are never common, and so shy that they are seldom shot; while Thompson speaks of them in Ireland as only known as winter visitants.

I may mention that in the *Ibis* for October last, Mr A. B. Brooke has recorded the occurrence of two fine broods—eight birds in each—in Butterston Loch, Perthshire, in July 1875, so that in addition to the instance given by Yarrell (B. B., 3d ed., vol. iii., p. 354), the present is the third authentic record of the Tufted Duck having bred in this country.

Wednesday, 19th January 1876.—JOHN FALCONER KING, Esq., President, in the Chair.

The following gentlemen were balloted for, and duly elected:

Librarian.—The Rev. James Kennedy, M.A., B.D., 17 Melville Terrace; *Resident Member.*—W. P. Bruce, Esq., 18 Athole Crescent; *Non-Resident Member.*—John A. Harvie-Brown, Esq., Dunipace House, Falkirk.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Transactions of the Berwickshire Naturalists' Club, 1874.—From the Club. 2. Proceedings of the Natural History Society of Glasgow, Vol. II., Part I., 1875.—From the Society. 3. Proceedings of the Philosophical Society of Glasgow, 1875, pp. 1-24. 4. "Trude" of the Botanical Garden of St Petersburg, December 1875.—From the Director. 5. Nova Acta Regiæ Societatis Scientiarum Upsaliensis Ser. tert., Vol. IX., Fas. II., 1875. 6. Bulletin Meteorologique Mensuel de l'Observatoire de l'Université de Upsal, Vol. VI., Année 1874.—From the Academy. 7. Oversigt over det Kongelige Danske Vidensk. Selskabs Forhandlinger, 1875, Nos. I. and III.—From the Academy. 8. Videnskabelige Meddelelser fra Naturhistoriske Forening i Kjöbenhavn for Aaret, 1874.—From the Society. 9. XII. Jahresbericht des Vereins für Erdkunde zu Dresden, 1875.—From the Society. 10. Report of the Medical and Surgical Registrars of the Middlesex Hospital, 1874.—From the Council of the Hospital. 11. Proceedings of the Royal Society, Vol. XXIV., No. 164.—From the Society. 12. Proceedings of the Geologists' Association, Vol. IV., Nos. 4 and 5.—From the Association. 13. Canadian Journal, Dec., 1875.—From the Canadian Institute.

The following communications were read:

I.—*Note on Spontaneous Combustion.* By J. FALCONER KING, Esq., City Analyst, Lecturer on Chemistry in the Extra-Academical Medical School.

The first case of what is generally known as spontaneous combustion to which my attention was called (in the course of last summer) was one in which an immense heap—of many thousand tons—of a waste material from an ironstone pit had caught fire, and at the time of my investigation—now some months ago—was burning fiercely, and is, I believe, still in an active state of combustion, all attempts to extinguish the fire having proved fruitless. This mineral had been allowed to accumulate for some years, and for a considerable period it evinced no sign of any change taking place till one day (somewhere about two years ago) smoke was seen to issue from near the centre of the mass. From that time the fire made great progress, all efforts, as I have said, to extinguish it having proved ineffectual. The interesting feature in this instance of spontaneous combustion is the uninflammable nature of this mineral. I put a piece of it in the midst of a strong furnace in full blast, and yet it would hardly inflame. Following up my investigations, I made an analysis of the mineral, which showed that it contained a considerable proportion of iron sulphide, with some carbonaceous matter, which substances becoming oxidised by the influence of air and moisture, had produced heat sufficient to inflame the mass. I produce a small portion of the mineral which has been subjected to the heat of the furnace, from the appearance of which you may form an estimate of the amount of heat which would be necessary to set the mineral on fire.

The second instance occurred in a railway waggon, and the material which inflamed was woollen yarn. I am aware that cotton waste, etc., has been known to catch fire, and in fact is an easily ignitible substance, but this woollen yarn is by no means of this nature. I put a piece of red-hot iron into a bundle of it, and this caused a slight singeing, but nothing more; and even when the yarn was set on fire by being held in the centre of a flame, it did not, as a rule, continue to burn—all signs of burning disappearing shortly after the source of heat was removed, and yet there is no doubt this material ignited spontaneously. When I first saw it, it was lying in a railway truck deluged with water. It had ignited some hours previous to my visit, and in order to extinguish the fire the contents of the truck had been subjected to a flood of water obtained from the hydrants used for replenishing the water cisterns of the locomotives. After carefully inspecting the half-burned bales, I ordered them to be covered up again until I got an analytical examination of the yarn made. In the course of the next day or two, although deluged with water, it again threatened to ignite. The chemical examination of this material revealed the presence of a small proportion of fatty matter, which, by becoming oxidised, had produced, I have little doubt, the heat—great as it must have been—which caused the conflagration.

I hope again to renew my experiments on this subject, the result of which will be communicated to the Society. Especially I intend to turn my attention to the investigation of the liability of different kinds of oil to ignite spontaneously, and also to the behaviour of the same oil under different circumstances. Insurance companies, I believe, at present make a different charge for insuring premises in which one kind of oil is used from that which they make in the case of certain others, this difference in rate being regulated, I understand, by the supposed greater facility with which certain kinds of oil will ignite spontaneously. Whether these peculiar rates are merely arbitrary, or are founded on some proper basis, I am not aware; but it appears to me—if my information as to their charges is correct—that they are at present rating exactly in an opposite way from what they should do. Until my investigations are further advanced, I cannot, however, speak with confidence on this subject.

II.—*On the Motion of the Sea, arising from the rotation of the Earth on its axis, and the difference of the force of gravity, on particles of equal magnitude, at the surface and at the bottom of the Sea.* By JAMES PRYDE, Esq., Lecturer on Mathematics in the Watt Institution and School of Arts.

Mr Pryde stated, that on reading the various theories which endeavour to account for these motions, he had been led to ask the following questions: Is there any reason to suppose that the under-currents of water which are known to flow at the bottom of the sea towards the equator, and the surface currents such as the Gulf Stream, which flow from the equator to the poles, have anything to do with the rotation of the earth on its axis, combined with the difference of the force of gravity at the surface and bottom of the sea, caused by the mass of the earth being much greater than a globe of water of equal bulk, and the additional density of water at great depths caused by its compressibility?

After performing many calculations founded on known physical laws, tabulating the results, and applying these to the subject of inquiry, he became satisfied that these motions of the sea are as necessary consequences of the physical constitution of the earth as the tides or any other physical phenomenon; and was thus led to investigate the three following physical problems: *First,* What is the density of the remaining globe, after a shell of water of given thickness is taken away? *Second,* What is the force of gravity at the surface of this remaining sphere? *Third,* What is the force tending to the equator at the surfaces of each of these remaining spheres? Having obtained these results, he showed that their necessary consequence was a continuous flow of the waters at the bottom of the sea towards the equator, and of those at the surface to the poles.

To find the density of the remaining globe after a shell of water of given thickness is taken away, he assumed the following as established facts, the specific gravity of water is 1, and that of the whole earth including the water on its surface is 5·67. Then assuming $r =$ the mean radius of the earth and $x =$ the thickness of the shell, r and x being both expressed in fathoms, or both in miles, he deduced the following formula:

$$\text{Density of remainder} = \frac{r^3 \times \frac{4}{3}\pi \times 5{\cdot}67 - \left\{r^3 - (r-x)^3\right\}\frac{4}{3}\pi \times 1}{(r-x)^3 \times \frac{4}{3}\pi}$$

$$= \frac{r^3 \times 4{\cdot}67 + (r-x)^3}{(r-x)^3}$$

$$\therefore d_x = \left(\frac{r}{r-x}\right)^3 \times 4{\cdot}67 + 1 \quad (A)$$

The results from this formula give for $x = 2000$ fathoms $d_x = 5{\cdot}678056$, for $x = 4000$ fathoms $d_x = 5{\cdot}686134$, and for $x = 7000$ fathoms $d_x = 5{\cdot}698283$; thus showing that at 7000 fathoms the density has increased by a 200th part of itself.

He next showed that if g_x represent the force of gravity at x fathoms or miles below the surface, its force can be calculated from the formula:

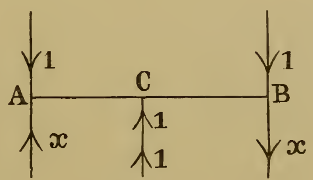
$$g_x = \frac{g}{rd}(r-x)\, d_x = {\cdot}000001631214\,(r-x)\, d_x \text{ for } r \text{ and } x \text{ in}$$

fathoms. The results of this formula, for $x = 2000$ fathoms gives $g_x = 32{\cdot}22723$, for $x = 4000$ gives $g_x = 32{\cdot}25451$, and for $x = 7000$ fathoms gives $g_x = 32{\cdot}29554$—which shows that at the depth of 7000 fathoms the force of gravity has increased by one 337th part of itself.

In order to find the pressure at the surface of each of the remaining spheres, from the poles towards the equator, he proved that we must use the formula:

$\frac{\pi^2 \ r \ sin \ 2l}{2(43082)^2} \times \frac{g_x}{g}(1 \cdot 000793)^f =$ the force sought where r must be = the feet in the radius of the sphere, l = the latitude of the place, and f = the hundreds of fathoms in the depth of the sea. From this formula he deduced that at the depth of 2000 fathoms the force = ·0564412 *sin* $2l$ at 4000 fathoms the force = ·0573588 *sin* $2l$, and at 7000 fathoms the force = ·0587636 *sin* $2l$, while at the surface of the earth it = ·0555381 *sin* $2l$. This shows that at a depth of 7000 fathoms the force had increased by about a 17th part of itself.

Having thus proved that the pressures towards the equator were greater at the bottom of the sea than at the surface, and the greater the depth the pressure increased the more rapidly, he supposed a column of water reaching from the surface to the bottom of the sea, and represented it by the line A B, where



A is the surface and B the bottom of the sea; he supposed forces applied at A and B each equal to the force acting at C, the middle of the column; then since the force at A would be too great, and that at B too small, he applied a force x in the opposite direction, at A, to reduce it to the true force; and also a force x at B in the same direction to increase it to the true force acting there; then applying two forces at C, each equal to the former forces, he found that the four forces marked 1 were in equilibrium, and might therefore be removed, and there only remained the two forces marked x acting in opposite directions, forming a couple, which must therefore cause the point B to approach towards the equator, and the point A to approach towards the pole; thus proving the necessity for the water at the bottom of the sea to move towards the equator, and that at the surface towards the pole. He also illustrated the subject by supposing pipes of equal bore lying along the bottom and surface of the sea, and joined by vertical pipes at the poles and the equator, and showed that the forces formerly proved would cause the water to descend at the pole and ascend at the equator, and thus, with the motion formerly proved, would constitute a continuous circular motion.

He then calculated the amount of velocity the water would acquire towards the equator at a depth of 4000 fathoms, acting without interruption from 46° to 44° of latitude, and found it would acquire a velocity of 15 miles per hour at the bottom, or $7\frac{1}{2}$ miles per hour of the lower half of the water; then allowing all the forces at other parts to be destroyed by resistances, he concluded that the two forces from opposite poles would produce a westward motion of the waters along the equator of about 84 miles a day, two-thirds of which would be driven into the Gulf of Mexico, from which they could only escape by the Straits of Florida, from which they rush out, forming the origin of the Gulf Stream. This stream would then proceed towards the north by virtue of its original *inertia*, and the force x acting upon it, and towards the east by means of the decreasing distance between the meridians, and would thus ultimately have a north-easterly direction, which causes it to pass along the west coast of Northern Europe.

He then ventured to predict that should the North Polar Expedition ever reach the pole, they will find it land, a mass of ice, or a whirlpool. Mr Pryde concluded by saying: "I have purposely avoided any direct attack on any of the theories formerly advanced. I have simply endeavoured to establish my own position by applying well-known physical and mathematical principles to an important problem which has been until now overlooked by physicists; and should it be the means of settling this much-vexed question, I shall consider myself richly rewarded for my labour."

Wednesday, 16th February 1876.—Dr John Alexander Smith, President, in the Chair.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Transactions and Proceedings of the Botanical Society, Vol. XII., Part II. 2. Proceedings of the Geologists' Association (London), Vol. IV., No. 4 (October 1875). 3. Transactions of the Manchester Geological Society, Session 1875-76, Vol. XIV., Part I. 4. Proceedings of the Royal Society, Vol. XXIV., No. 165. 5. Proceedings of the Philosophical Society of Glasgow, Sheet C (pp. 25-52 inclusive). 6. The Medical Examiner, Vol. I., Nos. 3, 4, 5, 6.

The following communications were read:

I.—*Notes of a Journey to, and Ornithological Observations on the Lower Petschora, Siberia in Europe, in* 1875. By John A. Harvie-Brown, Esq. (with exhibition of specimens).

The author and his friend, Mr Seebohm, of Sheffield, left London on the 2d March, and reached Archangel on the 15th of the month. They remained at Archangel until 6th April, and travelled by sledge to Ust Zylma, which they reached on the 15th of the same month. At Ust Zylma they remained until the ice broke up, and the river was clear, and left it on the 10th June. They arrived at Alexievka on the 19th June, having accomplished a journey from Archangel of 1400 versts in all, roughly speaking, or about 950 miles.

From the time they arrived on the banks of the Petschora up to the 19th June, they had identified just 100 species of birds, and between that date and the time of their departure for England on the 2d August, they added 16 more to their list—a very limited fauna, but one rich in interest, as will be seen from the following notes on the more remarkable forms:

"1. (in point of rarity), *Anthus Seebohmi* of Dresser, sp. nov. ('Birds of Europe,' part xlv., just published; *Ibis*, January 1876, also just published).—Of this bird we obtained only five specimens, and several nests of eggs. These five type specimens are distributed as follows: Professor A. Newton, of Cambridge, 1; Mr Howard Saunders, 1; Mr H. E.

Dresser, 1; Mr Seebohm, 1; and the fifth in my own collection, and which I have brought to-night for exhibition.

"2. *Phylloscopus neglectus* of Hume (*Ibis,* 1870, p. 143).—First described from India. Of this species we only obtained one specimen, the only record of its occurrence in Europe (*vide Ibis,* April number, 1876; MS. sent in to press).

"3. *Phylloscopus tristis* of Blythe.—Added by us to the European fauna. Not uncommon on the banks of the Petschora in summer. One set of eggs obtained for the first time on record. Hitherto only recorded as a winter visitant to India. Said to breed in Ladak, but no authority quoted (Brooks, *Ibis,* 1872, p. 31).

"4. *Phylloscopus eversmanni* (Bon.).—One specimen only obtained. A rare northern warbler; the eggs not yet known to naturalists. Also procured on the banks of the river Dvina in 1872, by Mr Alston and myself (*Ibis,* 1873, p. 61).

"5. *Budytes citreolus* (Pall.).—Not supposed to breed further north than 56½° N. lat., nor had the eggs been taken in Europe prior to our trip, when we found it abundant in 68½° N. lat., and obtained a series of their eggs. Bird figured and described in Dresser's 'Birds of Europe,' part xxxviii.; and in an Appendix in No. 45, Mr Dresser gives the results of our notes on the habits. Interesting notes on migration of this species may be found in a Russian work, entitled 'Descriptive Catalogues of the High School of the Imperial University of Kasan,' vol. i., part i., chaps. ii., iii., iv.—for full title, etc., *vide Ibis,* January 1876, where a short account of the birds' habits, etc., appears in a general paper 'On the Ornithology of the Lower Petchora,' by Seebohm and myself.

"6. *Parus kamschatkensis* (Midd.).—This is the eastern climatal form of the northern race (*Parus borealis*) of our British Marsh Tit (*Parus palustris*). Not hitherto recorded from Europe (*vide* 'Birds of Europe,' part xlvi., at present going to press, and *Ibis,* April number, 1876).

"7. *Parus cinctus.*—A variety, intermediate in size and coloration between type, *P. cinctus* from Lapland, and the eastern large pale race, *P. grisescens* of Dresser (*vide* 'Birds of

Europe,' temporary volume, 1871-72; *Ibis*, April number, 1876).

"8. *Saxicola rubicola.*—The white-rumped eastern form of our Stonechat—not before recorded (?) from Europe. The Stonechat obtained at Archangel is similar to ours.

"9. *Squatarola helvetica.*—The first authentic eggs brought to this country, with the exception of a few collected by Herr A. von Middendorff, on the Boganida and Taimyr Rivers in Siberia (*vide* 'Birds of Europe,' temp. vol. i., 1871-72). Our account and plates of eggs will appear in *Ibis*, for April 1876.

"10. *Tringa minuta.*—Also the first authentic eggs brought to this country, or existing in collections, except those obtained by Herr A. von Middendorff at the above-mentioned localities. Our account and plates of eggs will appear in the *Ibis*, July 1876. Dresser will probably figure the young in down, which we also brought home for the first time (*vide* also 'Birds of Europe,' temp. vol. i., 1871-72). Said to breed in Novaja Zemlia (Von Heuglin, *Ibis*, p. 63).

"11. *Calidris arenaria.*—Shot several in breeding plumage or beginning to change for the autumn moult. Had we not been unfortunately pressed for time, we believe we might also have procured the rare eggs, or at all events, discovered the breeding haunts. Professor Newton describes the only eggs which have reached this country (P.Z.S., 1871, p. 56 and pp. 546, 547: described, 'Zweite deutsche Nordpolanfahrt,' ii., pp. 240-242).

"12. *Tringa subarquata.*—We also obtained this species in full summer plumage. The same remarks apply to this as to the last, but the present species appeared to be scarcer.

"13. *Cygnus bewickii.*—Birds and eggs obtained by us, the latter the first authentic specimens on record (*vide Ibis*, October number, 1876, where a full account will appear).

"14. *Mergus albellus.*—Eggs and down from the nest procured. Extremely rare in collections. Nesting haunts in Finland, first discovered by the late Mr John Wolley, in 1858 (*Ibis*, 1859, p. 69).

"15. A gull differing from *Larus leucophæus*, the Mediterranean Herring Gull, in having the first primary *only* with a white spot, and in the coloration of the soft parts. This is constant in all the examples we obtained. We also procured the eggs. Before naming this species, if species it be, it will be necessary to compare a larger series of specimens than we at present possess."

II.—*Partridges* (Francolinus) *in South Africa: Notes on that Game in the Winterberg District.* By W. T. Black, Esq., Surgeon-Major.

Many sportsmen estimate the pursuit of this kind of small game as a much more agreeable pastime than hunting the larger quadrupedal animals, and it approaches nearly in character what grouse shooting is on Scottish and English moors and mountains.

The Cape Partridge is different from the English one, and is called a *Francolin,* of which there are two species known to sport, the *Francolinus Afer,* or *Greywing Partridge,* and *F. Levaillantii,* or *Redwing Partridge,* and the genus is distinguished by the birds having longer and stouter beaks and more developed tail than the others have, and generally by the stout *spurs* or *tubercles* on their legs.

They may be found over most parts of South Africa, frequenting the grassy undulating, or scrubby plains, and mountain summits, and intervening valleys, and dells, the Redwing Partridge preferring the more sheltered and grassy localities, and the Greywing the more bleak and rugged country.

The pursuit of the *Partridge shooting* is carried out most pleasantly by a small party, moving about the open country with waggon, and tents, and servants, and being mounted on good shooting ponies, with a brace and half of dogs, etc. A great extent of the wilderness has to be traversed, so that walking is out of the question, till the covies are found, when the sportsman jumps off his horse, leaves him to graze, and follows the dogs on the scent of the game. As may be imagined, there can be no better shooting, and the quantity bagged can never be colossal, but the enjoyment is greater in proportion as the sportsmen revel in mountain breezes, and magnificent scenery.

The *Redwing Partridge* is larger and heavier than the Greywing, more handsomely ornamented in plumage, and has white flesh, but the *latter* is the more gamy, though less showy bird, and has dark flesh, and is most delicious eating. *Anatomically* the chief difference between the two varieties consists in the *testis* of the Greywing being much larger than in the Redwing, which may be coincident with greater numbers, and more gregarious habits; and the inferior *larynx* is present in both to answer for their vigorous screaming.

Domestication.—The *Redwing Partridge* is strongly recommended as a suitable bird for conversion into farm poultry, as its habits seem to point it out for use by man for domestication.

The *Greywing bird*, on the other hand, from its more migratory habits, wilder and unsettled disposition, would be much less suitable for this purpose.

The Redwing birds would look well in a paddock or farmsteading, as they are handsome and plump in appearance, and erect in bearing, and would make as substantial a repast as any of the best bred poultry in this country both as to quality and quantity.

The *Winterberg District* is generally considered the best shooting ground for partridge in the eastern provinces of the Cape of Good Hope, and is much frequented by the old sportsmen of the frontier, who make up expeditions there for the winter season during May, June, and July. The writer had frequent opportunities of accompanying parties of officers from the border posts on these trips, when serving in South Africa, and kept a journal of their proceedings, from which the present account is extracted.

Retief Valley.—The first excursion detailed is one up this valley, lying between the Little Winterberg on the west, and the Didima Mountain on the east, and comprised an undulating grassy country with numerous rills trickling down to join the main stream, a spruit of the Koonap River.

Several covies of *Redwing Partridge* frequented this piece of country, some of which were duly hunted, with more or less success, on different trips, which were here easier, owing to the place being accessible and sheltered.

Boucher's Kloof.—This excursion went up to the valley lying between the Middle Winterberg and the Reed Flats, which was quite of Alpine appearance, with heights rising on each side to two thousand feet and more, and then it ascended into *Redman's Flats*, on the plateau above.

This was a grassy undulating piece of country, with many fine little dells and rills of water in it, and was well stocked with *Redwing Partridge*, whose covies afforded capital sport on more than one occasion.

Duval's Kloof.—This trip was made into a still wilder part of the district, and it lay at the east end of Smith's Valley, through which runs a spruit of the Koonap River, and which is bounded on the south by the Kabergen, and on the north by the Reed Flats mountains.

Finally, the summit of the Kabergen chain was reached after a heavy ascent of 2500 feet, and a rugged plateau appeared to view, diversified by scrubby bush, grass, and stony peaks and koppies.

Here some good covies of *Greywing Partridge* were found, which, however, were with difficulty hunted or bagged, owing to the natural fastnesses they had selected, which stood them in as good stead as the Alps were to the Swiss mountaineers.

Shooting Seasons.—As the seasons are reversed in the southern hemisphere to what they are in Britain, so is the shooting season altered to the winter months of April, May, and June, when the birds are full grown and strong in covey. The *Breeding Season* commences in August, when the birds begin to pair off and scatter, and the shooting to completely terminate everywhere; but the *game licence*, of value 7s. 6d., only sanctions shooting from December 1 to June 30 of the following year.

III.—*Bird-life in the City of Edinburgh and its Vicinity during the Frosts of December and January* 1874-75. By ROBERT GRAY, Esq., F.R.S.E.

The author of this paper stated that he had been accustomed for a long series of years to make almost daily observations on bird-life, and that since coming to reside in Edinburgh he had been much interested in the movements of many of the birds he had found living within and without its boundaries. Some of the species, indeed, had revealed facts of more than usual interest in the investigation of what might be called "Suburban Ornithology."

It was stated that during the month of December 1874 the thermometer in the neighbourhood of Inverleith Row was on twenty-seven mornings at or below the freezing point, and indicating collectively 277 degrees—the lowest markings extending from the 15th till the close of the month. Throughout the interval the intense frost had pressed heavily on bird-life in general, but particularly on thrushes of various species, and other soft-billed birds, hundreds of which had succumbed to the severity of the season. Among the birds which had been driven from their usual haunts into the centre of the city, the snipe, kingfisher, and blackheaded gull were the most noteworthy. They were found frequenting drains, to which they had been doubtless attracted by the moisture caused by heated water. Flocks of larks, pipits, redwings, and fieldfares had been seen in the public streets and squares, perching disconsolately on trees and shrubs, or cowering on the roadway; and numbers of blackheaded gulls had for two days been observed crowding together and feeding on the surface of refuse heaps near the Railway Station. The writer of the paper also stated that at his own residence in Inverleith Row he had caused a space in the snow to be cleared and quantities of food to be laid down for the starving birds. The experiment had resulted in an odd assemblage of species—as many as seventy-four birds having been counted at one time struggling together for a mouthful—starlings, magpies (three in number), rooks, thrushes, redbreasts, blue tits, hedge sparrows, blackbirds, missel thrushes, fieldfares, and sea gulls being of the number.

Early in January a rapid thaw set in, accompanied by heavy blasts of rain, and this had brought utter ruin to many of the feathered visitants who fell prostrate under the blustering power of the storm, and it had then been noticed that the poor creatures whose movements had afforded so much interest during the previous week were unfit for flight. Many, in consequence, perished at a time when it had been supposed their hardships were over.

In the outskirts of the city certain birds were notably abundant—golden plovers, bramblings, and snow buntings. Along shore mixed flocks of the two last named species, accompanied by starlings, redwings, and fieldfares, had dropped into the sea through exhaustion and become the prey of hooded crows, numbers of which were hovering in the vicinity on the look-out for the perishing birds. In several instances blackbirds and thrushes had been found perched on palings in the stiffness of death, and coots and other water birds frozen in corners of ponds which had suddenly closed up when the frost was at its greatest intensity. Similar occurrences had been recorded in the winter of 1860-61, which was one of unusual severity.

IV.—(1.) *Hybrid between Golden* (Phasianus pictus, *Lin.*) *and Common Pheasant* (Phasianus colchicus); (2.) *Goosander* (Mergus merganser); (3.) *Bohemian Waxwing* (Bombycilla garrula). By JOHN ALEX. SMITH, M.D., etc.

(SPECIMENS EXHIBITED.)

1. *Hybrid Pheasant.*—This bird shared some of the characters of both its parents. It has the bill dark brown and large, the large crest light reddish brown, and the tippet of the golden pheasant, but of a reddish brown colour; the front of neck showed the greenish iridescent feathers of the common pheasant; body nearly uniform deep salmon colour; belly darker red; wing coverts dark reddish brown; tail large and very long, like golden pheasant, middle feathers uniform light brown or fawn colour, some of the outer feathers mottled with dark brown, the pointed coverts dark reddish brown; spurs small, but sharp. The bird was shot by mistake in December last by Captain Kinloch, younger of Gilmerton, at Gilmerton, Haddingtonshire. It had been seen on the estate for about four seasons. About five years ago several golden pheasant cocks had escaped or been let loose in the preserves, but this was the only hybrid that had been noticed. Dr Smith was indebted to Mr John Dickson, jun., our well-known gunmaker, for being able to exhibit this very curious bird. Mr J. Keddie, bird-stuffer, informed Dr Smith

that in 1845 he had seen three hybrid pheasants of this kind, two males and one female, which were hatched at Cambo House, Fife, under a common hen, the parent birds being, as in this instance, the golden pheasant cock and common pheasant hen; and two of these birds were unfortunately destroyed when young, and the third was killed by accident when eighteen months old. It was a male; the colour of the pretty large crest was a buff yellow; the breast a light brown; wings dark brown; upper tail coverts buff; tail large, blotched with buff and brown. The golden pheasant is believed to be three years old before it acquires the mature plumage. This hybrid, therefore, showed the plumage of the immature bird.

2. *Goosander.*—Dr Smith exhibited a fine male specimen shot near Biggar on the 10th of February. It was remarkable as showing the commencement of the summer or breeding plumage in the pure white colour of the top of the breast. Mr Small, bird-stuffer, from whom he got the specimen, informed him that an unusual number of these birds had been killed this season between December and February, some sixteen birds, males and females, having come into his possession, shot in Midlothian and the neighbouring counties. It has been once recorded as breeding in Perthshire, by Mr Harvie-Brown.

3. *Bohemian Waxwing.*—This bird, a young male, was shot near Bannockburn on the 14th December. Several specimens of this occasional visitor had been killed in the neighbourhood of Edinburgh during the winter months.

V.—*Note of Plaster Casts destroyed by Weevils.* By JOHN ALEXANDER SMITH, M.D.

Dr Smith stated that Mr R. Carfrae (of Messrs Bonnar and Carfrae, George Street) had called his attention to the fact of some beautifully-modelled plaster casts of little children in his possession, which had been brought from Italy, being entirely pierced through and honeycombed with holes made by insects, so as to be almost destroyed, and requiring careful handling and repair. Dr Smith had never heard of plaster casts being destroyed in this way, and on getting them for examination he asked Dr Stevenson Macadam to analyse the plaster to see if any organic matter had been added to it. Dr Macadam made a chemical examination, and found that "the stucco was impregnated with organic matter of a fatty or resinous nature. When heated the stucco blackened, burned with minute scintillations, and evolved an aromatic odour." This sufficiently accounted for the attacks made on it by the beetles. Dr Smith asked Mr R. F. Logan to examine the insects, and he stated that they belong to the family *Tenebrionidæ*, of which the meal-worm is the most familiar example; but he did not know the species, which was probably not a British one.

VI.—*Note of* Bulimus acutus *and* Helix ericetorum *found in Iona.* By JOHN ALEX. SMITH, M.D.

(SPECIMENS EXHIBITED.)

Dr Smith stated that in the end of last July he spent some time in Iona, and on the sandy downs on the north-west coast by the sea he found a great abundance of both of these species of land shells. They are well-known species of the south and west of England, and have, he believed, been noticed on various parts of the west coast, as well as by Mr Charles W. Peach in Sutherlandshire. It is interesting to notice in reference to this distribution of these apparently local shells, that, as shown by Mr Alexander Buchan, although the isothermal lines of summer in Britain are nearly parallel with the lines of latitude, in winter they change their course, and run somewhat obliquely south and north through Britain. So that the January isothermals of 38° and 39° run from the south coast through the middle and west of England, the west and Hebrides of Scotland, and then through the very north of Scotland to the Orkney and Shetland Islands, beyond which they run westwards to the Atlantic Ocean; and have undoubtedly a relation to the somewhat corresponding animal life of these different localities.

Wednesday, 15th March 1876.—DAVID GRIEVE, Esq., President, in the Chair.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Journal of the Linnean Society (Botany), Vol. XV., No. 82; Do. (Zoology), Vol. XII., Nos. 60-62.—From the Society. 2. Proceedings of the Royal Society, Vol. XXIV., No. 166.—From the Society. 3. Transactions of the Royal Scottish Society of Arts, Vol. IX., Part 3.—From the Society. 4. Proceedings of the Literary and Philosophical Society of Liverpool, Title-page, Index, etc.—From the Society. 5. Catalogue of Plants for distribution by the Botanical Society of Copenhagen.—From the Society. 6. Medical Examiner, Nos. 7, 8, 9, 10.—From the Editor.

The following communications were read:

I.—*On some Proposed Processes for River Purification.* By J. FALCONER KING, Esq.

At the present time the subject of River Purification is one of very great interest to many people in this country. Those who offend, and those who are offended against in this matter, are alike interested, although on different sides of the question. The peculiar interest which is at present evoked is of course caused by the action which the Government seem likely to take in the matter. Regulations of too strict a nature in regard to river pollution, would no doubt to a certain extent affect injuriously the trade of the country; while on the other hand by having regulations too lax, or by having no regulations at all, as seems to be the case at present, a gigantic nuisance which is becoming worse every year, is allowed to go on unchecked. That something must be done by legislation to have the evil abated is pretty generally agreed. What form the legislation should take is the difficulty. I think it is a mistake to fix upon manufacturers and, without any previous inquiry, say to them, you shall not on any account put such and such things into rivers. To many a manufacturer such a command strictly enforced simply means ruin. A much better plan, I imagine, would be to appoint a body of scientific men to inquire fairly into the matter, and to ascertain and report as to the pollutions existing in each large river, and also to suggest means for the amelioration or removal of such pollutions.

In the neighbourhood of Edinburgh, many of the streams are still comparatively pure, while others again are certainly foul enough. The River Esk, which, as every one knows, has been the source of much contention, occupies a sort of midway position. By the time it passes Lasswade, it is not exactly so pure as we like to see a river, but it is certainly nothing like the Water of Leith, as it is seen passing Canonmills. The chief manufacture existing on the banks of the Esk is paper-making, and when one remembers that there are on this river no less than eight large paper mills, the marvel is that the water is not more filthy than it is. A great deal has been done of late years with the view of improving the condition of the Esk, much of which has been very successful. It is wished, however, to introduce if possible, still less foreign matter into the river; and with the object of rendering the effluent water from the mills purer than it is at present, I have lately been making some experiments on the large scale with different processes; and as many of our trials were fairly successful, I thought it might be interesting to the members of the Society to have an opportunity of witnessing these processes in operation.

In No. 1 Process, iron is the active ingredient, Mr Mackay of Leith, who has proposed this process for the purification of effluent water from paper mills, uses the iron in the state of per-chloride, but for a reason which will be obvious when you see the process performed, I prefer to use the iron as per-sulphate. This process, as all these processes should be, is very simple, and consists in adding to the dirty water, 1st, a small quantity of an acid persalt of iron, and 2d, a sufficient quantity of lime to render the mixture strongly alkaline. In a few minutes all suspended matter settles to the bottom leaving the water as clear as if it had been filtered. By using ferric-chloride, a large quantity of calcium chloride is produced, which being readily soluble in water, is carried into the river, whereas by using ferric-sulphate, as I recommend, calcium sulphate is formed and this being a difficultly soluble compound, it is in great part precipitated, and so kept out of the river. The sludge or precipitate which is thus produced, I should mention, has been worked up with great success in the manufacture of coarse paper.

In No. 2 Process, aluminium sulphate is used instead of iron chloride, but otherwise the processes are similar.

In No. 3 Process, the effluent water is first treated with acid aluminium sulphate, and then excess of finely-ground barium carbonate. The great beauty of this process, which I should say was first proposed by my friend Mr William Durham, is that in consequence of the barium carbonate being insoluble in water, any excess of it which may be used separates along with the other insoluble matter, and does not find its way to the river, as much of the lime used in the iron process must necessarily do. As aluminium salts do not appear to form a precipitate quite so fast as iron salts seem to do, I have proposed a modification of this process, in which I use iron sulphate and barium carbonate. In this combination very little matter indeed is left in the water.

[These processes were all carried out at the meeting, and were very successful—the dirty water becoming in a very few minutes almost as clear as spring water.]

II.—*Notes on the Coal Formation of Somersetshire.* By David Grieve, Esq., F.R.S.E.

Having last autumn spent a month at Clifton, near Bristol, the author was much interested in the geology of its neighbourhood. There is probably no place in England where, within a very limited area, typical examples of so many different formations occur as round this city. Bristol being the centre of an extensive coalfield, the author considered it necessary, as preliminary to his subsequent remarks, to give some account of the subjacent and superjacent strata.

Twelve distinct formations may be counted within a radius of ten miles from the centre of the city of Bristol; in short, there may be readily and easily investigated the Silurian, Devonian, Carboniferous, Triassic, Liassic, Oolitic, and Cretaceous formations, with igneous rocks of the paleozoic age. The juxtaposition of the rocks is curiously and often very eccentrically arranged, evincing the result of great disturbance. In many of the strata fossils abound. The coal measures are interlaced and modified in various ways by the over and under conterminous strata, which abounds in faults often of a very perplexing kind.

The author, in describing the boundaries of the Bristol, otherwise the Gloucestershire and Somersetshire coalfield, stated that it comprised an area of 338 square miles, which included 150 in Somerset, and the Radstock portion of Somerset, commonly called the Radstock coal basin, of 45 square miles.

The Report of the Royal Coal Commission, drawn up by Professor Prestwich, estimates the Bristol coalfield at 6104 millions of tons of coal, calculated to last for upwards of 4000 years at an actual "consumpt" per annum of 1,000,000 tons. This should tend somewhat to allay the fears of alarmists.

The portion of this great coalfield which Mr Grieve more particularly described was the Radstock basin above referred to. He spoke of its stratigraphical arrangement, and mentioned that the thickness of the coal measures here are estimated at 8000 feet. There are three series of coal—the upper, second, and lower. The coal rests in the upper series (which Mr Grieve only examined) on a base of mountain limestone, and is overlaid by the inferior oolite, lias, new red sandstone, magnesian conglomerate, and lower new red sandstone—these strata in a descending scale, and all which require to be pierced before the coal can be reached. The seams of coal vary from fourteen to thirty inches in thickness. Mr Grieve gave, further, some statistical particulars—for instance, as to depth of pit workings (averaging one hundred and forty-five fathoms), output of coal (exceeding 600,000 tons annually), described the old and new methods of working coal in this district.* A singularity peculiar to the old and very clumsy method may be noticed. The pit mouths and shafts generally till within the last twenty-five years or so were only four and a half feet in diameter, and the miners attached themselves by hooks to the pit chain, one over the other, in parties of ten or twelve, sticking together like so many onions on a string, and were thus lowered and raised through this narrow hole (often over a thousand feet deep), showing how much habit can render one callous to a sense of danger. An account was then given

* The present method being what is known to miners as the "longwall system."

of some curious faults in the strata, called locally "overlap vaults," by reason of which the same seam of coal is pierced twice through vertically in the course of working.

It was also observed that through the same disturbing agency, seams of coal from being horizontal had become vertical, appearing to have been tilted up much in the same way as the seams called Edge Coals have been in our own county of Midlothian.

Alluding to the antiquity of the coal workings in this quarter, Mr Grieve said that in the neighbouring Mendip Hills lead mining had been extensively carried on as early as the reign of Edward IV., and that the working of coal in the Radstock district was supposed to be coeval with that period. He parenthetically suggested that it is perhaps not very generally known that Dysart was the first place in Scotland where coal was wrought, and about the very same time as in Somersetshire, viz., four hundred years ago. Perhaps it was not much later, if tradition be correct, that the monks of Newbattle opened coalpits at Newmilns, a village near Dalkeith, where traces of the old workings are still to be seen.

The author then proceeded to give some account of the fossil botany of the Radstock coalfield. As regards this flora, he remarked that it is simply exquisite. The great abundance of large acrogenous trees, such as Sigillariæ, Lepidodendra, lofty plumose arborescent ferns, and a variety of other cryptogamous plants of tender and beautiful form, proclaim this carboniferous region to be perhaps the best type of a bygone tropical vegetation which our island can produce.

The specimens to be found here are abundant and excellently illustrative of their kind, although some of them, especially the Neuropteri, are perhaps somewhat rather fragmentary. The fossils are always found in a dark, heavy, indurated clay, which becomes rapidly decomposed on exposure to the weather. With very few exceptions, the remains of the plants have perished, and casts only remain. These casts, however, are generally of a very perfect description. The lineaments of the plants, more especially the form and venation of the leaves, so important in regard to classification, are beautifully sharp and well-defined. Another particular may be noticed, which is, that a greater number of genera and species of small dimensions are often found clustered together than in any other locality the author had visited. Thus in a small specimen ($3\frac{1}{2}$ inches by 3) exhibited were to be counted no less than three genera and eight distinct species of plants. Of ferns, the genus Pecopteris seemed to be the most plentiful; the Neuropteris next; Sphenopteris the most rare. Of the last, Mr Grieve only obtained one specimen, *Sphenopteris multifida* of Lindley and Hutton, and which, so far as he knew, had not been recorded as having been found in Scotland.

It was mentioned that there is nearly the entire absence of the carboniferous mollusca and of corals in the Radstock coalfield, and which are so abundant in other parts, more particularly in the vicinity of Bristol. It was also pointed out that this ground might be almost called classic in its way, for here, at Camerton, Radstock, Paulton, and some other places in the neighbourhood, M. Adolphe Brogniart got many of the specimens which are figured in his admirable work, the "Histoire des Vegetaux Fossiles;" and here also Messrs Lindley and Hutton got some specimens, also referred to in their similar work.

Mr Grieve concluded his paper by describing many fine specimens on the table, and by giving an enumeration of fossil plants collected by him at Radstock, in all thirty-two species. The list is as follows:

Pecopteris	sinuata, .	Br.
,,	Miltoni, .	,,
,,	Serlii, . .	,,
,,	Cyathea, .	,,
,,	marginata,	,,
,,	abbreviata,	,,
,,	dentata, .	,,
,,	adiantoides,	L. & H.
,,	aspidoides,	Br.
,,	Bucklandi,	,,
,,	arborescens,	,,
,,	oreopterides,	L. & H.
,,	aquilina, .	,,
,,	Devreuxi, .	,,
,,	helmiteloides,	,,
Neuropteris	aculeata,	,,
Neuropteris	acuminata,	L. & H.
,,	cordata,	,,
,,	attenuata,	,,
,,	tenuifolia,	Br.
,,	angustifolia,	,,
,,	heterophylla,	,,
,,	elegans, .	L. & H.
,,	cistii, . .	Br.
Sphenopteris	multifida,	L. & H.
Sphenophyllum	Schlotheimi,	,,
Annularia (undetermined).		
Calamites cannæformis.		
Sigillaria tesselata, L. & H.		
Lepidodendron selaginoides.		
Lepidophylla (various).		
Trigonocarpum (undetermined).		

For many of the measurements given, Mr Grieve acknowledged his obligations to the papers of the able resident mining engineers, Messrs Greenwell & M'Murtrie of Radstock.

Wednesday, 19th April 1876.—JOHN FALCONER KING, Esq., President, in the Chair.

The following gentleman was elected a Resident Member: Francis W. Moinet, M.D., Alva Street.

The following donations were laid on the table, and thanks voted to the donors:

1. (*a.*) Proceedings of the *Royal Swedish Academy of Science*, Vols. IX. (Part 2), X., XII. (XI. to be sent afterwards), *i.e.*, for 1870, 1871, 1873; (*b.*) Supplement I., 1 and 2, II., 1 and 2; (*c.*) Bulletin, Parts 28 to 31; (*d.*) Meteorological Observations, Vols. 12 to 14; (*e.*) Biographies of the Members, Vol. I., Part 3. 2. New York State Museum of Natural History, 24th, 25th, and 26th Annual Reports (1870, 1871, 1872). 3. New York State Library, 56th and 57th Annual Reports (1873, 1874). 4. New York State Cabinet of Natural History, 23d Annual Report (1869). 5. Proceedings of the Royal Society, Vol. XXIV., No. 167. 6. (*a.*) Proceedings of the Zoological Society of London, 1875, Part 4 (viz., papers for November and December); (*b.*) Transactions, Vol. IX., Parts 5, 6, 7. 7. Proceedings of the Berwickshire Naturalists' Club, Vol. VII., No. 2. 8. Transactions of Watford Natural History Society and Hertfordshire Field Club, Vol. I., Parts 1, 2, 3. 9. Geologists' Association: (1.) Annual Report, etc., for 1875; (2.) Proceedings, Vol. IV., No. 6. 10. Medical Examiner, Vol. I., Nos. 11 to 15 inclusive.

The following Committees were appointed for the summer:

Entomology: Messrs George Logan, W.S., R. Scot-Skirving, Andrew Wilson, J. Gibson, and Dr F. W. Lyon; *Convener*—Mr R. F. Logan. *Marine Zoology:* Dr M'Bain, R.N., Dr Traquair, the Rev. Professor Duns, D.D., Dr Strethill-Wright, Dr Lyon, and Messrs R. F. Logan, A. Wilson, C. W. Peach, James Anderson, and Robert Gray; *Convener*—Mr Andrew S. Melville. *Geology:* Dr M'Bain, R.N., Professor Duns, Dr R. Brown, and Mr Andrew Taylor; *Convener*—Mr C. W. Peach; *Vice-Convener*—Mr D. Grieve. *Chemical Science:* Messrs W. Durham, J. Hunter, and W. C. Crawford; *Convener*—Mr J. F. King.

The following communications were read:

I.—*On the Origin of the Serpentine of Shetland.* By ANDREW TAYLOR, Esq.

The scientific journals of this month give prominence to the question of the origin of Serpentine. Dr Hann, in the "Annals of Natural History," pronounces a decisive *non est* as to the entity of the *Eozoon Canadense;* microscopists, he affirms, have mistaken the minute appearances of varied mineral metheloyses in the same bed of rock for organic appearances. Again, Professors King and Rowney, the well-known combatants of Dr Carpenter in this special arena, announce in the current *Philosophical Magazine,* the discovery in the Serpentine of the Lizard, under a power of 373 diameters, of strange bodies like *Rotalaria, Globigerina,* or the fossil coral *Stenepora.* Their argument is that such bodies are due only to the varied crystalline shapes of minute microscopic minerals, taking different directions in the same bed of rock. A sufficient cause, at all events, has been shown for a minute microscopic study of Serpentine.

Dr Sterry Hunt stands almost alone in maintaining Serpentine to have been at once deposited in its present state. Others hold it as an example of that slow yet sufficient pseudomorphous action, which attacking the individual constituents of rock masses, has changed arenaceous and argillaceous beds into hornblende, gneiss, or mica schist. The relative position to other beds of the rock we are now specially studying, becomes important. Professors King and Rowney state that their examination of the Lizard Serpentine leads them to believe that it occurs both as a stratified rock and as intrusive masses. They were also able to trace the gradual change from both diorite, dolerite, and hornblende rock into that in question.

Having had occasion two autumns ago to examine very carefully the Serpentine which constitutes nearly the easterly half of the island of Unst in Shetland, I wish to call attention to its stratified character. This is particularly manifest at the Loch of Cliff, and near the Free church. At either of these points, as well as at several points on the road from Balta Sound to Uyea Sound,—and this indeed is the western boundary of the Serpentine formation,—a section may be traced on which the Serpentine rests conformably on a bed of black talcose schist, then on limestone, to which again succeed the talcose gneiss and mica schists forming the high western cliffs of this northernmost isle of Britain. Standing in the little land-locked Balta Sound, the tourist is attracted by the varied physiography of the surrounding hills. In front a background of serried gneissose peaks protected in their immediate front by the swelling ground so characteristic of the rapidly weathering Serpentine. Huge boulders with accompanying water pools and great sterility further define this region. I made out the Heogs, Cruci-field, and the peaks of the western side to be dioritic—aphanite in part. Balta Island shows the superior resisting power of the diallage rock to Serpentine. The scenic peculiarities of the Vord Hill, the southern boundary of Balta Sound, are owing, I think, to bands of diallage intersecting the Serpentine. This is the only correction I would make on Dr Hibbert's map.

I am inclined then (1st) to think the Serpentine beds of Unst and Fetlar a continuous stratified mass; (2d), the recent microscopic examinations of Drs Rowney and King bespeak a similar scrutiny for this special bed and its congeners.

Should undoubted organisms be found in it, they might also be discovered in that bed of limestone which runs through the length of the Shetlands.

II.—*Note on the Grampus* (Orca gladiator, *Lacep.*) *recently caught near Granton.* By JOHN GIBSON, Esq.

On Saturday, March 18th, a Grampus (*Orca gladiator,* Lacep.) was captured about one mile west of Granton. On being dragged ashore, while still alive, it gave forth shrill piercing cries, somewhat resembling in their sharpness a woman's voice. The specimen was an adult male having the following dimensions:

Total length along curve of back, 21 ft. 10 in. Girth of body, 13 ft. Height of dorsal fin, 3 ft. 10 in. Length of flipper, 3 ft. 10 in. Breadth of dorsal fin, 2 ft. 8 in. Length from snout to origin of flipper, 3 ft. 11 in.; to origin of dorsal fin, 8 ft. 1 in.; to blow-hole, 2 ft. 5 in. Dentition, $\frac{12}{12}$.

Colour on the upper surface, a uniform deep black, with the exception of a patch of light blue situated at the posterior base of the dorsal fin. Right over the eye, and extending posteriorly for 25 inches, was a narrow white blotch about 5 inches broad at the broadest part; the lower surface of a creamy white colour, the white of the anal region sending off a broad branch on each side. The front tooth on each side of the lower jaw was exceedingly small and almost hidden by the overlapping of the gum. The two teeth immediately succeeding these on each side were worn down almost to the level of the gum.

III.—*Note on the Occurrence of* Helix arbustorum, *Linn., var.* alpestris, *Zeigler, at a height of* 1730 *feet in the Ochils.* By J. C. PURVES, M.D.

Although *Helix arbustorum,* Linn., is a widely distributed species, ranging as it does throughout the temperate parts of Europe, it is by no means a common form, its occurrence being decidedly local. The shell is very little variable in colour and the pattern of its markings; but its form and dimensions are considerably affected by its vertical range. At great elevations it undergoes a marked diminution in size, the spire, at the same time, becoming relatively more elevated. Its usual habitat is in osier beds or clumps of *Epilobium hirsutum,* etc., by river sides, or in damp, shrubby places in woods. In the former localities, on the banks of the Meuse near Dinant in Belgium, I have found it attaining the dimensions of an average-sized *Helix nemoralis.* The specimens which I now submit to the Society do not reach half that size, are of a much lighter colour than that of the typical shell, and have the spire more raised and almost subconoidal. This is, I believe, the *Helix alpestris* of Zeigler. The animal, in most of the examples observed, instead of being of the usual leaden or greyish-green colour, was light-brown or drab.

I found this well-marked variety during a geological excursion in company with Mr R. L. Jack, of the Geological Survey, in Glen Shirrup, a little below the 1750 feet contour line of the Ordnance Map, feeding, in considerable numbers, in nettle beds on the bank of the stream, one of the affluents of the Devon. All the adult individuals were of the same form and dimensions.

As *H. arbustorum* is known to be one of the most Alpine of our Helices on the Continent, extending its range nearly to the summits of the Vosges and Jura, and even passing the snow-line in the Swiss Alps, there is nothing remarkable in the fact of its being found at the above-mentioned altitude; but not having found mention made of its occurrence in the Ochils, the communication of the foregoing observations may be of interest to the Society.

IV.—*On the Employment of Arsenic in the manufacture of Wall Papers.* By J. Falconer King, Esq., City Analyst.

As the result of certain experiments, Mr King found that not only expensive papers, and those which contained green, but the great bulk of cheap papers and those of the duller colours without a trace of green, contained arsenic in an appreciable degree.

V. Mr Herbert exhibited a series of Bird Skins from Transvaal and Natal, on which some remarks were made by Mr Gray.

The Society then adjourned to the third Wednesday in November.

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

ONE HUNDRED AND SIXTH SESSION, 1876-77.

Wednesday, 15*th November* 1876.—Dr JOHN ALEXANDER SMITH, President, in the Chair.

James Bryce, Esq., LL.D., F.G.S., etc., 18 Morningside Place, was elected a Resident Member.

The following Donations to the Library were received, and thanks voted to the Donors:

1. Proceedings of the Royal Society [of London], Vol. XXIV., Nos. 166, 167.—From the Society. 2. Journal of the Linnean Society, (Botany) Vol. XV., No. 82; (Zoology) Vol. XII., Nos. 60-62.—From the Society. 3. Transactions of the Royal Scottish Society of Arts, Vol. IX., Part 3.—From the Society. 4. Proceedings of the Literary and Philosophical Society of Manchester, Vol. XIV., Nos. 11-13.—From the Society. 5. The Medical Examiner, Vol. I., Nos. 7-10.

I. Dr J. A. SMITH, the retiring President, then delivered the following opening address:—

GENTLEMEN,—In meeting here to open this new session of the Royal Physical Society, the first thing that strikes us all is, that our well-known and highly-valued Secretary, Dr Robert Brown, is not present this evening to welcome us, and, as usual, conduct the preliminary part of our business. I am glad to say that it is not from ill health or any such evil cause that we have not his well-known presence with us, but that he has thought proper to migrate to the great metropolis, where he thinks and feels he will have more scope for his talents and acquirements. I am sure we wish him all success in his new sphere of life, and in the literary labours to which he is now devoting himself. We shall not soon forget the debt of gratitude the Society owes to him for the care and attention he has given to its business, and for the valuable communications he has made to us from time to time.

I have now to refer to another loss the Society has recently suffered, in the removal from among us of one well known to us all—at least, to the older Members of the Society—whose pleasant face we shall see here no more. I refer to Thomas Strethill Wright, M.D., who died, after a long illness, on the 13th day of October last. Dr Wright was an old Member of the Society, having been elected in January 1851. He was also one of the Presidents from November 1858 to November 1861, when he delivered an opening address, the science, the poetry, and the beauty of which were all alike remarkable.

The delicate state of Dr Wright's health in later years prevented him from coming often to the meetings of the Society; but we shall long miss him, as one of our leading scientific naturalists, specially great in his own departments of the *Protozoa* and the *Cœlenterata*. Personally I mourn for him as a long-known and talented man, and a highly-valued, warm-hearted friend. I have thought it right—to give you some idea of the amount of work done by the late Dr Wright in his active days in our Society—to make out a list of the communications he brought before us. I shall not refer here to his valuable observations on Electricity, and to the important papers brought by him before the Royal Scottish Society of Arts, and other scientific societies, nor to his more recent astronomical studies, which, while they expanded his ideas and knowledge of the heavenly bodies, at the same time deeply touched his heart, he told me, at the greatness and glory of the Almighty Creator of them all.

I shall simply confine myself to the communications he has made to our Society. It will at least let some of our younger Members see the kind of work done in this Society in by-past years. These communications are upwards of fifty in number, and all the results of his original observations. They are published in our *Proceedings,* and time will not permit me to go into details. I merely mention the titles of some of them, with the dates when he brought them before the Society :—

February 28, 1856.—I. On the Reproduction of *Cydippe pomiformis.* II. On two new *Actinias* from Arran (with plate).

March 26, 1856.—On Gemmiparous Reproduction (multiplication) in *Actinia dianthus* (living specimens were exhibited).

April 23, 1856.—I. Description of two Tubicolar Animals (with plate)—*Phoronis hippocrepia, Phoronis ovalis*, n. gen. and sps. II. Note on Indications of the Existence of Bilateral Symmetry, and of a Longitudinal Axis in *Actinia*, as shown in living specimens. III. Specimens of living Madrepores (*Caryophyllia Smithii*) from Ilfracombe, Devonshire, were exhibited. IV. On the Existence of Thread-Cells in the Tentacles of *Cydippe.*

November 26, 1856.—On *Hydractinia echinata* (2 plates).

January 28, 1857.—I. Observations on British Zoophytes—*Clava* and *Eudendrium* (2 plates). II. On the Prehensile Apparatus of *Spio seticornis* (plate).

March 25, 1857.—I. Observations on British Zoophytes: (1.) *Laomedea acuminata ;* (2.) *Trichydra pudica ;* (3.) *Tubularia indivisa* (3 plates). II. Description of New Protozoa: (1.) *Lagotia viridis*, n. gen. and sp.; (2.) *Vaginicola valvata*, n. gen. and sp. (2 plates).

April 22, 1857.—Observations on British Zoophytes: (1.) *Coryne gravata*, n. sp.; (2.) *Stauridia producta*, n. sp. (plate).

November 25, 1857.—I. On Reproduction by Ova from the Medusoid of *Campanularia Johnstoni.* II. On *Epehelota coronata*, a new protozoan Animalcule. Dr Wright also exhibited specimens of the new *Laomedea acuminata* (Alder) with its Medusoids.

March 24, 1858.—On Monœcious Reproduction in *Tubularia larynx.* Dr Wright exhibited a specimen of the *Hydra tuba* (Dalyell) throwing off Medusæ ; and also the *Myrothela artica*, Sars.

April 28, 1858.—Observations on British Zoophytes: (1.) On *Atractylis* (n. gen.); (2.) On the fixed Medusoids of *Laomedea dichotoma* (living specimens exhibited); (3.) On the Reproductive Organs of the Medusoid *Laomedea geniculata ;* (4.) On the Reproductive Organs of *Laomedea lacerata* (2 plates).

November 24, 1858.—I. On new Protozoa: (1.) *Lagotia producta ;* (2.) *Zooteirea religata ;* (3.) *Corethria sertularia ;* (4.) *Stentor Mülleri, Stentor castaneus* (plate). II. Observations on British Zoophytes: (1.) On the Reproduction of *Turris neglecta ;* (2.) On the Development of *Hippocrene Britannica* (?) from *Atractylis ramosa ;* (3.) On the Development of *Hydra tuba* from *Chrysaora* (plate).

December 22, 1858.—On the *Cnidæ* or Thread-cells of the *Eolidæ.*

January 26, 1859.—Observations on British Zoophytes: (1.) *Coryne implexa ;* (2.) *Coryne* (*Margarica*, St. Wright) *implexa ;* (3.) *Bimeria vestita ;* (4.) *Garveia nutans* (2 plates).

February 23, 1859.—On *Goodsirea mirabilis*, an undescribed Gymnopthalmatous Medusa. Dr Wright also exhibited specimens of *Gromia oviformis.*

March 23, 1859.—Observations on British Zoophytes : *Kionistes retiformis* (with figures).

April 27, 1859.—On a Method of Constructing Polarising Prisms of Nitrate of Potash.

January 25, 1860.—Note on an instantaneous method of finding Microscopic Objects under High Powers.

May 9, 1860.—Observations on British Zoophytes: *Halcampa fultoni*, a parasitic *Actinia* (two figures).

November 28, 1860.—Observations on British Zoophytes and Protozoa : (1.) Notice of *Ophryodendron abietina* (*Corethria sertularia*); (2.) On the Reproductive System of *Chrysaora* (plate).

February 27, 1861.—Observations on British Zoophytes and Protozoa: (1.) *Atractylis palliata*, n. sp. (plate); (2.) *Atractylis coccinia*, n. sp.; (3.) On Rhizopod Structure.

April 24, 1861.—Observations on British Zoophytes and Protozoa: (1.) On the Reproductive Elements of the *Rhizopoda* (plate); (2.) On the Reproduction of *Ophryodendron;* (3.) On *Dendrophyra radiata* and *D. erecta* (n. gen. and sps.); (4.) On *Lecythia elegans* (n. gen. and sp.). Appendix to *Cionistes reticularis* (*Kionistes retiformis*), with figure. Appendix to *Hydractinia.*

November 27, 1861.—I. President's Opening Address. II. On Reproduction in *Æquoria vitrina* (plate).

February 26, 1862.—Observations on British Zoophytes: (1.) *Atractylis arenosa;* (2.) *Atractylis miniata;* (3.) *Laomedea decipiens* (with plate).

March 26, 1862.—Observations on British Zoophytes and Protozoa: (1.) *Clava nodosa*, n. sp.; (2.) *Acharadria larynx;* (3.) *Zooteirea religata*, n. sp. (4.) *Freya* (*Lagotia*) *obstetrica;* (5.) *Freya stylifer;* (6.) *Chætospira maritima;* (7.) *Oxytricha longicaudata* (3 plates).

May 7, 1862.—I. On the Pigmental System of the Æquoreal Pipe-fish (*Sygnathus æquorius*). II. Observations on British Zoophytes: (1.) *Vorticlava proteus;* (2.) *Trichydra pudica;* (3.) On the Development of *Pycnogon* Larvæ within the Polypes of *Hydractinia echinata* (2 plates).

February 26, 1863.—Observations on British Zoophytes : (1.) On a supplementary Canal System in *Stomobrachium octocostatum* (with plate); (2.) On *Acanthobrachia inconspicua*, n. gen. and sp.; (3.) *Atractylis bitentaculata*, n. gen. and sp.; (4.) *Atractylis quadritentaculata*, n. sp.; (5.) *Coryne ferox*, n. sp.

January 27, 1864.—Remarks on Dr Stevenson Macadam's "Spheroidal Theory" of the Interior of the Earth.

March 23, 1864.—Observations on British Zoophytes and Protozoa: (1.) On the Structure and Reproduction of *Boderia Turneri*, a new Rhizopod (plate). (2.) On the Prehensile Apparatus and Sting-cells of *Cydippe;* (3.) On the Stem-Canals of *Tubularia indivisa.*

February 22, 1865.—On the Natural History of *Euglena.*

November 27, 1867.—Opening Address : a general view of the *Infusoria* and *Rhizopoda.* (Beautiful drawings, after nature, engraved by Dr Wright on the glass slides, were exhibited by aid of the lime-light and lantern).

November 25, 1868.—An Opening Address, with numerous illustrations of the Lower Forms of Animal Life. In continuation of the Opening Address of the previous year (illustrated by beautifully-detailed drawings by Dr Wright on the slides of lantern, shown by the oxy-hydrogen light.

These numerous papers show that good work was done in those days in our Society by Dr Wright. His powers of observation were great, and great also was the care and skill with which in his various small aquaria he watched the development and progress from youth to age of many of these marvellously beautiful, though minute denizens of the great sea. The ease also with which he could bring them under the examination of his powerful microscopes, and describe what was to be seen, was to me always a matter of astonishment and admiration, as was also the skilful way in which, with some simple broken needles fixed in pens or pencils, or other like tools of his own manufacture, he could engrave delicately on the lithographic stone the beautiful and most correct figures of these various wondrous creatures of such marvellous beauty, and thus prepare the plates to be printed for our *Proceedings.* The naturalist and the artist being one person gave a correctness and beauty to the figures which would otherwise have been quite unattainable. I may truly say, Gentlemen, in regard to Dr Wright, that I fear we shall not soon look upon his like again.

The Society has also to mourn the death of another member, who has been taken from us in his early manhood—Mr Andrew Smith Melville, Lecturer on Botany, Geology, etc., to the Watt Institution, and also to the Royal High School. He was the son of an old Member of the Society—Professor Melville, of Galway University. Mr Melville was apparently entering on a long course of usefulness and promise. I presume, however, from the abundance of his public labours, he had but little leisure to favour us with many communications at our meetings.

Another respected member—Mr George Meldrum, C.A.—has also, more recently, been removed from us by death. He was a good man, and well known in Edinburgh. As a lover of science, however, he was one who took the part of an interested listener more than a sharer in the public business of our ordinary meetings. I long had the pleasure of his acquaintance, and I know that both in his private and public position in the church and in the community he leaves a sad blank.

The mention of these recent losses makes me naturally turn my thoughts back to the many eminent men who have filled this presidential chair, and who have now passed away from us. Happily, some distinguished men still remain—of whom we are justly proud—to cheer and encourage us as a society, by their occasional presence with us; taking part in our meetings, and giving us the advantage of their age and experience, and drawing for us on their large stores of knowledge in the varied and extensive fields of Natural Science. I cannot, however, help recalling some of the many great men who stood as towers of strength around this Society when I first entered it, some six-and-twenty years ago. The Secretary at that time was the generous and amiable William Oliphant, the publisher; who was then succeeded by C. Wyville Thomson, now our distinguished Professor of Natural History in the University; we rejoice in his recent success, and trust he may be long spared to add to our knowledge of Nature and her laws, and to enjoy the honours he has so happily and justly won. Sir C. Wyville Thomson, having held the office of Secretary for a couple of years, was then succeeded by myself, and the office remained in my hands for twenty-one years; but I shall not go into any detailed account of the varying circumstances of the Society during that long period. I am glad, however, to have been able to edit and put on permanent record some at least of the work done in part of that time, in the three goodly octavo volumes of the printed *Proceedings* of the Society, which include many papers of both interest and value, and many illustrations of great beauty, especially, let me say, the series of papers with their illustrative drawings, by the late Dr T. Strethill Wright. The *Proceedings* were a credit to the Society, and we only regretted that the limited funds at our disposal obliged us at that time to bring them to a close. The Society, I have said, was poor in money, in those days, but it was then rich in men—men whose names will be long remembered and referred to by all cultivators of the Natural Sciences. At the time of my admission, I looked up with much respect to the learned Presidents of the Society—Robert K. Greville, LL.D., the accomplished botanist, conchologist, and artist, and the pleasant, polished gentleman; Professor John Goodsir, the careful, learned, and philosophical anatomist; Dr John Coldstream, zoologist, ethnologist, and kind-hearted, philanthropic man, whose richly-illustrated lectures on Ethnology many will remember with pleasure—each and all of them high authorities in various branches of Natural Science. In the Council at that time were the previous President, John Fleming, D.D., Professor of Natural Science in the New College, a genial, cheerful, original, and many-sided man, full of knowledge on every branch of Natural History—the well-known author of the excellent "British Animals" (an early favourite of mine) and the "Philosophy of Zoology," somewhat different in its tone, perhaps, from some of our later treatises on similar subjects, and more in accordance, in some respects, with the religious feelings and instincts of, at least, our Scottish people; Hugh Miller, the wonder-working geologist, historian, and poet of the "Old Red Sandstone," and many more works besides; Alexander Bryson, the geologist, the mineralogist, the ingenious mechanician, the social, warm-hearted friend, and the fearless searcher after truth, giving and taking hearty blows on its behalf, with the joy of a strong man rejoicing in his strength; Robert Chambers, LL.D., who to varied stores of antiquarian lore added a knowledge and a love for geology, in relation to which he published various works, and also of zoology, his keen, inquiring mind making him especially take an interest in the older and somewhat fanciful theories and hypotheses of Oken and Lamarck, and at last in what its Author thought fit at that day to designate as the "Vestiges of the Natural History of Creation." Subjects of that debatable kind, I may, however, say, never came up for discussion at our pleasant little meetings, where facts, and not fancies, more usefully occupied our time. The potent literary authority, Charles Maclaren, of the *Scotsman* newspaper, classical antiquary and geologist, was also added to our list of office-bearers; and James Wilson of Woodville, brother of the professor, a pleasant man and writer alike on science and on sport; also Alexander Rose, the quiet, unobtrusive, but learned mineralogist and practical geologist, who for many long years taught these sciences in his well-known corner tenement, close by the University, where he had for pupils many men who afterwards became famous as geologists, mineralogists, and engineers.

These have all passed away, but their services to science and to humanity still abide.

Among the living who did good service to us in by-past years, or who stood in relation more or less close to "The Physical," I shall only name as old Presidents and other office-bearers, Andrew Murray, a distinguished naturalist, and author of several works in various branches, especially in Entomology; Dr W. H. Lowe, an entomologist—both now living in the neighbourhood of London; Dr J. H. Balfour, our well-known Professor of Botany; Dr M. Forster Heddle, Professor of Chemistry, University of St Andrews; Dr Cleland, Professor of Anatomy, Queen's College, Galway; David Page, LL.D., Professor of Geology in the College of Science at Newcastle-upon-Tyne, in connection with Durham University; and Professor Turner, the accomplished anatomist, of our own University. There are many other names I could mention, of men who have done good work with us, but I have confined myself principally to some of the old office-bearers of the Society, who have now mostly left us.

Looking back, then, on the men and the work done by this Society for a series of years past, it has been almost entirely one of observing and recording facts, and describing structure, and exhibiting, with accompanying notes of more or less interest, objects of rarity and specimens in all the various departments of Natural History. With the occasional exception, perhaps, of a passing reference in the opening addresses of some of our later Presidents, I may almost quote, as still true of the business at our meetings, the words of Dr T. Strethill Wright, in his remarkable opening address, to which I have already referred. Dr Wright says: "We are men of work, not of talk. We have given forth no voice on the grand hypothetical questions which are now troubling the Commonwealth of Natural Science. We have been singularly apathetic as to whether or no the stock of our first parent struggled upwards through innumerable adversities, from a monad to a man. I fear, indeed, that we are a prejudiced people, and would rather leave the question as we found it settled many a year ago at our mother's knee."

Since the day when these wise words were spoken there has, however, been a wonderful development of these theories and hypotheses to which Dr Wright referred. Works, filled with much curious and valuable information, but associated, at the same time, with some of the most startling hypotheses, have been published from time to time in England, and have gone through many editions. I allude, of course, specially to works on the principles of biology, as it is called, and on such subjects as the Origin of Species, the Descent of Man, the Variations of Plants and Animals under domestication, Man's place in Nature, etc., etc. Some of these works have been hailed by great naturalists as introducing a new era of progress and expanded thought, in connection with the investigation of the history of the vegetable and animal kingdoms. Indeed, of late years we have had all these new views and principles propounded by some of their most distinguished supporters, who have occasionally occupied academic chairs; so that they have in this way been very forcibly brought to our very doors. I therefore feel somewhat constrained to take at least a passing notice of them now; to try and see to what they are endeavouring to lead us, as the natural result and outcome of all their teaching, which, I regret to say, seems to me to be something very different indeed from what, in our younger days, we would have thought likely to have met with any favour, at least in Scotland. I have no need, however, now to attempt to show where these theories lead, for they have been more recently taken up by learned Germans and others on the Continent, and carried forward by them to what appears to be their legitimate outcome and conclusion; as in recently published works on the history of creation, or the development of the earth and its inhabitants by the action of natural causes—in short, a non-miraculous history of creation. Here we learn of the probable eternity of matter—plastic matter, I should say—evolving forces, starting thus into life, and going on to self-evolve and develop all creatures, vegetable and animal alike—running thus upwards in various ascending lines of development (I should say, by a series of miracles), to form all the so-called species, genera, orders, families, and classes of animated nature. Everywhere, however, among these newly-formed creatures, from their very abundance, we are told there is over-crowding, there is not room for all, the strong choke out the weak, and then many of these stronger ones, not content with more room, struggle and strive by natural selection, as it is termed, and otherwise, after something unknown, but different from what they are, to which they are impelled by some force or other. Thus stretching and straining after some unknown capacities, and powers, and structures, these, somehow or other, become evolved within them, and their life thus progresses to higher and still higher forms, until one line of development, more fortunate in some of its circumstances than all the others, culminates in rational man. The links between the irrational brute and him—(the ape, being not his father, but his great-great-great-great-grandfather perhaps;) these links, like many other much-wanted intervening and connecting links in the many-evolving chains of both vegetable and animal life—have unfortunately not been as yet discovered, though doubtless they must have existed, if the theory be true. A wondrous parentage, truly, requiring, it seems to me, a still more wondrous faith in these modern interpreters of Nature, and of Nature's laws! Here, then, we seem to find ourselves face to face with a system of theories which appears to leave all creatures, high and low alike, in a world without a God, either as a Creator at the first, or as still ruling over all by His superintending providence. Need I say that these theories, thus carried out, strike absolutely at the root of all revelation, and, therefore, at all the aspirations and hopes of man, either for time or for eternity.

Cowper sketches a somewhat similar but perhaps less advanced class of scientific theorists of his day so well, that I must quote part of his description here, as his bold declaration of the opposing truth applies to all, doubtless, of every kind and degree :—

> "Some say that, in the origin of things,
> When all creation started into birth,
> The infant elements received a law,
> From which they swerve not since.
> . . . . .
> Thus dream they, and contrive to save a God,
> . . . . .
> The Lord of all, Himself through all diffused,
> Sustains, and is the life of all that lives;
> Nature is but a name for an effect
> Whose cause is God."

As a believer in the Holy Scriptures as the inspired and revealed word and will of God to man, I agree with what our old President, Professor Fleming, D.D., said long ago, but which is still as true now as when it was written :—

"Without controversy, the works and the words of God must give consistent indications of His government, provided they be interpreted truly. The talent, sagacity, learning, and industry occupied for ages with the Book of Revelation have produced a mass of evidence by which its *moral authority* has been established. But unfortunately for the interpreters of the Book of Nature, they have been few in number, their field of observation too limited, and their prejudices too obvious to permit any high value to be attached to their theoretical deductions." . . .

Personally, I cannot put aside the most ancient history we possess of creation, as given us in the books of Moses, which have, I believe, been intended for the information of the human race in every state of civilisation, and in every land, though I may not be able to understand or explain it in all its details. Indeed, I do not expect or ask to understand the deep mysteries of the creation, and all the relations of matter and of life, or to be able to catalogue and classify the march and order of creation; except in a very general way indeed. There are truths, however, announced in this old account which I cannot but believe, viz.: the original creation of matter—the worlds—by the Almighty Maker; a progress of creation, after light and order had been evolved from an apparent state of disorder; the sequence or succession of vegetable and animal life, each in its turn declared by its Creator to be perfect, "good, very good;" and the special circumstances mentioned at the creation of man sufficiently mark him out, to my mind at least, however closely allied his physical frame may be to the lower animals, as a creature very different indeed from them.

Then let me remind you that the Bible history of man is not one of development by slow degrees in the course of untold ages, from a state of degradation allied to the brute creation. On the contrary, we are told that man was created at the first upright, and lord of all the lower creation. From this state he soon fell, but doubtless he still retained at least his lordship over the creatures, and very early took some of them specially under his protecting care; one of the first family being, we are told, a keeper of domesticated cattle. It would almost appear, as, indeed, I have elsewhere stated, as if the Creator had stamped a peculiarly plastic or mobile character on the whole group of these very domestic animals which man has brought under his sway, to suit them, shall I say, in their varied descendants, under man's superintending care, for accompanying him as he spreads abroad over almost all the regions of the earth. It is this very peculiarity, indeed, which has been taken by some learned writers to attempt to prove the mobile characters, not of these domesticated animals alone, but of the whole animal kingdom. The after-history of the human race, instead of being one of regular progress and advancement, seems rather to have been one of fall and degradation; again of rise and progress, at least in some of its branches; and again of fall and degradation, followed again by rise and progress; the modern barbarism thus covering in some places and concealing the older civilisation. But into this wide though tempting subject I cannot at present enter; only I believe, as we are told in Scripture,—"Righteousness exalteth a nation," and that we have here the preserving salt, the possession of which alone will in the end prevent a nation from relapsing again into barbarism. . . . Truths such as these taught so plainly in Holy Scripture, bearing on the relation of all living creatures, and the world itself, to their Great Creator, have, to me, at least, a sublimity, a beauty, an order, a fulness, adapted to the nature of man, infinitely surpassing any or all of the theories of the sad, struggling, and evolving creation of man's devising.

And now, gentlemen, a word in conclusion on the present state and prospects of our Society itself. I have already said we are still fortunate enough to have among us some of our old Presidents, men like Mr C. W. Peach, who can enlighten and charm us on many branches of Natural History; James M'Bain, M.D., R.N.; Professor John Duns, D.D.; Mr R. F. Logan; Dr Stevenson Macadam; also Dr Traquair, Mr Andrew Taylor, Mr Robert Gray, and many others, whose names occur to us all, and are amply sufficient to show what power and energy still remain in this old Society, now entering on the one hundred and sixth year of its age. I am sure, by the active support of our Members bringing everything of interest under our notice that may come in their way, the Society, led by the well-known naturalists among our office-bearers, and by the accomplished men whom the Council expect to fill the vacant places among our officials, the Royal Physical Society will hold on the even tenor of its quiet pleasant way, with perhaps greater vigour and activity, zeal and success, than before; in the examination and pursuit of all the varied branches of Natural, ay, Physical Science; for the old and happy name and constitution of our Society makes it right and proper to include among its workers all the lovers and cultivators of the many branches of science.

And now, gentlemen, in leaving this chair, it falls to me to resign my office of President, the term of which has now come to a close. You were good enough to appoint me one of your Presidents, when failing health and strength admonished me to retire from the office of the Secretary, which I had the honour and the pleasure to fill for so many years. Unfortunately, however, I could not but feel that this state of matters by no means fitted me the better for filling the more prominent and important office of the President; and in now resigning that office, I have warmly to thank my fellow office-bearers for their constant courtesy and kindness to myself, and, indeed, gentlemen, my hearty thanks are due to all the Members of the Society, in these by-past years, for the invariably pleasant intercourse I have had with them on all and every occasion.

On the motion of Professor DUNS, D.D., a vote of thanks was unanimously awarded to Dr Smith for his able address, and for his valuable services while President of the Society.

II. *Ornithological Notes:* (1.) Buteo lagopus, *Rough-legged Buzzard;* (2.) Pernis apivorus, *Honey Buzzard;* (3.) Otus brachyotos, *Short-eared Owl;* (4.) Lanius excubitor, *Great Grey Shrike;* (5.) Upupa epops, *Hoopoe;* (6.) Charadrius morinellus, *Dotterel.* (Specimens exhibited.) By JOHN ALEXANDER SMITH, M.D.

(1.) *Buteo lagopus,* Rough-legged Buzzard.—This fine female specimen of this bird was shot near Roslin on the 23d October.

(2.) *Pernis apivorus,* Honey Buzzard.—This bird is also a female, and its plumage is remarkably dark in colour. It was shot near Pencaitland, Haddingtonshire, on the 22d September last. Another fine specimen of this bird was shot last year on the 20th September at Kilberry, Argyleshire. It was an adult male, and its stomach on being opened was found to be filled with full-grown specimens of the common wasp.

(3.) *Otus brachyotos,* Short-eared Owl.—Various specimens were exhibited; this bird having been recently unusually common this season in various parts of Scotland, the native birds being probably supplemented by many from the Continent, owing to the great prevalence of easterly gales.

(4.) *Lanius excubitor*, Great Grey Shrike.—A male specimen of this occasional visitor. It was shot by one of the Duke of Buccleuch's keepers, on the 9th of March, at Bowhill, Selkirkshire.

(5.) *Upupa epops*, Hoopoe.—A fine male bird, and rare visitor, was killed at Burntisland, Fife, on the 25th April of this year. The specimen exhibited, was purchased, on the 6th October, by Mr Stavert, 18 Royal Terrace, from a railway surface-man at the Innerwick station (Haddingtonshire) of the North British Railway, who had recently caught it there alive, and it was brought by Mr Stavert alive to Mr William Hope, taxidermist, George Street. The bird was a female.

(6.) *Charadrius morinellus*, Dotterel.—Two young males and two females, also young birds. These birds were brought to Mr William Hope, taxidermist; they had been shot at Dalnaspidal, Perthshire, on the 17th August; also a female, shot in the same neighbourhood, on the 8th September 1876. Other birds of the same kind had been noticed on the tops of the hills of this high district for several years past, about the same time of the year, but the species had not before been determined. The bird is one of our local summer visitors, and its rare breeding-places occur only on the very tops of high mountains. Mr T. C. Heysham first described their breeding-places near Carlisle, in Cumberland, and Westmoreland; and Mr Robert Gray, in his valuable "Birds of the West of Scotland," has gathered together for us, various notices of its rare occurrence and supposed breeding-places; in Sutherlandshire, Inverness-shire, Aberdeenshire, and the adjoining counties, and also in Dumfriesshire; they appear, however, to occur only in small flocks; and some of these localities may perhaps need further confirmation. This, then, appears to be an addition to the localities where these birds have been observed; and from the time of the year when they were killed, and the immature state of the plumage of some of them, it may, probably, be considered an addition also to the breeding-places of these very locally-distributed birds. I may mention that two of these specimens were secured for our "Museum of Science and Art;" another pair by Mr

Robert Gray, for his own collection; and a single bird for the Berwick Museum.

(I have to thank Mr William Hope, taxidermist, George Street, for enabling me to examine and exhibit these specimens, and the Hoopoe, Shrike, etc.; and also Mr Small, taxidermist, George Street, for being able to bring some of the other birds under the notice of the Society.)

Wednesday, 20th December 1876.—DAVID GRIEVE, Esq., President, in the Chair.

The following gentlemen were elected Office-Bearers for the Session:

Presidents.—David Grieve, Esq.; John Falconer King, Esq.; Ramsay H. Traquair, M.D.

Council.—James M'Bain, M.D., R.N.; William Durham, Esq.; Professor Duns, D.D.; R. Scot-Skirving, Esq.; John Alex. Smith, M.D.; James Pryde, Esq.

Secretary.—Robert Gray, Esq.

Treasurer.—E. W. Dallas, Esq.

Honorary Librarian.—Rev. James Kennedy, M.A., B.D.

Assistant Secretary.—John Gibson, Esq.

Library Committee.—James M'Bain, M.D., R.N.; Thomas Robertson, Esq.; R. F. Logan, Esq.; Robert Gray, Esq.; F. W. Lyon, M.D.; James Anderson, Esq.

The following gentlemen were balloted for and elected Resident Members of the Society:

John Thomson, Esq., Student of Natural Science, 26 Queen Street; Andrew Thomson, Esq., 13 Inverleith Place; T. D. Gibson Carmichael, Esq., All Saints' Parsonage, Newton-Stewart; Andrew Moffat, Esq., 8 Kirk Street, Leith; Thos. W. Drinkwater, Esq., 47 Forrest Road.

The President, in referring to the much regretted retirement of Dr Robert Brown from the office of Secretary in consequence of his removal to London, spoke in high terms of the manner in which he had conducted the business of the Society, and the zeal and ability with which he had promoted its best interests. He, therefore, proposed a cordial vote of thanks to Dr Brown, and that the same should be recorded in the Minutes, and the extract thereof forwarded to him by the Secretary, with the best wishes of the Society. The proposal was most cordially received, and unanimously agreed to.

The following communications were read:

I. *The Elements of Organisms.* By Professor Duns.

The author had seen, with much regret, naturalists leaving the old starting-point of observation and research, and, instead of allowing living forms to record their own history, making a history for them. The older and, as he thought, the wiser observers began with mature organisms, finding in them permanent specific marks, and from that point of view they studied their developmental history. It is only in poetry that the child is "father of the man." The apparently commonplace remark could not be too earnestly repeated, namely, that they could have no true and definite knowledge of the embryo apart from the parent, or of the seed apart from the plant which bore it. The whole tendency, however, of recent research in biology was to assign uncertainty to specific marks in mature forms, and to magnify the importance of a knowledge of constituents and beginnings; in a word, to subject biology, in which there was the all-important factor "life," whose nature was still unknown, to the methods of chemistry, in which uncertainty has no place. After criticising the introductory positions laid down by Herbert Spencer in his book on the "Principles of Biology," the general conclusions of the paper were given as follows: (1.) That ultimate elements being sub-sensible, the biologist is indebted to belief where observation is impossible for a starting-point in order to observe; (2.) That thus the leading principle of positivism is absurd, because while it claims to limit itself to observation, it is forced to assume as a starting-point that which no man has ever observed; (3.) While it is granted that the elements of organisms carry with them their essential qualities into compounds, there is nothing to show that these are not modified by this association; (4.) That, truly interpreted, the behaviour of these elements in compounds affords no favour to the theory of organic evolution; (5.) That life neutralises tendencies to specific change in organisms when these tendencies come into play, and ever acts in directions antagonistic to evolution.

II. *Note on the Shoaling of the Californian Rivers.* By Henry T. Trowbridge, in a letter to Dr Robert Brown.

Having recently had occasion to inquire into the effect of certain human agencies in physical geography, I was curious to ascertain how far hydraulic mining had affected the rivers of California. When I was in that state, this form of gold-washing was then in its infancy. But even at that date (1863-66), the Californian rivers, once clear as crystal, were turbid with the mud washed into them by the operations of the miners in the ordinary *placer* or shallow diggings, in separating the gold from the mud, sand, and gravel with which it is mixed. The hydraulic method, being on an infinitely more extensive scale, could not fail to have greatly intensified these appearances. Accordingly, I presented certain queries to my friend, Mr Trowbridge, who is well acquainted with such matters, and it may be interesting if I communicate the substance of his note to the Society. Before doing so, however, I may briefly describe what hydraulic mining is, since the term must be a novel one to most of the members.

After the shallow diggings in California were all but exhausted, it was necessary to reach the deeper-deposited gold lying on "the bed rock," and covered or mixed with deep deposits of gravel and the *débris* of the rocks, in which it was originally contained. To do so by the mechanical process of shovelling off the superficial *débris* would be a slow and ineffective process. Besides, the earth, etc., would require to be washed, in order to obtain the gold. Now, if both processes could be effected by the same agent, then, undoubtedly, "two birds would be killed by one stone." Accordingly, the "hydraulic" process was invented; and, without going into details, it may be described as one of the most ingeniously simple and yet effective of the many engineering schemes which the *auri sacra fames* has devised. The water is conveyed from a reservoir at a considerable height, so as to give force to the stream which is to be directed against the bank. The stream is conveyed in a canvas hose, which, when full, will bear a perpendicular column of water fifty feet high. Sometimes the pipe will be eight inches in diameter where it connects with the hose, and not more than two inches at the mouth; and the force with which the stream rushes from it is so great, that it will kill a man instantly, and tear down a hill more rapidly than could a hundred men with shovels. One or two men are required to hold the pipe. They usually turn the stream upon the bank near its bottom, until a large mass of dirt tumbles down; and then they wash this all away into the "sluice," or plank or stone paved ditch; when they commence at the bottom of the bank again, and so on. If the bank is 150 feet high, the mass of earth that tumbles down is, of course, immense; and the "pipe-men" must stand far off, lest they should be caught in the avalanche. Such accidents are of daily occurrence, and the deaths from this cause probably are not less than seventy or eighty every year. Often legs are broken. When they are buried in the falling dirt, the water is used to wash them out. The gold contained in the earth is washed into the "sluice," or long ditch. Being heavier than the earth and gravel, it sinks, and is caught by the "riffles" (cross-bars or obstructions) placed here and there. At convenient intervals this auriferous mud is washed, and the gold sifted out, or, if fine, combined with mercury; after which the resulting amalgam is "retorted"—in other words, the mercury is vaporised by heat, when the spongy gold remains behind. Of course, some escapes; and in future times, when labour is cheaper in California than at present, this mud, which forms great dreary flats in the vicinity of hydraulic diggings, will be profitably rewashed.*

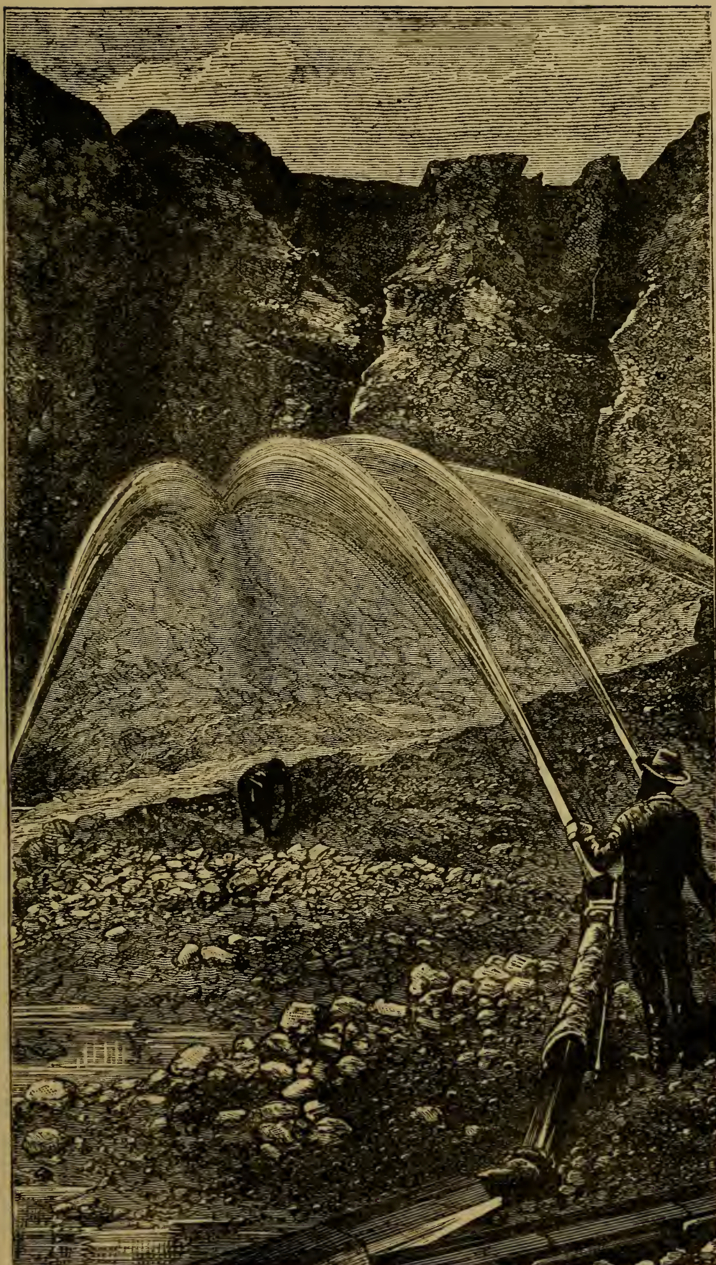
The various processes of gold-mining have all greatly altered the physical features of California; but none of them have had such an effect as "hydraulic" mining. Hills melt away and disappear under its influence, every winter's freshets carrying to lower and yet lower points portions of the *débris,* while whole valleys are filled with clean, fresh-washed boulders of quartz and other rocks. Meantime, the Sacramento and the San Joaquin flow turbid with mud. Bars are formed where none existed before; and the hydrography of

* Hittel: "Resources of California," p. 254.

the Bay of San Francisco is changing under the influence of the same cause. The desolation which remains after the ground, thus washed, is abandoned, is remediless and appalling. The rounded surface of the "bed rock," torn with picks and strewn with huge boulders too large to be removed, shows here and there islands of the poorer gravel, rising in vertical cliffs with red and blue stains, serving to mark the former levels, and astounding the stranger who first sees them at the changes, geological in their nature and extent, which the hand of man has wrought.

Mr Trowbridge informs me that unless dredging is resorted to, it is questionable if the Sacramento ten years hence will be navigable. The bed of the river has been gradually and sometimes even rapidly rising. It is affirmed by some experienced pilots that the bed of the lower river is twenty feet higher than it was twenty-five years ago. The farms on the banks have been seriously injured. "Injunctions," even could they have been obtained, would be useless, for gold-mining is too important an industry of California to be checked by any process of law. In some cases, to save themselves trouble, the miners have bought up the farms, and so their work of digging and washing for gold goes on. The colour of the river water shows that vast amounts of earth are suspended in it; and this is being continually deposited in the beds of rivers, and the current is insufficient to remove it from the channel. Some considerable time since, it was found necessary to withdraw the large steamers from the Sacramento trade, and substitute boats of less draught. In time, the river will become shoaled up, as the San Juan, and other Central American rivers have been, by the natural process of silting, within the last few years. The shallow bays off San Francisco Bay are also getting shoaled. Suisun Bay is already shallow, and in course of time may be converted into cultivatable land, unless the bed of the river should rise faster than the bottom of the bay.

The shoaling of the Sacramento is only one example of many others which could be cited. Meanwhile, the Californian engineers are devising expedients to meet the numerous difficulties which the case calls for just now,



and is likely to present still more obtrusively in the future.

Two photographs were exhibited, one showing the stream of water playing on the bank; the other, the flats of mud formed by the operation. The accompanying illustration, showing hydraulic mining, is reduced from an illustration in Dr Brown's "Countries of the World," vol. ii., p. 5 (by permission of Messrs Cassell, Petter, & Galpin).

III. *Ornithological Notes:* (1.) Buteo lagopus, *Rough-legged Buzzard;* (2.) Anas clypeata, *Shoveller.* (Specimens exhibited.) By JOHN ALEXANDER SMITH, M.D.

(1.) *Buteo lagopus,* Rough-legged Buzzard.—A beautiful female specimen. It was caught on the 30th November in a rabbit-trap, at the Glen, Mr Tennant's property, near Innerleithen, in Peeblesshire.

(2.) *Anas clypeata,* Shoveller.—A young male, shot near Kincardine-on-Forth on the 13th of November. I have before exhibited to the Society other specimens from the same neighbourhood.

Wednesday, 17th January 1877.—J. FALCONER KING, Esq., President, in the Chair.

The following communications were read:

I. *Remarks on the Chessil Bank, Weymouth.* By W. T. BLACK, Esq.

The Chessil Bank of pebbles is one of the great sights for visitors to Weymouth. It stretches in an unbroken line north-west from Portland to Bradstock, for about ten miles along the sea-coast of Dorsetshire. It appears like a huge railway embankment, varying from thirty feet high at the north-west end, to fifty feet at the south-east end, and is from three hundred to six hundred feet broad at the same bases at low-water mark. It is composed of a mass of rounded pebbles and stones, the larger of which appear at the top and back of the mound, and the smaller lie in front, towards the sea; and the south-east end of the bank has larger stones in it than the north-west end, where sand even exists superficially. The base of the bank is conjectured to have a layer of sand, resulting from the *débris* of the trituration of the pebbles above, and lying on a stratum of *mud* or clay, which may also be sounded in the bottoms of Lyme Bay, a considerable distance out. The bigger base, or larger end, rests on the north end of the Isle of Portland at Chessil Town, thence it stretches across the sea to the ferry at Wyke, dividing Lyme Bay from Portland Bay, and afterwards courses along the sea-coast. The sea face of the land inside it is low, till the cliffs at Bradstock are reached, and between the land and the bank lies a water lagoon, ranging from three-quarters to one quarter mile broad, called the Fleet Water, emptying itself into Portland Bay.

The Chessil Bank has been amply described by numerous writers for some time, and has formed the subject of long controversies regarding its formation and constitution, which are not yet satisfactorily concluded. Amongst them may be mentioned the paper of Sir J. Coode, contributed to the *Proceedings* of the Institute of Civil Engineers (vol. xii., May 1853), as the most valuable; and the debate on the question that followed in the meeting of the Society is extremely interesting, supported as it was by eminent scientific and professional men. Next follows Professor Prestwich's communication to the Institute of Civil Engineers, and the report of the discussion thereon at the meeting of February 2, 1875, recorded in the *Proceedings* of the Institute of Civil Engineers (vol. xl., 1874-75). Professor Prestwich has further discussed the Chessil Bank in a paper in the *Quarterly Journal of the Geological Society* (No. 121, February 1, 1875), and in the *Geological Magazine* (vol. xii., 1875). Messrs Bristow and Whitaker have also written articles in the *Geological Magazine* (vol. vi., 1869), on the same. The chief points of discussion entered into are those stated in the papers of Coode and Prestwich, round whose rival arguments range the rest of the writers on either side of the controversy.

The following remarks are chiefly founded upon reductions to diagrammatic representation of the geological and mechanical features of the bank, according to natural scale, taken from the surveys of Sir J. Coode and the Ordnance Survey, supplemented by personal inspection of the site:

1*st,* That the pebbles are assumed to be driven from the west, at Bridport, by west-south-west waves running along the beach obliquely, and also another set from the south, at Portland, by south-south-west waves, according to the respective prevalence and force of these winds.

2*d,* That the highest point of the bank on the Isthmus of Portland may probably mark the meeting of these two sets of wind waves' actions from west and south, and the respective lengths of the bank west and south of this may be commensurate with the greater or less prevalence and force of each of these winds.

3*d,* That the pebbles are not driven by the tides from the bottom of Lyme Bay, as there is nothing there but mud and sand in the soundings, but that they are derived from the disintegration of the chalk, greensand, and red sandstone cliffs of the coast farther west from Exmouth, and from the marl cliffs at Chessil Town at Portland.

4*th,* That a line drawn perpendicular to the axis of the bank lies in a south-west direction, and that lines drawn perpendicular to the two ends of the bank will meet together about forty-five nautical miles out in the channel to the south-west, so that the bank may represent the arc of a great circle of that radius.

5*th,* That a line drawn parallel to the Portland perpendicular will be found to lie between Start Point and Bridport, and that the intervening space may be supposed to represent the area of the west-south-west waves, driving the pebbles along the bank, to the south-east, to Portland.

6*th,* That a line drawn parallel to the Bridport perpendicular will be found to correspond to one drawn between Downend Point and Otterton Point, and the area between them may be taken to represent the S.S.W. waves, driving the pebbles from the west along the Dorsetshire coast.

7*th,* That by the aid of the latter forces the pebbles are driven from Exmouth to Bridport, and by the former they are carried along the bank itself towards Portland, where their further progress is arrested by the counter-wave forces that then take action under the influence of the south-south-west winds prevailing at other periods.

8*th,* Much argument has taken place regarding the distribution of the pebbles on the bank, to account for the presence of the larger stones on the crest, and at the south-east or larger end, and the smaller at the north-west end, and at the base, and views on this point are to be found fully stated in the communications previously quoted.

9*th,* It may, however, be mentioned that the storm waves, which are the builders of the embankment, have a tendency to urge upwards a mass of pebbles by their forward surge, containing the larger ones foremost, and the smaller ones behind; and that the backwash leaves them stranded in the order of its inability to drag them back.

10*th,* This may be due to the velocity of the surge being greatest on its margins to the land side when rising, and least there when beginning to fall back again down the slope, where it is further spent by sinking down between the stones into the interior of the bank.

11*th,* An explanation of the transportation of the larger pebbles from the smaller north-west end of the bank to the larger south-east end, may be offered by supposing that the storm waves, when surging obliquely against the slopes in west-south-west winds, drive the pebbles up the bank obliquely, and leave them there to be projected still further obliquely by the next following surges, as they rose higher and overtook them towards the eastward.

12*th,* Why does the Chessil Bank lie in a north-west and south-east direction? The reply may be that the south-west storm waves, which surge in parallel lines to its length, overcome by their superior force the migratory actions of the west-south-west and south-south-west wind waves, exerted at other times, and drive the stones then left behind perpendicularly up the bank to its crest, which the other weaker wind waves are unable to reach afterwards.

13*th,* The seaward face of the bank is terraced by the plunging action of the surf breaking on it, and has a steeper slope than the landward face, which is more level in conformation, so that the crest of the bank is seen to lie nearer the sea half than the land half.

14*th*, This would lead to the inference that the bank might be gradually advancing inwards on the land, and that it formerly existed much more out to sea than it does now, but of this there is no historical evidence yet forthcoming; but Professor Prestwich's discovery of the existence of raised beaches on Portland and the Devonshire coast gives a geological support to the idea.

15*th*, This conjecture may derive some further confirmation from the fact of the twenty-fathom line of soundings in Lyme Bay, stretching in an unbroken curve from Portland Ledges to Start Point, indicating that the bay might formerly have been dry land, and had since been scooped out by the denuding action of the sea, and had left these stones and pebbles as the remains and records of its action.

If a straight line be drawn between Portland Point and Charmouth, representing the chord of the arc of Chessil Bay, the perpendicular raised upon this to the circumference of the arc at the pebble bank may be assumed to be proportional to the effects of the storm waves at each spot. These lines will be seen to be larger in the middle of the bank, and represent therefore the greater force in driving back the shingle, and shorter at the sides, where the effect of the wind waves would be less. Again, if a tangent line be drawn on the outside of the arc of the bay perpendicular to the middle of the bank, then the perpendiculars erected on this may be taken to represent the landward resistance to the invasion of the sea. This will then be seen to be strongest at the sides, where the bank rests on rocky cliffs, and weaker in the middle, where the cliffs are absent, and the superficial strata and deposits reach the level of the sea.

II. *Conchological Notes made at Elie, Fife, during the Summer of* 1876. By ROBERT ETHERIDGE, Jun., Esq., F.G.S. Communicated by JOHN GIBSON, Esq.

The notes from which the following remarks are drawn up were collected during a short visit to Elie, on the coast of Fife, during the past summer (1876).

(1.) *Scrobicularia piperata* (Bellon.); *Mya arenaria* (Linn.); and *Tellina Balthica* (Linn.), in the Cocklemill Burn.

For two or three hundred yards above its mouth in Largo Bay the Cocklemill Burn has formed small alluvial flats, twenty to thirty feet below the general level of the St Ford Links, through which it winds its course, locally called "Inks." These small flats are, as a rule, dry at low water; but at the rise of the tide they become pretty generally flooded, or, at all events, sufficiently so to fill up and replenish a number of small irregular holes or depressions a few yards in circumference, which are scattered here and there. A visit was paid to the locality in the company of Dr M'Bain, R.N., and Mr Howie of Upper Largo, to obtain specimens of *Scrobicularia piperata,* which were known to occur in the before-mentioned holes by both these gentlemen. During the recession of the tide, we succeeded in digging out a quantity of the black mud forming the bottom of the holes, and from which we extracted many specimens of *Mya arenaria, S. piperata, Tellina Balthica,* all living, and, as regards numbers, the first named in greatest abundance, and the second predominating over the third. The shells were all much stained in parts by the black material in which they were found, although the molluscs appeared in a perfectly healthy condition. When placed in clean water, the long siphons of *S. piperata* were displayed to advantage, and the tube of *M. arenaria* was extended to its full length.

Dr Gywn Jeffreys remarks on the capabilities *Mya arenaria* possesses of living in brackish or fresh water, and mentions a list of shells, chiefly fresh-water, which are found in company with it in the Baltic. Amongst these is *Tellina Balthica.* The individuals of *M. arenaria* from the Cocklemill Burn are a somewhat more transversely elongated variety, in proportion to the height of the shell, than the examples figured either by Forbes and Hanley, or Jeffreys. Many of the *Scrobiculariæ* are strong thick shells.

The mud in which these species were living was black, stinking, and offensive in the extreme, and contained a quantity of partially-decayed vegetable matter, and the shells are all much stained with a ferruginous and blackish tinge, arising from this.

The occurrence of *Scrobicularia piperata* in the fossil state in beds forming the banks of the Cocklemill Burn has already been pointed out by the Rev. T. Brown, M.A.,* the individuals, in every case, being found in their natural position with the posterior or siphonal end of the shell uppermost. It is quite unnecessary for me to dilate on the importance, from a geological point of view, of the occurrence of this species in the fossil and living state so close together at one locality.

(2.) On varieties in colour and banding in *Helix aspersa* (Müller); *H. nemoralis* (Linn.); *H. arbustorum* (Linn.); and *H. ericetorum* (Lister).

I have next to draw the attention of the Society to the unusually large number of the foregoing species of *Helix* inhabiting the links around Elie during last summer. On the links east of Elie, *H. aspersa* and *H. nemoralis* occur in thousands, especially the latter species, with a few *H. ericetorum*. The two former are also equally plentiful on the links west of Earlsferry, and along the cliff-edge above Kincraig. It was, however, on the St Ford Links, west of Kincraig, around the Cocklemill Burn, that the greatest profusion was met with of all except *H. aspersa*, which was comparatively scarce. When walking across the links, the observer could not avoid crushing under his feet hundreds of *H. nemoralis*, and thousands of *H. ericetorum;* indeed, I do not recollect ever seeing any shell, recent or fossil, in such overwhelming abundance as the last named. Along the hedgerow leading to Kincraig farmhouse, a locality pointed out to me by Mr Howie, *H. arbustorum* was found in abundance, and I also found the same species feeding amongst the long

* *Transactions*, Edinburgh Royal Society, xxiv., p. 624.

herbage on the banks of the Cocklemill Burn, and again amongst bushes in hollows of the links towards Largo.

The author then exhibited and described specimens of the foregoing species: Of *H. aspersa,* 4 vars.; *H. nemoralis,* 30 vars., differing from one another either in the arrangement of the bands on the whorls or in the colour of the shell; *H. arbustorum,* 3 vars.; *H. ericetorum,* 2 well-marked varieties, with intermediate forms.

III. *The Influence of Recent Gales on some Marine Forms of Life.* By Professor Duns, D.D.

Shortly after the strong easterly gales that marked the close of 1876 and the opening of 1877, I walked along the shore from Leith to Portobello, with the view of picking up any of the less common marine forms that might have been washed ashore in that locality. On many occasions I had found that part of the coast very productive after a storm. In the present instance, I was struck with the unwonted numbers of some of the forms left a little below the high-water mark. While mollusca prevailed, they were associated with other classes, which told how very general the influence of the storm had been. There were rays and fragments of discs here and there of the common sand-star (*Ophiura texturata*), the same in greater numbers of the lesser sand-star (*O. albida*), in greater numbers still the same of the common brittle-star (*Ophiocoma rosula*), the arms of the common crossfish (*Uraster rubens*) and of the sun-star (*Solaster papposa*), limbs of crustacea—*Carcinas, Lithodes, Galathea*—and, in pretty large numbers, dead hermit crabs (*Pagurus Bernhardus*) either in their naked condition, or connected with the gasteropodous shells in which they had found a home. At the high-water mark, on the shore near Leith, the common sea-mouse (*Aphrodita aculeata*) might have been picked up in dozens.

But I wish to refer chiefly to certain species of mollusca, specimens of which are on the table in the condition in which they were gathered. Looking at them from the point of view of the numbers in which they occurred, they may be set down as follows :—*Buccinum undatum*, *Lutraria elliptica*, *Pecten opercularis*, *Cyprina Islandica*, *Mytilus edulis*, and *Cardium echinatum*. The number of *Buccinum undatum* was very great. One could hardly have imagined the existence of so many of this species in the Forth. In an area less than three feet square I counted 256, and they were quite as plentiful for about a mile along the coast in a line some feet below that of high-water mark. In nineteen cases out of every twenty the shell contained the dead animal, with the anterior part of the body and the operculum hanging out about half-an-inch in length. In like proportion the body whorl, or first turn of the shell, was broken in the fashion now shown by the specimens on the table. I have not seen this part of the shore for more than ten days, but if it presents the same appearance as when last seen, these large whelks might, literally, be gathered in cart-loads.

The condition of *Lutraria elliptica* is in marked contrast with that of *Buccinum undatum*. The former rarely occurs attached to the shell. Only after considerable search, I obtained two or three specimens in which animal and shell were united. The vast majority of specimens were naked. Indeed, comparatively few shells are to be seen, but the *débris* on the shore, and every shore pool, contained the naked forms, and especially the peculiar-looking elongated flattened tube formed by the united siphons. I counted thirty of these in a pool formed around one of the boulders, which occur in great numbers at several parts of this shore.

The other species named above are much fewer than the two now specially noticed. *Pecten opercularis*, while well represented by single shells, when compared with the remains of the waved whelk, might be said to be few in number. But it is very uncommon to find the broken shells of this species with the dead animals attached scattered along the shore. It is, moreover, far less common to meet with the strong shell of *Cyprina Islandica* so shattered while the animal clings to some of the fragments, as is seen in the specimen now on the table. In very many cases the common mussel, animal and shell, is met with in a like condition. The *Cardiadæ*, which are, curiously, not so numerous as any of these now mentioned, have as a rule the shells entire, their hinges complete and fastened, open in front, with the highly-marked sickle-like foot of the animal protruding.

Looking at the distribution of these forms in depth, *Buccinum* is met with from low water to a hundred fathoms, *Lutraria* from low water to twelve fathoms, *Cyprina* from five to eighty fathoms, *Pecten* from fifteen to twenty-five fathoms. The other two are low-water forms.

Certain species one might have expected to find in considerable numbers, were represented only by broken shells here and there, as *Solen siliqua, Fusus antiquus,* and *Chiton fascicularis.*

From the facts now narrated, I infer (1.) That the destruction of certain forms of molluscan life has been unusually great during the recent gales; (2.) that the four species first mentioned must have been brought from a distance, having evidently been dashed by a tempestuous sea on a rocky shore before they were cast on the gently sloping sandy beach, where they were left by the tide at the cessation of the gales; (3.) that the condition of the shore as now referred to is highly suggestive as shedding light on some geological phenomena. More than twenty years ago, when passing along the Bathgate hills, I was attracted to a limestone quarry by an unusually loud report in connection with blasting operations. The workmen had arranged to fire several heavy shots almost simultaneously, and great masses of rock were torn from their bed, revealing in them great numbers of *Productidæ, Spiriferidæ, Euomphali,* here and there fragments of *Orthoceros,* all of them, one might almost say, "*pounded*" together, in association with *Favosites, Cyathophyllum,* etc. For few, if any, of the molluscan remains had been embedded entire. It might be asked, " Were these laid down in connection with the action of forces analogous to those which sorted the forms on the shore now described?"

IV. *Notice of some Remarkable Remains of* Rhizodus (*bones, scales, and teeth*), *recently discovered at Gilmerton by Mr Robert Tervet.* By David Grieve, Esq., F.G.S. (Specimens exhibited.)

These fossil remains were found by Mr Robert Tervet at West Edge, near Gilmerton, on 7th July last. The large plate bone was in numerous pieces, and afterwards patiently and carefully cemented together.

Mr Tervet has taken considerable trouble in making an analysis of a portion of one of these bones (Spec. 16), and has sent me an elaborate statement of his formulæ in arriving at his conclusions. I consider it only necessary, however, to give the latter as under:

Percentage of Fossil Bone.

Fluoride of Calcium (not estimated, but appreciable, inasmuch as it etched words on glass), .	
Phosphate of Lime, ...	50·15
Carbonate of Lime, ...	28·85
Animal matter, ...	1·25
Constitutional water, ...	1·70
Silica, ...	10·35
Alkalies, ...	6·00
	98·30

I apprehend that the constituents of the bones of all or most of those large fossil fishes whose bones approximate to the solid form and substance of the bones of the mammalia are very much alike. I intended to have compared the above analysis with that given by Dr Hibbert as the constituents of the so-called *Holoptichius* included in his paper, which is to be found in the *Transactions* of the Royal Society, vol. xiii., but in consequence of being confined by illness have been unable to do so. This fish, subsequently named *Rhizodus Hibberti* by Agassiz, is presumably the same to which belong the remains now exhibited, so that the analysis should be similar.

The fossils have been under examination by my learned colleague in the presidency, Dr Traquair, who has kindly undertaken to describe their anatomical features to the Society.

Dr TRAQUAIR, in the absence of Mr Grieve, gave a short description of some of the specimens which had been forwarded for exhibition.

V. Dr TRAQUAIR exhibited a tooth of *Archichthys sulcidens* (Hancock and Atthey), from the roof shale of the splint coal seam at Smeaton, near Dalkeith. *Archichthys*, of which only one species is as yet known, is a characteristic fish of the true coal measures, and is allied to *Rhizodus*, differing from it, however, in the absence of cutting edges in the laniary teeth. It is abundant in Northumberland, occurring also in Lancashire; but is now, for the first time, recorded from one of the Scottish coal-fields.

VI. *Ornithological Notes:* (1.) Buteo lagopus, *Rough-legged Buzzard;* (2.) Mergulus melanoleucos, *Little Auk;* (3.) Larus glaucus, *Glaucous Gull.* (Specimens exhibited.) By JOHN ALEXANDER SMITH, M.D.

(1.) *Buteo lagopus*, Rough-legged Buzzard.—A male bird shot in the Pentland Hills, also a female from the same locality, another from Yester, Haddingtonshire, in the months of November and December.

(2.) *Mergulus melanoleucos*, Little Auk.—One specimen recently shot near North Berwick, another at Tyninghame, and another from the Fife coast. The birds are winter visitors, and have been probably driven inland by the easterly winds.

(3.) *Larus glaucus*, Glaucous Gull.—Another of our winter visitors. One was shot near Newhaven, and another near North Berwick.

Wednesday, 21st February 1877.—Dr RAMSAY H. TRAQUAIR, F.G.S., President, in the Chair.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Videnskabelige Meddelser fra Naturhistorisk Forening i Kjöbenhavn, for Aaret 1875.—From the Society. 2. Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger og dets Medlemmers Arbijder—1875, Nos. 2, 3; 1876, No. 1.—From the Society. 3. Acta Horti Petropolitani, Tomus IV., Fasciculi 1, 2; cum Suppl. ad. IV.—From the Imperial Botanic Garden, St Petersburg. 4. The Canadian Journal of Science, Literature, and History, Vol. 15, No. 4; January 1877.—From the Canadian Institute, Toronto. 5. Proceedings of the Royal Society (of London), Vol. 25, No. 175 (Nov. 1876).—From the Society. 6. Journal of the Linnean Society—Botany, Vol. 15, No. 87; Zoology, Vol. 13, No. 66.—From the Society. 7. Proceedings of the Geologists' Association (London), Vol. 4, No. 9 (Oct. 1876).—From the Society.

The following communications were read:

I. *On the Structure of the Lower Jaw in* Rhizodopsis *and* Rhizodus. By RAMSAY H. TRAQUAIR, M.D.

Among the detached and broken-up remains of the Coal-measure fish known as *Rhizodopsis sauroides*, one of the most frequently observed is a bone of a somewhat narrow and elongated form, truncated and somewhat expanded at one extremity, which may be assumed to be the anterior, and pointed at the other or posterior. One margin, nearly straight, save just in front, where it shows a slight convexity, is set with a single row of small pointed teeth of nearly uniform size; but the anterior extremity bears in addition a single more or less incurved laniary tooth, much larger than the others, and also more internal in its position; the opposite margin, thin and sharp, displays a gently flexuous contour. Seen from the inner aspect, the anterior extremity of the bone presents a conspicuous thickening, in which the large laniary is socketed, and which at the dental margin passes into a delicate ledge, which runs back for some distance along the roots of the smaller teeth.

This bone, whose external form has been well described by Messrs Hancock and Atthey,* was considered by them to be the *præmaxilla* of *Rhizodopsis*, being obviously distinct from

* Ann. & Mag. Nag. Hist. 1868, ser. 4, vol. i., pp. 350, 351.

another well-known dentigerous bone, which is indisputably the maxilla, and closely resembles in form the maxilla of *Magalichthys.* To all appearance it would also seem to be distinct from the mandible, the margins of which "are nearly parallel," and which displays, besides a large laniary tooth in front, "three or four others placed along the ramus, in a line within the small teeth."

With the bones described by Messrs Hancock and Atthey as the præmaxilla, maxilla, and mandible of *Rhizodopsis,* every student of carboniferous ichthyology must be familiar. The interpretation of the first of these as "præmaxilla" has been accepted by the Messrs Barkas,* and, so far as I am aware, has remained hitherto unquestioned. Nevertheless the accuracy of its determination as such was to me a matter of doubt from the first. It is true the bone in question does in some measure remind us of the elongated præmaxilla of Teleostei of the most specialised type, in which that element, loosely articulated with the front of the skull, extends backwards so as to shut out the now edentulous maxilla from the edge of the mouth (*Perca, Gadus,* etc.). But as *Rhizodopsis* is a Crossopterygian ganoid of the type possessing two dorsal fins and subacutely lobate pectorals, one would naturally expect that its præmaxillary bones would resemble in form and relations those of its natural allies, whether rhombiferous or cycliferous, in all of which, whose cranial osteology is sufficiently known, each præmaxilla is comparatively small and short, firmly fixed to the front of the cranial shield, and, in fact, very unlike the bone of *Rhizodopsis* which has been so interpreted. How to fit this bone into the præmaxillary region was to me somewhat puzzling; and, accordingly, to find it *in situ* in the head of the fish was an object to be attained, before giving in adherence to the views usually maintained regarding it.

A short time ago my friend Mr Ward of Longton, to whose liberality in lending specimens from his magnificent collection I am on this, as on other occasions, so largely indebted, sent

* "Manual of Coal-measure Palæontology," by T. P. Barkas (London, 1873), p. 24, pl. ii., fig. 61; W. J. Barkas in *Monthly Review of Dental Surgery.*

me a number of unusually good examples of the head of *Rhizodopsis* preserved in nodules of hard ironstone from the Coal-measures of Fenton in Staffordshire. One of these displays the entire extent of the gape on both sides of the head. Each maxilla measures here $1\frac{1}{10}$ inch in length; the upper margin is injured; but the lower, bearing one row of small teeth, is quite intact; the anterior extremity shows the little articular process projecting upwards and forwards as in the similarly shaped maxilla of *Megalichthys.* Now, placed between and articulating with the anterior extremities of the right and left maxillæ, while they are joined with each other in the middle line, are two small dentigerous bones forming the front edge of the mouth below the snout. Each of these two bones is nearly as high as long, these measurements being respectively $\frac{4}{16}$ and $\frac{5}{16}$ inch; they are firmly fixed to each other and apparently also to the front of the cranial shield: the teeth, which in this specimen are seen attached to them, resemble those of the maxilla; but in another example there are traces of others somewhat larger. That we have here the true *præmaxillæ* is beyond all doubt; some other signification must therefore be found for the bones hitherto considered such. Turning now to the mandible, both rami of which are displayed in the specimen under description, we find that over a considerable area the bony matter of the outer aspect has flaked off, leaving behind it a pretty sharp cast with sutural lines. On close examination a suture is now seen commencing near the posterior extremity of the upper margin of the jaw, and, passing gradually downwards and forwards, marks off as *dentary* an element precisely the counterpart in shape of the reputed præmaxilla. The pointed extremity is placed backwards, the enlarged one forwards, the toothed margin upwards. The rest of the outer surface of the mandible is composed of at least three additional bony plates, separated from each other by sutures which pass obliquely forwards and upwards. The posterior and largest of these, covering over the articular region of the jaw, may be perhaps equivalent to the *angular* element, though it also occupies very much the place of a *supra-angular;* the other two, in front of the latter and below the dentary, may be called *infradentary;* and there is also some evidence of a fourth small plate on the lower margin of the jaw, separating here the angular from the first infradentary for a little distance.*

In another specimen, compressed vertically and showing the top of the head, both maxillæ are seen, forming the upper margin of the mouth, while, forming its lower margin, both dentaries are seen on the edge of the nodule, here retaining their bony substance and external sculpture. Their contour proves beyond a doubt that the dentary element of the mandible of *Rhizodopsis* is undistinguishable from the bone hitherto reckoned as præmaxilla, but which I have already shown cannot possibly be so. The very same thing is most clearly shown in a shale specimen belonging to Mr Plant of Salford, in which a vertically compressed head is seen from below; so that I have no hesitation in affirming the identity of the bones in question.

Here, however, an objection to this view may be raised. The mandible of *Rhizodopsis* when perfect, as in most of the specimens from Fenton now before me, shows not merely one large tooth in front, but two or three additional ones behind it and internal to the series of small teeth, though, as stated by Messrs Hancock and Atthey, these additional larger teeth "are seldom present." What has become of these in the detached dentary, if such be the real nature of the reputed præmaxilla?

A ready explanation of this is found in the structure of the lower jaw of certain Old Red Sandstone "Dendrodonts," in which the laniary teeth are not attached to the dentary bone proper, but to a series of accessory "internal dentary" pieces articulated to its inner side.† Should this be also the case with the posterior laniaries of the mandible of *Rhizodopsis*, then, in cases where its elements are broken up and separated,

* That these sutures on the outer surface of the mandible in *Rhizodopsis* have not been previously observed is fully accounted for by the difficulty of tracing the line of demarcation between constituent and closely united osseous elements, in cases where we have to deal with a granulated or otherwise ornamented external bony surface. Such lines of demarcation are more easily determined where the bones are seen from the inner surface, or where a sharp cast in hard ironstone of that inner surface has been preserved.

† See Pander's "Saurodipterinen, Dendrodonten, etc., des devonischen Systems," pp. 41-43, tab. x., figs. 2, 3, 4, 14, 22.

these additional pieces will also get detached, and the absence of all but the anterior laniary in the isolated dentary bone will thus be amply accounted for.

The material at hand not furnishing me with absolute proofs of this condition in *Rhizodopsis,* I now turned to its gigantic ally, the *Rhizodus* of the Scottish Lower Carboniferous strata. I had previously observed the not uncommon occurrence of detached dentigerous bones belonging to *R. Hibberti,* which had exactly the same shape as the so-called præmaxillæ of *Rhizodopsis,* and, like them, frequently bear only one laniary, the large one in front. On now carefully examining the exterior of several more or less perfect mandibles, it became at once evident that the bone in question was nothing more or less than the dentary element, the rest of the outer surface of the jaw being formed by several additional bony plates quite analogous to those occurring also in *Rhizodopsis.* In *Rhizodus* there are four such additional plates: of these the posterior one, covering up the articular region, is probably equivalent to the angular element, though, indeed, occupying also the position of a supra-angular; while in front of it, below the dentary, and forming the lower margin of the jaw, are three others, diminishing in size from behind forwards, and separated from each other by sutures passing obliquely forwards and upwards, and to which, as in *Rhizodopsis,* the name of *infradentary* may be applied.

Several detached specimens of the dentary bone of *Rhizodus* in the Edinburgh Museum exhibit its inner surface, which is also conformed just as in the corresponding element, the so-called præmaxilla, of *Rhizodopsis.* The upper margin, comparatively thin, is set with one row of small teeth; but at the symphysial extremity the bone shows a great thickening, the anterior part of which is marked by a very rough area for articulation with the bone of the opposite side. In this thickening is implanted the anterior great laniary, behind and close to which is another socket, usually empty, sometimes occupied by a "twin" tooth.* There are also in the Museum several jaws seen from the internal aspect and in which

* The more posteriorly situated laniaries of *Rhizodus* occur also occasionally double.

the posterior laniaries are present; but being imbedded in hard ironstone, the surface of the bone is so injured as to render recognition of sutures a matter of difficulty; they show, however, very clearly that these posterior laniaries are implanted in a thickened ledge, somewhat nodulously enlarged round the base of each, and continuing backwards the symphysial thickening of the dentary proper—this ledge with its teeth being totally absent in the detached dentaries above alluded to. I now selected for special preparation two jaws, seen from the outer surface, and fortunately imbedded in a rather soft laminated clay. The first of these was a portion of a comparatively small jaw, $3\frac{1}{4}$ inches in length, and broken across $\frac{3}{4}$ inch behind the stump of the second laniary; and by softening the matrix with water, I succeeded in completely detaching it and cleaning its inner surface. The surface of the bone being here quite intact, I obtained a clear proof of the fact which I had anticipated, viz., that the second laniary tooth is attached to a separate piece of bone articulated by a distinct suture to the anterior thickening of the dentary, and having its outer surfice in apposition with the flat inner surface of the dentary behind that thickening. The next jaw was a larger one, measuring 14 inches in length, showing three entire laniaries and the stump of a fourth, the articular extremity being, however, unfortunately broken off. Having covered up the outer surface of the specimen with a sufficient mass of Portland cement, I turned it over and worked down upon it from the other side, the preparation thus obtained entirely corroborating the conclusions previously arrived at. The large teeth are seen to be borne upon a thickened ledge, diminishing in strength from before backwards, the anterior part of which is the previously described symphysial thickening of the dentary proper, and carries the first great laniary; the suture between that and the anterior of the accessory internal dentary pieces bearing the second laniary is distinctly seen; but posteriorly the separation of the others is obscured by the obstinate adherence to the bone of a thin layer of the matrix, which cannot be thoroughly cleared off without iujuring the surface. My attention was next directed to a block of the same laminated clay containing several bones of *Rhizodus.* From this I succeeded first in extracting the anterior half of an isolated dentary bone, that of the right side, showing the stump of the symphysial laniary with the adjoining empty socket. Then, lying about 2 inches from it in the same block, I observed a piece of bone bearing a large tooth, which on being in like manner extracted entire proved to be nothing more or less than the *detached* accessory piece carrying the second laniary of the same jaw, and would have fitted perfectly on to the dentary found beside it, had not the latter been a little distorted by crushing. Finally, several vertical sections through another mandible led to the very same result—namely, that the laniary teeth behind the great anterior one are attached to bone which is quite distinct from that of the dentary proper; and as the piece to which the second laniary is attached has occurred quite isolated, we may very safely assume that the third and fourth had also each a piece for themselves.

Summary.

The general results of the researches briefly detailed above may be summed up as follows:

The mandible has, as far as ascertained, essentially the same structure in *Rhizodopsis* as in *Rhizodus.* In both, the *dentary* element is narrow and pointed posteriorly, its upper margin bears one row of small teeth, while at the symphysis it is peculiarly thickened where it bears the first or anterior laniary. This bone, turned upside down, has, in *Rhizodopsis,* been previously considered to be the præmaxillary; the last-named element of the skull of that fish has now, however, been ascertained to be a different bone, which is quite similar in form and relations to the præmaxilla in other Crossopterygii.

The laniary teeth behind the anterior one are borne upon separate *internal dentary* ossicles, which, when the constituent elements of the lower jaw are broken up and separated, will also become disarticulated and dispersed. This is absolutely proved in *Rhizodus,* and may be considered morally certain in *Rhizodopsis,* though a clear view of the inner aspect of the complete mandible of the latter, with the posterior laniary teeth *in situ,* has not yet been obtained.

Below the dentary the inferior margin of the jaw is formed by a series of *infradentary* plates, while posteriorly the articular region is covered by a plate corresponding in position apparently both with the *angular* and *supra-angular* elements. I may add that in one specimen of *Rhizodopsis,* I have seen very distinct evidence of a *splenial.*

The great complexity of the structure of the mandible in these forms and in the allied "Dendrodonts" of the Old Red Sandstone need not astonish us when we take into account the remarkably segmented splenial of the recent *Amia,* or the similarly segmented maxilla of *Lepidosteus.*

II. *On the Occurrence of the Black Redstart* (Ruticilla tithys) *in Stirlingshire.* By John A. Harvie-Brown, Esq. (Specimen exhibited.)

This specimen of *Ruticilla tithys,* the fourth occurrence of the species in Scotland, as far as I am aware (for the three previous records see Mr Gray's "Birds of the West of Scotland," p. 84), and which was shot at Higginsneuk, in Stirlingshire, opposite Kincardine-on-Forth, by myself, on the 10th November 1875, I took to be an immature female; it is a female by dissection.

The distinctions between females of this species and those of the common redstart (*R. phœnicurus*) are not always easily diagnosed, but one distinction pointed out by various authors is, I understand, sufficient to distinguish them in all stages and phases of plumage, viz., in *R. phœnicurus* the tail feathers are uniformly rufous throughout (except at the base), except the two centre feathers, which are brown in both species. In *R. tithys,* the tips of the tail feathers are brown as in this specimen.* The faintness of the brown in this specimen points to immaturity. The absence of decided

* Mr Cecil Smith, "Birds of Somersetshire," p. 89, says the female black redstart has "the tips of all the tail feathers reddish brown like the two centre feathers." Shelly, "Birds of Egypt," p. 84, says, "Tail bright rufous tipped with brown." Professor Newton ("Yarrell," fourth edition, p. 338) says, "The outer pair of feathers with the outer web brown."

alar patch is also a symptom of immaturity. Although seen in old birds (and in adult males in winter occasionally), the alar patch is absent or very faint, as pointed out by several authors.*

A further distinction may be found in the generally lighter colour of the under parts of *Ruticilla phœnicurus* as compared with the same parts of *Ruticilla tithys,* which, as in this specimen, are uniform, or almost uniform, with the upper plumage.

Although so rare in Scotland, this species may be considered as a regular winter visitant to the coasts of England. It has occurred in Faroe (Yarrell), Norway, and at its farthest northern point in the middle districts of Sweden. I find no record of it in North Russia, north of 60° N.E. Although its occurrence in Scotland must be considered exceptional, still, I think we can hardly class it as *purely* accidental, as I believe it will be found there is a natural law accounting for many occurrences of Continental species as far north in Great Britain as the present example. Indeed, I think the suggestion may be hazarded that if certain species extend their northerly breeding limit on the Continent, we may safely calculate upon their occasionally alighting on their autumn migration farther to the north in the British Isles than they would otherwise do. What we have for a long time considered as *accidental* (purely accidental) occurrences of Continental species ought, I think, in many instances rather be held as indications of extension, towards the north, of breeding limits on the Continent. This supposition would seem to be borne out by what we know of the regular occurrence of many rare eastern species in the island of Heligoland, where almost every autumn such species as *Phylloscopus superciliosus* and *P. borealis* occur on migration, species which have their breeding quarters, so far as is at present known, in the Eastern Palæarctic Region, and at Archangel and in North-East Russia. The present species has also ocurred in Heligoland in autumn on migration sparingly, and I am inclined to think that the specimens so occurring

* Mr Gatcombe, quoted by Mr Dresser, "Birds of Europe," double part, Nos. xxix, xxx. J. H. Gurney, Jun., "Rambles of a Naturalist," p. 162.

were not necessarily driven there by unusual winds, but were birds passing from their summer quarters at some locality farther to the north and east of their usual limit on a regular migration. Such of the black redstarts, therefore, that reach Scotland may, it is true, in so far be considered accidental, that they may have overshot their turning-point or usual *north-west* limit on migration, which turning-point would appear, in the case of many other species, to be somewhere in the neighbourhood of Heligoland. That such a turning-point does exist there would seem to be good reason to believe, for how otherwise can we account for species which breed far to the east in Siberia or North-East Russia, and winter nowhere in Europe or Africa (the above-named *Phylloscopi*, for instance), how can we otherwise account for their almost regular appearance in that one little spot of some 150 acres, viz., Heligoland, and nowhere else in Europe? I will not pursue this subject here further, but I think I have shown some reason for *not always* considering the occurrences of Continental species in Scotland as *purely* accidental, but rather, as before stated, as indications of a gradual northerly extension on the Continent of their breeding range, and as resulting from a natural law and a regular migration. Ornithologists are now looking forward with some expectancy to the clearing up of much that has hitherto been mysterious in the matter of migration, and many believe, myself amongst the number, that a key will ere long be found in the fauna of this curious, isolated fragment of Europe, above mentioned, as elucidated by the able hand of its native naturalist, Herr Gaetke.

III. *Notes on the Ornithology of Yedo.* By Colin A. M'Vean, Esq. Communicated by the Secretary.

INTRODUCTORY REMARKS.

I purpose giving in this paper a short account of the birds observed by myself frequenting Yedo, the capital of Japan. During a residence of some years in that city I was much struck with the extraordinary number of birds of various kinds to be seen within its boundaries. The profusion of bird life indeed appeared to me to be specially worthy of remark, bearing in mind the great extent and population of Yedo, and the traffic and noise of its busy streets. In the midst of this, and often within reach of the cast of a trout-rod from the sides of crowded streets, wild fowl of all descriptions, from a snipe to a swan, floated quietly at their ease or fed on land, without heeding the bustle around them, or being disturbed by the passing crowds. They were, indeed, very rarely molested, owing, I believe, to the shadow of the old law, which made it death to kill a duck in the moats and waters within the town. The law still protects them, though the death penalty has been removed, and I was therefore obliged to content myself by watching their movements with a field-glass, from the roadways and lanes, at a convenient distance.

In order properly to understand how such numbers and varieties of wild birds can take up their quarters in the very heart of a large city (and this is perhaps the chief feature I have to communicate), a short description of Yedo will be necessary.

Yedo, the present capital of Japan,* is situated at the head of the gulf that bears its name, on the east coast of the island of Nipon, in lat. 35° 42′ N., and long. 139° 50′ E. approx. The city was founded about three hundred years ago, has a strong castle, and, until 1868, was the chief stronghold of the Tycoons, or commanders-in-chief of the imperial forces, who for some centuries had usurped the chief executive power—a power which belonged alone to the Mikado, who was kept like a state prisoner in his palace in Kioto, the ancient capital of the country. Since the revolution of 1868, which abolished the Tycoonate and restored the emperor to full power, the Mikado has resided in Yedo.

The rivers, or branches of one river—Sumida and Nakagawa—fall into the Gulf of Yedo; one branch passing through the city, and the other just outside its bounds. Between the mouths of these rivers there is a considerable extent of marshy ground, with patches of tall reeds and open water.

* Yedo has been renamed since the revolution of 1868. It is now called Tokio.

The waters at the head of the gulf and round its shores are very shallow, and the country for some miles inland is generally low and flat, and cut up by streams and canals, with here and there ridges of higher ground often thickly wooded. The greater part of Yedo is built on low land, hardly more than ten feet above the level of high water. It covers an area of about twenty-five square miles, and has a population of 700,000.

The castle occupies the end of a spur of higher ground, that runs through one side of the town from south-west to north-east, and is surrounded by three moats, besides branches, from one to two or three hundred feet in width, the extent of the outer moat being fully five miles round. Besides the main river and moats, several small rivers run through the city; also numerous canals which are generally bordered by firs and pine-trees. Like cities in other parts of the world, Yedo has its aristocratic quarter, business quarter, and poorer localities. In the aristocratic quarter the houses and yashikis of the ex-Daimios have generally a considerable extent of garden ground around them, beautifully laid out, and always in imitation of the natural landscape, there being invariably a small lake or pond, with rushes, in corners, surrounded with bamboo and other trees. Even in the most crowded business centres gardens are found so arranged and laid out that, sitting under the verandah overlooking the indispensable pond, it is hard to realise that outside the belt of bamboo there are streets as crowded and busy, without exaggeration, as Princes Street or the North Bridge in Edinburgh, at the busiest time of the day. Within the inner moat of the castle are some very beautiful grounds, with fine old trees and miniature lakes, streams, and waterfalls, and even rice-fields. The same are to be found on a smaller scale within temple and yashiki or palace grounds of all the ex-Daimios. These grounds, and the numerous streams, moats, and canals, with their wooded margins, give room and shelter to the birds.

The following authorities have been consulted in preparing the catalogue of species: (1.) Temminck and Schlegel—" Fauna Japonica: Aves." (2.) Captain Blakiston—" On the Ornithology of Northern Japan," *Ibis*, 1862, p. 309. (3.) Do.—

"Corrections and Additions" to the foregoing paper, *Ibis*, 1863, p. 97. (4.) Henry Whitely, jun.—"Notes on Birds collected near Hakodadi, in Northern Japan," *Ibis*, 1867, p. 193. (5.) Robert Swinhoe — "Notes on the Ornithology of Northern Japan," *Ibis*, 1863, p. 442. (6.) John Cassin—Paper on "Birds Collected in Japan," in vol. ii. of Commodore M. C. Perry's "Narrative of the Expedition of an American Squadron to the Chinese Seas and Japan in 1852-54;" Washington, 1856.

LIST OF SPECIES.

Sea-Eagle (*Haliaëtus pelagicus*), Faun. Jap., pl. 4, p. 11 (1850).—I have once or twice seen this very handsome white-tailed sea-eagle fly over the bay. I was not, however, able to procure a specimen.

Osprey (*Pandion haliaëtus*), Linn.—The osprey is very common in Japan. Two or three may be seen almost any day circling over the shores of the bay of Yedo, seemingly indifferent to the boats and crafts of all kinds that crowd the bay, or the bustle and noise on the wharves.

Goshawk (*Astur palumbarius*).—Is occasionally met with in the capital. Shortly before I left, one was caught alive in a trap specially set for him, in the grounds of the ex-Prince of Chikusen. It was probably attracted by the tame birds of its own species kept by the prince.

Kestrel (*Falco tinnunculus*).—Is not uncommon.

Peregrine (*Falco peregrinus*).—I have several times seen a falcon which I took to be this species. I was never, however, able to identify it in the hand.

Black-winged Kite (*Milvus melanotis*).—This is perhaps the commonest bird to be found in the towns and villages of Japan, especially those on the sea-coast. On the wing it is rather an elegant bird, as it wheels in graceful circles over the streets, swooping down now and then perhaps to seize a fish from the basket of the unwary pedlar, and at times even attacking the stalls of the street vendors of food. It acts as town scavenger, and hardly anything comes amiss to it.

Japanese Owl (*Scops Japonicus*), Faun. Jap. pl. 9.—I have often seen a large brown owl, which, I presume, to have been this species, about my house at night; but not having been able to trap him, or get a specimen caught in town, I am unable to name the bird with certainty.

Thrush (*Turdus fuscatus*), Pallas.—This noisy bird is common in all the town gardens.

Naumann's Thrush (*Turdus Naumanni*), Faun. Jap., p. 61. —As common as the preceding species, but quiet and shy in its habits.

Red-backed Shrike (*Lanius bucephalus?*), Faun. Jap., p. 39. —The red-backed shrike is often seen perched on the top of a fir or other pointed tree. I once caught one that followed a young sparrow into a room in which I was seated.

Nightingale (*Philomela?*).—The nightingale is not uncommon. In the early summer nights its note is to be heard in Yedo wherever there is a garden or shrubbery of any extent.

Cole Tit (*Parus ater*), Linn.

Marsh Tit (*Parus palustris*).

These two tits, besides other species which I have been unable to identify, are found in the town in winter. They seem to go out into the woods in summer.

Wagtail (*Motacilla lugens*), Faun. Jap., p. 60, pl. 25.—This bird, which strongly resembles the pied wagtail of this country, but with more white about the head and neck, is very common.

Tree Sparrow (*Passer montanus*).—This species is simply swarming everywhere, and builds in every corner about the outside of a house where a nest can be constructed.

Starling (*Sturnus cineraceus*), Faun. Jap., p. 85. — This bird is as common in Yedo as the common starling is at home.

Japanese Crow (*Corvus Japonensis*), Bp.—As an inhabitant of the towns, this crow rivals the kite in numbers and boldness. When assembled together, they will even enter the houses and carry off anything they can seize. They are very lively active birds, keeping up a continual croak and caw, and making a variety of other noises as they chase one another in strings round the corners, over the house-tops, and through the trees.

Great Spotted Woodpecker (*Picus major*), Linn.—This bird is found wherever there is a clump of trees of sufficient height and size to tempt a visit.

COMMON CUCKOO (*Cuculus canorus*), Linn.—Although this species is mentioned by Temminck and Schlegel in the "Fauna Japonica," I am by no means certain of having met with it. The cuckoo which I have seen in the temple grounds of Shiba in Yedo seemed to be a shy bird, never feeding in the town, and flying very high on its visits to the country, uttering a peculiar sharp cry three or four times in quick succession at intervals as it flew. One passed over my house daily in summer, but always at too great a height to admit of correct identification.

KINGFISHER (*Alcedo Bengalensis*), Gmelin.—This pretty little bird is often seen flitting about the miniature lakes in the gardens of Yedo, flashing in the sunlight as it darts from one side of a pond to the other, or perching upon twigs overhanging the water.

SWALLOW (*Hirundo Javanica*), Sparrman.—Not distinguished from the common chimney swallow by Temminck and Schlegel in the "Fauna Japonica." A very common bird, building in the rooms within the houses, where boards are specially put up for them to rest on. They are shut into the house at night with the family.

SPINETAILED SWIFT (*Cypselus caudacutus*), Latham.—I have frequently seen swifts and spinetailed swallows flying above the city, but at too great a distance to make sure of the species.

TURTLE-DOVE (*Turtur rupicola*), Pall.; Bp. Consp., ii., p. 60.—Very common everywhere, and not at all shy, being easily approached within shot. In the days when shooting was allowed, this dove could always be counted on to supplement a badly-filled bag. It is, however, rather dry eating.

SŒMMERING'S PHEASANT (*Phasianus Sœmmeringii*), Temm. —Very common all over Japan.

DIARD'S PHEASANT (*Phasianus versicolor*), Vieillot.—This species makes its home in Yedo, where, in every garden of any size, at least one pair may be found. They even breed within the town. I have often, while sitting under the verandah, watched them walking about my garden. They are wonderfully tame, but always ready to run under cover on the least movement or unusual noise. It is a curious fact, which I have myself often noted, that just before earthquake shocks, which are very frequent in Japan, the pheasants call as if frightened. In this way they may almost always be counted on, if within earshot, to give warning of a coming shock a few seconds before it is felt.

Japanese Quail (*Coturnix Japonica*), Temm. and Schl., Faun. Jap., p. 103.—Is not rare, though far from being so common as it is in some other countries—Turkey in Europe, for example.

Kentish Dotterel (*Ægialites Cantianus*), Lath.—Is met with in small flocks.

Mantchurian Crane (*Grus montignesia*), Bp.—This elegant bird—called by the Japanese *tsuru*—is frequently seen on the marshes between the mouths of the Samida and Nakagawa. It is held sacred in Japan, and is considered emblematic of long life and good fortune. It is never molested except by the nobles, who sometimes take it while hawking. A hawk that has killed a *tsuru*, is specially prized, and receives a sort of title by which it is ever afterwards called. The Japanese often make coloured drawings of this bird, and it is to be seen beautifully carved in wood over the entrance gate of nearly every Buddhist temple. They are often to be found tame in the gardens of the nobles.

White-naped Crane (*Grus leucachen*).—Is also abundant, considerable numbers being at times seen together. This bird is more shy, however, than the *tsuru*, and is not so large and striking looking.

Common Heron (*Ardea cinerea*), Linn.—This species is also met with, but is somewhat rare, being shy and retired in its habits.

Great White Heron (*Herodias alba*), Linn.—Not so rare as the preceding. I have also seen a bird resembling at a distance the great white heron, but of a beautiful roseate hue all over.

Little Egret (*Herodias garzetta*).—Very common. It is easily tamed, and becomes bold and familiar after a few days' confinement.

Night Heron (*Ardea goisaga*).—Equally common. I have seen a perfect cloud of them rise from a favourite clump of trees when disturbed.

Bittern (*Botaurus stellaris*), Linn.—The bittern is commonly found among the reeds or the margins of ponds. It is very shy, although when in good cover it allows one to approach very near before taking wing.

Spoonbill (*Platalea major*), Faun. Jap., p. 119, pl. 75.—Has been recognised, but is rarely met with.

Japanese Ibis (*Geronticus Nippon*).—Is frequently met with in the marshes and paddy fields.

Curlew (probably *Numenius australis*), Gould.—I have repeatedly seen a bird which appeared to me to be of this species, but it is not common. It seemed to be smaller than the European bird.

Avocet (*Recurvirostra avocetta*), Linn.—I have only once seen the avocet in Yedo.

Woodcock (*Scolopax rusticola*), Linn.; Temm. and Schl., Faun. Jap., p. 112.—Is very plentiful in winter.

Snipe (*Gallinago media*, Leach; and *Gallingo stenura*), Temm.—Plentiful in the market. They are snared and caught by bird-lime, along with the preceding species. In fact, all birds found in the market, including ducks, etc., have either been netted or taken by bird-lime.

Painted Snipe (*Rynchæa capensis*), Linn.—This species is common just outside the city, and I have no doubt is to be found within its bounds also, though I have never seen it there.

Temminck's Sandpiper (*Tringa Temminckii*), Leister.

Dunlin Sandpiper (*Tringa alpina*), Linn.

Thick-billed Sandpiper (*Tringa crassirostris*), Faun. Jap., p. 107, pl. 64.

I believe I have seen these three species; but from the difficulty of obtaining specimens, it is not easy to pronounce definitely.

Baillon's Crake (*Crex Bailloni*), Vieillot.—I have met with one or two specimens of this bird in Yedo.

Water-rail (*Rallus aquaticus*), Temm. and Schl., Faun. Jap., p. 112.—Is not uncommon. It seems, however, larger than the European bird.

Moorhen (*Gallinula chloropus*), Linn.—I have several times seen the moorhen, but it is far from common.

Pink-footed Goose (*Anser brachyrhyncus*), Baillon.

Grey-lag Goose (*Anser ferus*), Steph.

Bean Goose (*Anser segetum*), Steph.

White-Fronted Goose (*Anser albifrons*), Gmelin.

These four species are very common.

Snow Goose (*Chen hyperborea*), Boie.—I have also seen the snow goose, though rarely. It was my fortune to have my office—a branch of the Board of Works—situated on the banks of a lake formed by a break in the outer moat, a favourite resting-place for crowds of ducks and geese of all descriptions. The noise made by the birds was at times distracting, and I was often tempted to stroll out in the garden to watch them at play, when they would allow me to approach within thirty or forty yards without showing the slightest signs of uneasiness.

Hooper Swan (*Cygnus musicus ?*).—The most conspicuous bird to be seen on the moats in winter is the swan, but of what species I am not able to say with certainty, as the laws forbidding the killing or capture of birds within the bounds of the city are rigidly enforced, and I was consequently unable to obtain a specimen. I remarked, however, that the bird is not common in this part of Japan, and that I have never seen one in the market. Nearly every winter two or three pairs took up their quarters on the moats, always in the same place each year, and I may here remark that the different kinds of water-fowl seemed to attach themselves to particular haunts.

Shoveller (*Anas clypeata*), Linn.; Faun. Jap., p. 128.—Common in the winter season.

Gadwall (*Anas strepera*), Linn.—Common in the winter season.

Pintail (*Dafila acuta*), Linn.; Faun. Jap., p. 128.—Common in the winter season.

Mallard (*Anas boschas*).—Generally distributed, occurring in considerable numbers.

Garganey (*Querquedula circia*), Linn.—Frequently met with.

Common Teal (*Querquedula crecca*), Temm. and Schl., Faun. Jap., p. 127.—Only a winter visitor to the city, but at that season it is extremely abundant. Flocks of teal are literally swarming everywhere. Some idea of their numbers may be formed from the fact, that on a pond in the grounds of the ex-Prince of Chikusen, situated only a few hundred yards from my own house, where they are preserved for sport, the estimated number on the water any day during the season is 10,000. I have every reason to believe that the estimate is correct. At night these flocks go out of town, but are always back in the pond before sunrise.

MANDARIN DUCK (*Anas galericulata*), Linn.; Temm. and Schl., Faun. Jap., p. 127.—This beautiful little bird is generally found in pairs, the male and female keeping together the whole year. They roost in the trees in many of the gardens and temple grounds.

SUMMER DUCK (*Anas sponsa*).—Is often found in company with the mandarin duck.

WIGEON (*Mareca penelope*), Linn.; Temm. and Schl., Faun. Jap., p. 127.

GOLDEN EYE (*Anas clangula*), Linn.; Temm. and Schl., Faun. Jap., p. 128.

TUFTED DUCK (*Fuligula cristata*), Leach.

SCAMP DUCK (*Fuligula marila*), Linn.

HARLEQUIN (*Anas histrionica*), Linn.; Temm. and Schl., Faun. Jap., p. 129.

AMERICAN WIGEON (*Anas Americana*), Gmelin.

MERGANSER (*Mergus serrator*), Linn.

The foregoing seven species are all found in the private ponds, often swimming in mixed companies.

GREBE (*Podiceps Phillippensis?*).—This little grebe is to be seen everywhere. I have not observed any other species, unless a bird I once saw in a quiet corner within the private grounds of the castle was a grebe. I never saw it again, nor had I previously noticed it. I once, however, saw a painting of it on a Japanese screen. It was a curious-looking bird, and I exhibit a small copy, from memory, of the sketch on the screen.

CORMORANT (*Carbo cormoranus*), Temm. and Schl., Faun. Jap., p. 129.—The common cormorant ranks first amongst the birds of Yedo as to numbers and permanent habitation. A very large breeding station is situated in a fine grove of fir-trees at an angle of the second moat. The birds are in thousands, and the noise of their croaking can be heard a quarter of a mile off as they come in crowds in the evening to roost. The greater number go out to sea daily to fish. They are not at all early birds, as I noticed that they generally left the town for the fishing grounds between eight and nine o'clock in the morning, returning about sunset, always flying in a string, or wedge, like geese. I imagine, however, that the state of the tide influences in some measure their time of leaving and returning. Several smaller colonies exist in various situations within the city, and numbers of the birds remain fishing in the moats and canals all day, being probably too lazy to accompany the crowd on the longer excursion to the sea. I have often seen them diving and coming up within reach of a stick from the bank of a canal where a stream of vehicles and people was passing. The natives tame them and use them for fishing.

SEA-GULL (*Larus melanurus*), Temm. and Schl., Faun. Jap., p. 103, pl. 61.

SEA-GULL (*Larus ichthyaëtus*), Pall.

SEA-GULL (*Larus brunneicephalus*).

SEA-GULL (*Larus occidentalis*), Aud.

SEA-GULL (*Larus niveus*), Pall.

I have seen numbers of sea-gulls of the foregoing species frequenting the bay of Yedo. Though not actually in possession of specimens, they could be sufficiently recognised by the description of the various authors who have recorded the occurrence of these gulls in Japanese waters.

IV. *Ornithological Notes:* (1.) Astur palumbarius, *Goshawk;* (2.) Sitta Europœa, *Nuthatch;* (3.) *Hybrid Pheasant (?) between Golden and Common Pheasants;* (4.) Mergus albellus, *Smew;* (5.) Larus Glaucus, *Glaucous Gull.* (Specimens exhibited.) By JOHN ALEXANDER SMITH, M.D.

(1.) *Astur palumbarius,* the Goshawk.—This very fine specimen of a large adult female was shot on the 26th of

January near Elie, Fifeshire. This rare bird, though belonging to the short-winged hawks, was much in favour with the falconers in days long gone by; and as it is almost the only large hawk that generally breeds in trees, our Secretary, Mr Robert Gray, in his "Birds of the West of Scotland," has suggested that the hawks referred to in some of our old charters where grants of land have been given to churches, and the right of preserving the hawks and their nests, and even the trees in which they have nested, has also been reserved by the donor, were probably goshawks, and though this bird is now very rare, it was probably much more common in Scotland when it was thus so carefully preserved and protected. In one of these charters, granted by Roger Avenel, of lands in Eskdale, to the Abbey and Monastery of Melrose, in the time of Alexander II. (A.D. 1235), it is stated that if the hawk had nested in any tree, that tree shall not be cut down in the following year until it is seen whether the bird may make its nest in it again. Reference is made to the subject of these and many other reservations in the preface to the "Liber de Melros," published in 1827 by the Bannatyne Club, where these charters are printed at length.

(2.) *Sitta Europæa*, the Nuthatch.—This bird has been very rarely observed in Scotland. In March 1856 I exhibited to the Society one that had been shot near Dunse, and indeed only one or two instances of its occurrence in Scotland have been recorded altogether, although it is not impossible it may have passed unnoticed in the woody districts, which it specially frequents. The bird is common in England, but gets less abundant towards the northern counties. It is said, however, to be well known both in Denmark and Sweden. The specimen is a female, and was shot on the 18th of January near Jedburgh.

(3.) *Hybrid Pheasant*, between *Thaumalia picta*, the Golden Pheasant, and *Phasianus Colchicus*, the Common Pheasant.—This beautiful bird was shot by William M'Inroy, Esq., on the 27th January, at North Meols, in Lancashire, within two miles of Southport. The bird was a male, and measured about half an inch less in length of body than the common male pheasant. The yellowish crest of the head was about half the length of that of the adult golden pheasant, and more of a buff colour, but, as the spurs of this bird were of a considerable size, I consider it to be full-grown. The red and black tipped feathers spring from the nape of the neck, the tippet is also shorter and duller in colour, the dark-green feathers of the back are less in bulk, the feathers covering the lower part of back and root of the tail are also of a yellowish buff like the crest, and the tail feathers are very long and broad, of the same shape and colour as the golden pheasant, but had dark bars crossing them like the common pheasant, the long tail coverts being of a brownish red colour. The breast is not so bright a red as that of the golden pheasant, but more of the reddish-brown colour of the coverts of shoulder of wing. Legs stouter and longer than golden pheasant, and it had a spur about half an inch long on one of the legs. The bill is also of a dark colour like the common pheasant.

Some thirty years ago several birds of this description were noticed at Cambo, Fifeshire, after several golden pheasants had escaped from the aviaries there; and when eggs of the common pheasant were collected for hatching, it was found that various young birds were hatched which gradually showed a plumage like that described, and were therefore believed to be hybrids. One of them was preserved by Captain Fielding. I also exhibited to the Society, in February 1875, another and beautiful bird of very similar character to the one now exhibited, which was shot by Capt. Kinloch, yr. of Gilmerton, at Gilmerton, near Drem, Haddingtonshire. The bird had been observed for four seasons, and about five years before one or two golden pheasant cocks were let loose on the estate.

(4.) *Mergus albellus*, the Smew.—A beautiful male bird shot on the 25th January at Bowhill, the seat of his Grace the Duke of Buccleuch, in Selkirkshire. The bird is one of our winter visitors.

(5.) *Larus glaucus*, the Glaucous Gull.—A female shot on the 20th January at Musselburgh. Various specimens of this gull, and also of *Buteo lagopus*, to which I referred at last meeting, still continue to be captured in unusual abundance in various localities in the neighbourhood of Edinburgh.

I may again express my indebtedness to Mr Small, Mr W. Hope, and Mr Keddie, our well-known taxidermists, for being able to exhibit these interesting birds.

Wednesday, 21st March 1877.—David Grieve, Esq., F.G.S., President, in the Chair.

The following gentleman was balloted for, and duly elected a Resident Member: John Philip, Esq., Head-Master of St Leonard's Public School.

Tho following communications were read:

I. *Notes on some Recent Experiments in Water Analysis.* By T. W. Drinkwater, Esq.

The object of these notes is not to refute the now very generally received theory that vegetable contamination in drinking water is as hurtful as animal, but merely to show that we have means by which we can distinguish between these two impurities, and thus be in a position to give valuable information regarding the origin and removal of the source of impurity.

It has been urged that if a water give over ·009 grs. per gallon of albuminoid ammonia, it matters not whether it be derived from animal or vegetable matter, it is just as hurtful to health.

If the impurity arises from decomposing vegetable matter, I admit the truth of this statement, but if, as in the case of a peaty water, the vegetable matter is not in a decomposing state, then we have no right to condemn a water as unfit for drinking purposes, though it gives as much as ·01 grs. per gallon of albuminoid ammonia.

In Lincolnshire the well water is strongly impregnated both with the peaty colour and flavour; this water is drunk without any bad effects following, yet on analysis it yields albuminoid ammonia to the extent of ·01 to ·05 grs. per gallon, and would be condemned by many analysts as unfit for dietetic uses.

It was with the view of clearing up some disputed differences between these two contaminations that led me to conduct the following experiments, the result of which I now lay before the Society. The first experiment related to animal contamination.

A pint of Crawley water was rendered impure by the addition of 0·1 grs. of dried blood, and distilled in the usual manner.

The 1st distillate of albuminoid ammonia gave	0·024	grs. per gal.
,, 2d ,, ,, ,,	0·008	,,
,, 3d ,, ,, ,,	0·004	,,
Total, .	·036	

In this experiment it will be observed that the principal portion of the ammonia came over with the first distillate, the second and third containing comparatively small quantities.

Experiment 2.—A small portion of powdered peat was digested in half a gallon of distilled water for three days, and then filtered through ordinary filtering paper, and one pint distilled in the usual manner.

The 1st distillate yielded albuminoid ammonia,	·0084	grs. per gal.
,, 2d ,, ,, ,,	·0056	,,
,, 3d ,, ,, ,,	·0056	,,
,, 4th ,, ,, ,,	·0028	,,
Total, .	·0224	

In this experiment it will be seen that instead of the yield being chiefly with the first distillate it came over in the first, second, and third, in very much the same quantity, even a fourth distillate contained a very appreciable quantity of ammonia.

The third experiment was made on the same artificially prepared peaty water, only this time it was unfiltered. The results, though somewhat higher than the filtered sample, were the same as regards the manner in which the ammonia distilled over.

For verification a fourth experiment was tried with animal contamination.

A small quantity of putrefying butcher's meat was digested for some hours in a pint of distilled water; the yield of albuminoid ammonia was as follows:

1st distillate,	. .	·0266	grs. per gal.
2d ,,	. .	·0098	,,
3d ,,	. .	·0028	,,
Total,	. .	·0392	

This experiment verified the first. I next treated the artificially prepared water used in experiment No. 2 with animal charcoal. It was filtered through small lumps of pure animal charcoal in an ordinary funnel, being passed through twice.

On distillation the albuminoid ammonia was decreased from ·0224 grs. per gal. to ·004, the yield, however, still coming over slowly.

On treating the water contaminated with animal matter in the same way, the ammonia was only decreased from ·0392 to ·0194 grs. per gal., the yield being principally in the first distillate.

The conclusion to be drawn from these results is this: That with a water contaminated with animal matter, the first and second distillate of the albuminoid ammonia contain the principal portion of the yield, whilst if the contamination be of a vegetable nature, the ammonia is more evenly distributed between the distillates.

II. *On certain Phenomena connected with Insect Metamorphosis.* By T. D. Gibson Carmichael, Esq.

The two features in the metamorphosis of insects to which the author draws attention are: (1.) the influence which external conditions have on the form of insect larvæ, and (2.) the quiescence of the pupæ of certain insects. In treating of the first he shows how in an order so homogeneous as the *Hymenoptera* in the perfect form a large amount of difference prevails among the larvæ, these being divisible into three groups—(1.) the vermiform and apodal, (2.) those with slightly-developed thoracic legs, and (3.) those with well-developed thoracic legs, and abdominal prolegs. Such differences in the larval forms of the same order he attributes to differences in the habits of the grubs. The principal object of the author under the first head is to draw attention to the influence of external conditions in modifying the form and colour of the larva for protective purposes. He says: Lepidopterous larvæ are those best suited for an inquiry into the subject; because besides living exposed to all the attacks of birds and predatory insects, it is frequently found that individuals of the same genus, or even of the same species, feed on different plants, and so become subject to the influence of different conditions. In these larvæ the ground colour is usually some shade of green, grey, or brown. It is easy to understand the way in which a green ground colour helps to protect a caterpillar, by its resemblance to the colour of the leaves of the food plant. It is a peculiar fact, however, that many larvæ are born with a green ground colour, but eventually change this for some shade of brown. In some species, indeed, we find two varieties, as it were, the first composed of individuals retaining the green colour throughout the whole larval state, and the second of others which become brown after their second or third moult; this phenomenon occurs most commonly in larvæ which feed on low herbs, and which attain a large size when full grown. The reason for this change undoubtedly is that the larva, so long as it was young, passed the whole of its time among the leaves (as do also those individuals which remain green), but when larger it changes its habits and only feeds at night, hiding during the day amid the soil and dead leaves at the roots of the plant, where, of course, some shade of a brownish or yellowish colour is the most adapted to conceal it. There are other caterpillars, however, which are brown or grey in colour through life, and which pass their time among the leaves and branches of their food plant: in some of these, as in the Geometers generally, the colouring greatly resembles that of a young shoot or a dry twig, and this resemblance is further strengthened by the attitudes they assume when at rest; others, however, being of a grey hue, rest at full length on the larger limbs, where it is almost impossible to see them amongst the lichens which they so strongly resemble in colour. With regard to markings occurring on this ground colour, those on grey and brown tree-feeding caterpillars often resemble the slight roughnesses and other marks found on twigs and shoots, and are often accompanied by excrescences and roughnesses on the body of the larva itself; or they resemble the patches of lichens and crevices in the bark of the larger branches, as also do the thick bunches of hair on certain larvæ. In those brown larvæ again, which hide about the roots of plants, the markings harmonise with the tints of the earth and dead leaves. At first sight it is not quite so easy to account for the markings found on larvæ having a green ground colour, but this difficulty disappears on a little consideration. Those marks usually take the form of longitudinal or diagonal lines. Now suppose we have a green larva, so long as it is small, it is sufficiently well concealed by the resemblance of its colouring to that of the leaves of its food plant, but when it increases in size, there arises the necessity, if it is to escape notice, of some means being provided whereby the attention may be drawn from the outline of the larva, and it is in these markings that we find this means: first, with regard to longitudinal lines, these are most common in caterpillars feeding on narrow-leaved plants, and when they occur in those feeding on large leaves it is only in medium-sized individuals; the reason for this being that these lines mimic the lines found on grasses, etc., and the streaks of light occurring in masses of foliage. In a small larva such lines would be comparatively useless, and it is for this reason that they seldom make their appearance till after the third moult. Again, in broad-leaved plants there are of course no lines on the leaves corresponding to these longitudinal lines, nor do we commonly find long narrow streaks of light let in among such foliage; so that in larvæ feeding on those leaves, it is obviously most beneficial that such lines should only occur on those of a medium size, or, when on a large larva, should be broken and not continuous. On the other hand, in grass-feeding caterpillars, as the *Satyridæ*, we find this arrangement strongly developed, as also among many pine-feeders, in some of which, as *Fidonia piniaria*, the green is striped with white; in others, as *Anceryx*, with brown, thus resembling the glimpses of the brown twigs seen among the green spikes. This arrangement, I may mention, exists also in certain saw-fly larvæ, while in *Dendrobinus pini*, in addition to this, there are tufts of hair closely imitating the green spikes of the pine. Second, with regard to diagonal lines, they mostly occur on larvæ feeding on broad-leaved plants, and among these more especially on such as attain a large size. Some larvæ possess both longitudinal and diagonal lines, and in these, so far as I recollect, the longitudinal always appear before the diagonal; and on the appearance of the latter, the former either disappear altogether, or leave those segments on which diagonal lines are now formed. Those lines mimic the diagonal ribs of leaves, so if the resemblance is to be complete, they must also be distant from each other in the same proportion as the ribs on the leaves, and for this reason they appear on large larvæ only. Now, it may be asked, why should the longitudinal lines disappear on the appearance of the diagonal lines? Simply because if they did not, there would be coloured or white lines crossing each other at an angle, and this would be like nothing found among the leaves, and so would merely render the larva more conspicuous. There is one other fact connected with these lines worthy of notice, namely, that they are often white, edged with colour; this at first sight would seem to render the larva more conspicuous, but in reality the contrary is the case, for now both the rib and the shadow thrown by it are represented, and unless the eye is directly focussed on the larva, it is all the harder to perceive. After briefly noticing those cases in which colour and form protects unpalatable insects, not by concealing but by rendering them more conspicuous and so leading insect-eating birds to avoid them, the author passes to the consideration of the quiescence of the pupa in some insects. He says: Although insects are popularly supposed to pass through four stages—the egg, larva, pupa, and imago—still in most insects it is impossible to distinguish the two intermediate stages from each other. A clue to the difference between insects possessing an inactive pupa and those which do not lies in the structure of the mouth. Quiescence, it must be remembered, is not a state peculiar to this stage in the insect's life, for after every change of skin the larva remains inactive for a longer or shorter period of time in proportion to the extent of the changes going on in it. Thus, the extreme quiescence of the pupa is in reality only a prolongation of the quiescence accompanying every change of skin, and this prolongation is due to the great amount and rapidity of the changes going on in it. In those insects whose metamorphosis consists principally of a mere increase of size and the acquirement of wings, there is no stage corresponding to the pupa of butterflies and moths. In others whose changes are more extensive, the pupa, though at first inactive, gradually acquires activity. On the other hand, in those insects, as *Lepidoptera*, in which not only does the external form but also the whole internal organisation undergo change, there is an inactive pupa; still even these pupæ have some power of motion, and this power is greatest shortly before they make their final change. A great clue to this difference is to be found in the structure of the mouth. In those insects in which the mouth and digestive organs are the same throughout life, the changes which occur are slight and very gradual, so that there is no marked period of quiescence. On the other hand, in those insects, as *Lepidoptera*, in which the insect has an entirely different method of feeding when a larva from what it has when perfect, the changes, if gradual, would necessitate the death of the larva; so they are compressed, as it were, into one stage, which stage is therefore necessarily inactive.

III. *On the Occurrence of a South American Butterfly in Britain.* (Specimen exhibited.) By John Gibson, Esq.

In July 1871 Mr Gibson Carmichael observed a butterfly on the roof of one of the carriages of the London and South-Western Railway shortly after leaving Wokingham station. He captured it and placed it in his cabinet as a variety of the Painted Lady (*Pyrameis cardui*), but subsequently he was led to think that it agreed more closely with a North American species nearly allied to our Painted Lady, viz., the *Pyrameis Huntera*. On sending it to an entomologist in London, it was found, on comparing it with the specimens in the British Museum, to be the Brazilian variety of the *Pyrameis Huntera*

—a fact which renders its occurrence in England all the more wonderful. Although it is several years since this specimen was taken, and Mr Carmichael has in the interval formed a considerable collection of British and foreign butterflies, he assures me that by no chance could he have made any mistake as to the exact specimen caught on the railway carriage. It has been suggested as a possible explanation of the appearance among us of this South American stranger, that it may have been brought by one of the Brazilian mail packets, which come to Southampton, a station on the London and South-Western Railway.

IV. *Notes on a few Silurian Fossils from the Neighbourhood of Girvan, Ayrshire, in the collection of Mrs Robert Gray, Edinburgh.* By Robert Etheridge, Jun., Esq., F.G.S., etc. [Plate II.]

It affords me much pleasure to offer the following notes on and descriptions of a few of the more interesting fossils in the cabinet of Mrs R. Gray. The collection, gathered from the rich fossiliferous deposits of Silurian age in the neighbourhood of Girvan, has been wholly brought together through the energy and zeal of the lady in question. We are already indebted to her hammer for several Silurian Brachiopoda new to science, which have been from time to time described by Mr T. Davidson, F.R.S., and a few Crustacea described by Professor John Young, M.D., F.G.S., etc.

CLASS CRUSTACEA—SUB-CLASS CIRRIPEDIA.

Genus Turrilepas—*Woodward*, 1865.

Plumulites, Barr. Reuss, Sitz. Berichte d. K. Akad. d. Wissen, Sch. 1864, xlix., p. 215 (note 2).

Turrilepas, H. Woodward, 1865. Quart. Jour. Geol. Soc., xxi., p. 486.

Plumulites, Barrande, 1872. Systême Sil. Bohême, i., supp. p. 565.

Oploscolex, Salter, 1873. Cambridge Cat. Camb. Sil. Foss., p. 129.

Turrilepas, H. Woodward. Cat. Brit. Foss. Crustacea, 1877, p. 143.

Obs.—The genus *Turrilepas* was established by Dr H. Woodward, F.R.S., from certain peculiar ovate triangular plates from the Dudley limestone, previously known under the name of *Chiton Wrightianus,* De Koninck. Dr Woodward satisfactorily showed that these plates were more properly referable to a form of *Cirripedia* allied to the recent *Loricula,* and for which he proposed the name *Turrilepas,* than to *Chiton,* or any other mollusc. Priority is claimed by M. Barrande for his term, on the plea of previous publication. For my own part, I hardly think the facts support M. Barrande's claim. Dr Woodward's name was both proposed and published in 1865; and although the genus was certainly not defined in so many words, it was, nevertheless, founded on a well-known and perfectly-defined fossil, and what is more, was copiously illustrated. I take this to be satisfactory publication. It appears that M. Barrande had discovered similar plates in the Silurian rocks of Bohemia, and applied to them the name *Plumulites,* a fact which was communicated by Professor Reuss to the Imperial Academy of Science of Vienna at their meeting of 18th February 1864, and was published in a paper of the latter,* but unaccompanied either by description or figure. The plates in question were referred by M. Barrande to the *Cirripedia,* and their alliance to *Loricula* pointed out; but so far as I understand the question, no description or figure was furnished by the latter until the appearance in 1872 of the supplement to the first volume of his magnificent work on the "Silurian System of Bohemia."† I think, under these circumstances, that strict impartiality requires the adoption of Dr Woodward's *Turrilepas.* Again, Messrs Hall and Whitfield‡ adopt *Plumulites* in preference to *Turrilepas,* on the ground that the latter was never characterised, but my previous remarks equally apply in this case.

There are certainly two, and perhaps three variations in

* Sitz. Berichte d. K. Akad. d. Wissensch, xlix., p. 215.

† Système Silurien du Centre de la Bohême, Supp. vol. i., 1872, p. 565.

‡ Ohio Geol. Report, ii., pt. 2, p. 106.

form amongst Mrs Gray's *Turrilepas* from Girvan. One of these I propose to call

Turrilepas Scotica, sp. nov., Figs. 1 and 2.

Sp. Chars.—General form elongately kite-shaped, curved; superior end curved and much attenuated, produced into a fine needle-point; inferior margin slightly convex, and a little concave in the middle; lateral margins, one convex throughout the whole of its length, the other and opposite convex in the lower part gradually becoming concave towards the finely drawn out superior end; lobation very indistinct, only traceable through the curvature of the transverse striæ; a median, ridge-like, sharp, and narrow keel, dividing the plate into two sub-equal parts, passes from the central concavity of the inferior margin to the sharp superior extremity; the latter is, in fact, formed by the extension of this central keel, the plate on each side of it becoming abortive; surface ornamented with a very large number of transverse imbricating striæ, which in the central lobe are parallel to the inferior margin, and on the lateral lobes are bent down parallel to the lateral margins.

Obs.—*T. Scotica* differs from the Dudley *T. Wrightii*, De Koninck, in form, proportion, breadth of the central keel, in the much augmented number of concentric striæ, and particularly in the extended superior extremity. The same characters also appear to separate it from all the species described by M. Barrande. I feel confident that the present form is a distinct type from any of the above, more especially as one of Mrs Gray's specimens exhibits several of the plates in close proximity to one another, all with the characteristic attenuation of the superior extremity, and evidently belonging to one individual. Unfortunately the state of preservation in this specimen is not sufficiently good to be worth figuring. The other plates in the collection differ much from *T. Scotica* in form, but notwithstanding the variation found in the plates of any species of this genus, they will, I think, prove to be different from *T. Scotica.*

Loc. and Horizon.—Balcletchie, south-east of Girvan, in rocks of Silurian age; exact horizon not yet determined.

ORDER PHYLLOPODA.

GENUS SOLENOCARIS—*J. Young*, 1868.

(Proc. Nat. Hist. Soc. Glasgow, i., p. 171.)

Solenocaris solenoides, J. Young.

S. solenoides, J. Young; *loc. cit.*, pp. 171-173, t. 1, f. 7, *a* and *b*.

Obs.—Several fragments of this peculiar crustacean are in the cabinet of Mrs Gray, by whom it was originally discovered. They do not, however, throw any additional light upon its structure.

Loc. and Horizon.—Balcletchie, south-east of Girvan, in rocks of Silurian age; exact horizon not yet determined.

GENUS PINNOCARIS, *gen. nov.*

Gen. Chars.—Carapace bivalve, bent along the middle line; each half is pinnaform, much attenuated towards one extremity; dorsal margin almost straight, but rising at a little less than a third from the rounded end into a kind of false umbo; ventral (? lateral) margin elongately sigmoidal; the expanded end of the carapace is broadly but gradually rounded; attenuated end produced into a long, narrow rostrum or beak, truncated at its extremity; substance probably very thin; surface striated parallel to the curved margins.

Obs.—I have given the above name to a very peculiar fossil in Mrs Gray's collection, from the resemblance each half bears to the genus *Pinna*. The general outline is that of a small *Pinna*, so much so, indeed, that I hesitated whether to regard them as a species of Pelecypoda (Lamellibranchiata) near the genera *Pinna*, *Pteronites*, or *Aviculopinna*, or as the carapace of a phyllopodous crustacean, allied to *Ceratiocaris*, *Discinocaris*, and other like forms. In their present state the specimens appear as black, flattened, shining bodies, the produced and truncated end retaining more of the original convexity than the other portions. On analysing the various characters of these fossils, for, or against their crustacean nature, we find that in support of the latter view we have the absence of any definite separation into anterior and posterior ends, as in a bivalve shell; secondly, the nature of the projecting part of the dorsal margin, here called the false umbo, which in no way appears to partake of the characters of the umbo in the Pelecypoda; thirdly, the presence of the object, indicated at *a*, Fig. 3, which, although without organic connection with the carapace near it, is, I believe, one of the telson spines, similar to those of *Ceratiocaris*, and other genera; fourthly, the lines of growth instead of graduating outwards from the projecting point of the dorsal margin, as the similar striæ do on the valve of a shell (bearing in mind that the umbo of a bivalve is its "initial point"), appear to me to be much more regularly concentric (or as we see them, semi-concentric) round a central point or apex, as would be the case if both valves were spread out, similar to the genera *Discinocaris* or *Peltocaris*. On the other hand, in support of the molluscan affinities of these fossils, we have the general *pinna* or *pteronites*-like form, although the larger end is more obliquely rounded than is usually met with in these genera, and the entire absence of the characteristic punctate ornamentation seen on the carapace of many crustacea, combined with the absence of all trace of the eye-spot. It appears to me that the balance of evidence is at present in favour of the crustacean affinities of these fossils, and that they cannot be placed in any of the genera known to me, such as *Ceratiocaris*, M'Coy; *Hymenocaris* (*Saccocaris*), Salter; *Physocaris*, Salter; *Peltocaris*, Salter; *Dictyocaris*, Salter; *Dithyrocaris*, Scouler; *Myocaris*, Salter; *Discinocaris*, Woodward; *Solenocaris*, Young; *Lingulocaris*, Salter; *Caryocaris*, Salter; *Aptychopsis*, Barrande; *Anatifopsis*, Barrande; *Solenocaris*, Meek (*non* Young); *Colpocaris*, Meek; *Archæocaris*, Meek; *Cryptocaris*, Barrande; and *Pterocaris*, Barr. I have therefore, as above stated, proposed for them the name *Pinnocaris*. As none of the specimens to which I have access have the valves spread out, it is impossible to say with certainty whether *Pinnocaris* had a dorsal furrow along the back, like *Peltocaris*, or was devoid of one, as in *Discinocaris*.

I desire that my remarks on these fossils may be taken as purely of a provisional character, and I shall look with much interest for the discovery of further and more complete examples, with the view of definitely ascertaining their systematic position. Upon the production of further evidence of molluscan affinity, I shall be perfectly willing to abandon the view here advanced, which, however, I am convinced, is at present the more satisfactory of the two. The body represented in Fig. 3 may possibly be a small *Theca* which occurs in the same beds.

Pinnocaris Lapworthi, sp. nov., Figs. 3-5.

Sp. Chars.—Identical with those of the genus; the greatest breadth is at a little less than the middle of the valve; concentric lines fine and close.

Obs.—I have much pleasure in naming this species after Mr C. Lapworth, F.G.S., who, I am informed, on looking through Mrs Gray's cabinet, also regarded it as a crustacean. I am also indebted to Professor T. C. Archer, Director, Edinb. Mus. Science and Art, for the loan of a well-preserved Girvan specimen, from the "Hugh Miller Collection," deposited in that institution.

Loc. and Horizon.—Balcletchie, south-east of Girvan, in rocks of Silurian age; exact horizon not yet determined.

ORDER TRILOBITA.

Genus Lichas—*Dalman*, 1826.

Lichas sp.

(Compare *L. avus*, Barrande, Syst. Sil. Bohême, i., Supp., p. 40. Atlas, pls. 5, 6, and 10.)

Obs.—There is a portion of the head of a large *Lichas* (the glabella and fixed cheeks), which Mrs Gray refers to the above species. It is larger than most of the British species of the genus, with the exception of *L. obscurus*, Portlock; * *L. Hibernicus*, Portlock; † and *L. patriarchus*, Edgell. ‡ The ornamentation closely resembles that of *L. avus*, but the form of the glabella is somewhat different.

Loc. and Horizon.—Craighead, near Girvan; Lower Llandovery, according to the map of the Geological Survey of Scotland (sheet 14, 1 inch Scotland).

* Geol. Report, Londonderry, p. 274, t. 24, f. 4.

† *Ibid.*, p. 274, t. 4, f. 1.

‡ Geol. Mag., iii., p. 162, f. 1-6.

Genus Salteria—*Wy. Thomson*, 1864.

(Mems. Geol. Survey, Decade xi., No. 6.)

Salteria primæva, Wy. Thomson.

S. primæva.—W. Thomson, *loc. cit.*, pl. 6.

Obs.—So far as I am aware little or nothing has been done towards the elucidation of this peculiar trilobite since the original description in 1864. Two of Mrs Gray's specimens represent portions of the head, neither of which, strange to say, afford any further details. Both, as in the original specimens, are devoid of the free cheeks, but one of them is larger than either of the latter. A third specimen exhibits the body segments and pygidium in union, a feature which is not represented in any of Professor Thomson's figures. There are certainly seven body rings, and perhaps one or two more, whilst on the central lobe of the pygidium ten divisions are discernible.

Loc. and Horizon.—Balcletchie, south-east of Girvan, in rocks of Silurian age; exact horizon uncertain. Sir Wyville Thomson's specimens were found in "schists forming the base of the Graptolite and Orthoceratite flags, Penwhapple Glen, in the Girvan district—the equivalents of the Upper Bala or Caradoc Rocks."

Genus Acidaspis—*Murchison*, 1839.

(Sil. Syst., p. 658.)

Acidaspis Grayæ, sp. nov., Figs. 6-8.

Sp. Chars.—The head is not in a good state of preservation, and little can be said about the characters of the glabella, its lobes and furrows, the facial suture, and the fixed and movable cheeks, except that the glabella and lobes appear to have been convex and prominent. The front margins of the free cheeks are produced into a series of close non-denticulated spines, which gradually decrease in length forwards; posterior angles produced into genal spines which extend backwards for about half the length of the thorax, and appear to be but little bent or curved; neck segment prominent and apparently non-spinous; surface of the glabella and lobes covered with scattered tubercles or granules. Thoracic somites, nine or ten, probably the latter, with a narrow prominent convex axis, gradually decreasing in width towards the pygidium; lateral portions or pleuræ, horizontal, traversed by a nearly central groove, and produced laterally into long, recurved, denticulated spines, those of the last segment (that next the pygidium) bent down almost in a parallel direction with the limb spines of that division of the body—no trace of surface ornamentation preserved. Pygidium short, semi-circular, surface reticulate; axis of two segments; limb produced into fifteen sub-equal radiating denticulated spines; the anterior axis segment gives off a ridge on each side, continuous with the anti-penultimate spines on each side the central one of the pygidium; the denticles are sub-alternate on each side of contiguous spines.

Obs.—All the specimens of this species contained in Mrs Gray's cabinet are more or less fragmentary, with the exception of that represented by Fig. 6, a cast, and even here the specimen is a good deal crushed, and the characters of the carapace obliterated. So far as present observation has enabled me to judge, the spines projecting from the anterior part of the carapace are simple, whilst those of the thorax and pygidium are unquestionably denticulated.

Amongst British species, *A. Grayæ* must be first compared with three species of *Acidaspis* from Girvan, described by Sir Wyville Thomson, F.R.S.* The form and general proportions of the thorax and pygidium closely resemble those of two of these, *A. lalage*, and *A. hystrix*, but the characters of the carapace, so far as they can be made out, do not correspond particularly in the absence of any cervical spines in *A. Grayæ*. The form of the carapace much more closely approximates to that of Sir Wyville Thomson's third species, *A. callipareus*, of which, unfortunately, the thorax and pygidium are unknown. *A. Grayæ* undoubtedly differs from *A. lalage* in its denticulated spines, those of the latter being quite simple and plain, both on the pygidium and thorax. Similarly it is also distinguished from *A. hystrix*, Wy. Thomson, and *A. Caractaci*, Salter; in the first of these each pleura terminates in two reflected spines, one passing under the other, and in the latter

* Quart. Jour. Geol. Soc., 1857, xiii., pp. 206-209.

is bispinose, one spine being much longer than the other, but in neither case are the spines denticulated. Again, *A. Grayæ* does not appear to agree with any other described British species with which I am acquainted, either by specimens or figures, such as *A. Barrandei*, Fletcher; *A. bispinosa*, M'Coy; *A. Brightii*, Murchison; *A. coronatus*, Salter; *A. Jamesii*, Salter; or *A. Hughesii*, Salter. In fact, the increased number of spines round the pygidium separates *A. Grayæ* from all the foregoing forms, to say nothing of their denticulated character, except *A. lalage* and *A. hystrix*, where the spines are twelve to fourteen in the one case, and twelve in the other, and apparently all simple. All the specimens of pygidia which I refer to *A. Grayæ*, have constantly fifteen denticulated spines.

Leaving British species and passing to Bohemian Silurian trilobites, we find there are several with which a comparison may be made. M. Barrande has figured two species with the pleural spines denticulated—*Acidaspis Keyserlingi*, Barr.,* and *A. mira*, Barr.† In the first of these the spines in question are of a totally different form to those of *A. Grayæ*, and the thoracic axis is very much broader in proportion to the general size of the trilobite. In *A. mira* the pleural spines are of two kinds, one denticulated and the other not, both attached to the same pleura. In neither are the spines of the pygidium denticulated, but M. Barrande also figures at least five species in which these particular spines are so, viz.:

1. A. Verneuilii, *Barr.*, loc. cit., t. 38, f. 1-9.
2. A. Portlockii, ,, ,, ,, f. 10-12.
3. A. vesiculosa, ,, ,, ,, f. 13-21.
4. A. tricornis, ,, ,, suppl., t. 8, f. 21.
5. A. rara, ,, ,, ,, t. 12, f. 28.

In the first three of these the form of the pygidium, and the number, form, and arrangement of the spines into which the limb of each is produced, are so different as to necessitate little or no comparison. The ornamentation of these trilobites consists of small granules or tubercles, both on the thorax and pygidium; on the other hand, on the only part of *A. Grayæ* where the ornamentation is preserved, it is seen to be

* Système Sil. Boh., i., t. 36, f. 10-22. † *Ibid.*, t. 39, f. 1-11.

reticulate, as in *A. lalage* and *A. hystrix.* In *A. tricornis,* Barr., the pygidium spines are only eight in number; finally, there are eight also in *A. mira,* but the arrangement of them is again different from any of the preceding.

So far as I have been able to ascertain this is an undescribed form, with which I have much pleasure in associating the name of Mrs Gray.

Loc. and Horizon.—Balcletchie, south-east of Girvan, in rocks of Silurian age; exact horizon not yet determined.

Genus Cheirurus—*Beyrich,* 1845.

(Über. Bohm. Trilob., p. 5.)

Cheirurus trispinosus—J. Young.

C. trispinosus, Young. Proc. Nat. Hist. Soc. Glas., i., pt. 1, pp. 169-171, t. 1, f. 4-6.

Obs.—This species was established by Dr John Young for a peculiar form with the cervical fold prolonged backward into a spine, and curved in a similar manner to the genal spines. Mrs Gray now has in her cabinet a more perfect specimen than that figured by Dr Young, with the three spines or remains of them in position. That on the left (when looking down on the head from behind forwards) is perfect, but of the right one only about a third is preserved, whilst the middle spine is broken off close to its attachment to the cervical fold. The entire head, as far as preserved, is densely covered with small unequal tubercles or papillæ.

Loc. and Horizon.—Penkill, south-east of Girvan, in rocks of Silurian age; exact horizon uncertain.

Genus Agnostus—*Brongniart.*

Agnostus trinodus, Salter.

A. trinodus, Salter, Mems. Geol. Survey, 1848, ii., pt. 1, p. 351, t. 8, f. 12 and 13. *A. trinodus,* Salter, Mems. Geol. Survey, 1864, Dec. xi., No. 1, p. 8, t. 1, f. 8-10.

Obs.—The specimens of this species found by Mrs Gray consist of disconnected heads and pygidia. In the former the slight lateral indentation of the glabella is visible, and in some of the latter the minute lateral spines are well preserved.

Loc. and Horizon.—Balcletchie, south-east of Girvan, in rocks of Silurian age; position uncertain.

CLASS BRACHIOPODA—TRETENTERATA.

GENUS DISCINA—*Lamarck*, 1819.

(Hist. Anim. sans Verteb., vi., pt. 1, p. 236.)

Discina Portlocki, Geinitz (?).

Orbicula Portlocki, Geinitz. Dei Graptolithen, etc., 1852, p. 26, t. 1, f. 31 and 32.

Obs.—Mrs Gray informs me that these little shells were so named by Mr C. Lapworth, F.G.S. They certainly bear a considerable resemblance to Geinitz's figure, especially his Fig. 31. They have the almost marginal umbo, and behind it the "last-shaped" elevation mentioned by Geinitz. They are oval-circular, and the lines of growth are both close and well marked. Geinitz considered his shell identical with *Orbicula lævigata*, Portlock (Geol. Report on Londonderry, p. 445, t. 32, f. 11 and 12), but not of Münster. Now, *O. lævigata*, Portlock, is a much larger and more circular shell, and is placed by Mr Davidson as a synonym of *Discina oblongata*, Portlock (Mon. Brit. Sil. Brachiop., p. 66). The whole subject requires investigation.

Loc.—Balcletchie, south-east of Girvan, in rocks of Silurian age; position uncertain.

GENUS ACROTRETA—*Kutorga*.

Acrotreta (?) Nicholsoni, Davidson (?).

A. (?) Nicholsoni, Dav. Mon. Brit. Sil. Brachiopoda, p. 343, t. 49, f. 36-40.

Obs.—This little shell has been noticed hitherto from the Upper Llandeilo Graptolite shales near Moffat. Mrs Gray has three specimens bearing this name, which appear to possess the peculiar hinge structure described by Mr Davidson, although they are more conical than represented in the figures quoted above.

CLASS GASTEROPODA.

Genus Bellerophon—*De Montfort*, 1808.

(Conch. Systematique, i., p. 51.)

Bellerophon expansus, J. de C. Sowerby.

B. expansus, Sow. Sil. Syst., 1839, p. 613, t. 5, f. 32.

B. expansus, Sow. " Siluria," 4th ed. 1867, t. 25, f. 8.

Obs.—There is a shell in Mrs Gray's collection possessing all the characters of the above species, except that it is more arched along the median line; but this, I think, arises somewhat from distortion. The general outline, sinus and concentric striæ are well and distinctly marked.

Loc. and Horizon.—Balcletchie, south-east of Girvan, in rocks of Silurian age; exact horizon uncertain.

Bellerophon, sp. nov. (?).

(Compare *B. subdecussatus*, M'Coy. Brit. Pal. Foss., p. 311, t. 1, L. f. 25).

Obs.—In describing his *B. subdecussatus*, Professor M'Coy called attention to its close resemblance to the carboniferous *B. decussatus*, Flem. I would on the present occasion follow Professor M'Coy's example by pointing out the similarity of the present form to another carboniferous species, *B. Urei*, Flem., in the large, well-defined band and spiral striæ; the latter, however, are finer and more numerous than is usually seen in *B. Urei*, and there are indications of transverse striæ, which do not exist in the carboniferous species. Amongst Silurian forms, the Drummuck examples are perhaps nearest to *B. subdecussatus*, M'Coy, but they differ in the much larger size, well-defined band, and stronger spiral striæ; both specimens are only casts, and somewhat compressed downwards, so their exact form is not to be altogether determined. There are a few strong transverse and oblique fluctuations or undulations on one of the specimens, in addition to the remains of the transverse striæ. In all probability the discovery of perfect specimens will prove their form to be a new species. As the specimens are only casts, and not good ones, I refrain from giving them a name.

Loc. and Horizon.—Drummuck, near Girvan, in rocks of Llandeilo age, according to the map of the Geological Survey of Scotland.

Note.—In addition to the fossils here described, there were exhibited at the meeting of the Royal Physical Society, at which the paper was read, the following:

1. *Trinucleus*, sp.—A fine form nearly allied to, but distinct from, *T. Bucklandi*, Barr. (Syst. Sil. Bohême, 1852, i., p. 621. Atlas, p. 629, f. 10-17.) Drummuck, near Girvan.
2. *Trinucleus*, sp.—Closely allied to, if not identical with, *T. seticornis*, His. Drummuck, near Girvan.
3. *Lingula Canadensis*, Billings. Balcletchie, near Girvan.
4. *Lingula quadrata*, Eichwald.
5. *Siphonotreta Scotica*, Davidson. Craighead, near Girvan.
6. *Strophomena corrugatella*, Davidson. Balcletchie, near Girvan.

(Nos. 3, 4, and 5 have lately been described by Mr T. Davidson, F.R.S., as new to British Silurian rocks, from specimens obtained by Mrs Gray at the localities mentioned.)

I have, in conclusion, to express my thanks to Mrs Robert Gray for her kindness in giving me access to the valuable contents of her cabinet.

Explanation of the Plate.

Fig. 1. *Turrilepas Scotica*, R. Eth., jun.—Twice the natural size, showing the finely drawn out superior end. Balcletchie.

Fig. 2. Another specimen, nearly twice enlarged. Balcletchie.

Fig. 3. *Pinnocaris Lapworthi*, R. Eth., jun.—Natural size, showing the rounded larger end of one-half the carapace, the attenuated and truncated end, and the tail spine (?) displaced. Balcletchie.

Fig. 4. Another specimen of the same, natural size, showing the false umbo and two halves of the carapace in apposition. Balcletchie.

Fig. 5. A third example of the same, natural size, showing one-half of the carapace slightly displaced from the other half, at the attenuated end, and the concentric striæ. Balcletchie.

Fig. 6. *Acidaspis Grayæ*, R. Eth., jun.—A mould about twice the natural size, with the head, thorax, and pygidium, so far as preserved, united together. Around the frontal margin of the head may be seen the non-denticulated spines, whilst those projecting from the pleuræ of the thorax are so.

Fig. 7. Another pygidium and a few thoracic somites of the same, some-

what enlarged. The fifteen terminal spines, with the denticles, are also shown.

Fig. 8. Mould of a third specimen of the same, showing a part of the thorax attached to the pygidium, with the denticulated spines projecting from both, nearly twice the natural size.

Fig. 9. *Bellerophon*, sp. nov. (?), a cast, natural size: compare *B. subdecussatus*, M'Coy. (Brit. Pal. Foss., t. 1, L. f. 25.)

Fig. 10. Another specimen of the same, partly a cast, and partly retaining the original shelly matter; natural size.

Figs. 11 and 12. *Discina Portlocki*, Geinitz?—Two specimens twice the natural size. The ridge from the umbo to the margin is shown.

V. *On the Occurrence of the Hobby* (Falco subbuteo) *in Forfarshire.* By Robert Gray, F.R.S.E.

About eighteen months ago Mr Henderson of Dundee sent me word that he had shot a falcon near that town, which he took to be the Orange-legged Hobby. On describing the bird minutely at my request, I found he had mistaken the bird, and that it was but the commoner species, *Falco subbuteo.* When in Dundee a few weeks ago, he kindly offered me the falcon for my collection, and I have thought it of sufficient rarity as a straggler into North Britain to justify me in laying it before the Society.

In the West of Scotland the hobby has occurred in the island of Arran, but in no other locality so far as I am aware of. In the eastern counties, however, it has been found repeatedly. In the records of this Society there is mention made of one which was shot near Portobello in July 1863. It has likewise been met with in Roxburghshire, Kirkcudbrightshire, and Dumfriesshire. In the north-eastern counties, it has occurred in Banff, Caithness, Aberdeen, Kincardine, and Forfar. The earliest authentic record of its having been met with in Scotland, is perhaps that of Mr George Don, who mentions it as having been "rather rare" in Forfarshire in the beginning of the present century. Subsequent writers, notably Selby, Jardine, and Macgillivray, speak of it as being totally unknown in Scotland. I give these particulars, therefore, as a contribution to a more exact knowledge of its range in the British Islands.

I believe this bird, which is a well-known, though somewhat rare summer migrant in England, will yet be found breeding in Kincardineshire. Glen Dye is one of the most likely places where it will be met with. The specimen which I now exhibit was killed as I have said near Dundee in October 1875, and I have no doubt that when shot, it was on its way south from that quarter.

VI. *Note on the Occurrence of the Whimbrel* (Numenius phæopus) *in Greenland.* By Robert Gray, F.R.S.E.

For some years past I have been much interested with the specimens of birds brought home by the masters of the Dundee whaling ships, who have been induced to collect and preserve all that comes in their way, and I was lately pleased to find that a pair of whimbrels had been captured on board the "Polynia" when passing Cape Farewell on the 20th of May last year. The master of the ship informed me that the two birds had followed the vessel for some days, and that they had at length fallen upon deck quite exhausted. The birds were in full breeding plumage, and it is highly probable that they would have landed to the north of the locality off which they were captured. Professor Reinhardt of Copenhagen, in a paper contributed by him to the *Ibis* for 1861, mentions that five or six had been seen by himself, all sent from Greenland, and that six others had been sent to his father from that quarter in the years 1831 and 1835. This is really all the information we possess regarding the occurrence of this bird in that part of the world, for although an exhaustive list was published three years ago for the use of the officers of the recent Arctic Expedition, by Professor Newton of Cambridge, he had nothing to add from the observations of other writers during the last sixteen years.

The specimen which I now exhibit is the male—the female being now, as I am informed, in the collection of Mr Harvie-Brown.

Wednesday, 18th April 1877.—J. FALCONER KING, Esq., President, in the Chair.

The following gentlemen were balloted for, and duly elected as Resident Members:

John J. Dalgleish, Esq. of West Grange, 8 Atholl Crescent; Sir William Gibson Carmichael, Bart., Castle Craig, Dolphinton.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Transactions of the Zoological Society of London, Vol. IX., Part 10.—From the Society. 2. Proceedings of the Royal Society of Edinburgh, 1874-75, and 1875-76. Transactions, Vol. XXVII., Parts 3 and 4.—From the Society. 3. Proceedings of the Royal Society of London, Vol. XXV., No. 176 (Dec. 1876), and No. 177.—From the Society. 4. Transactions of the Manchester Geological Society, Vol. XIV., Parts 6 and 7 (session 1876-77).—From the Society. 5. (*a.*) Catalogue of Western Scottish Fossils; (*b.*) Some Leading Industries of Glasgow, etc.; (*c.*) Fauna and Flora of the West of Scotland.—From the British Association for the Advancement of Science. 6. Buckton's Monograph of British Aphides, Vol. I.—Ray Society. 7. Kongliga Svenska Vetenskaps—Akademiens (*a.*) Handlingar, Vol. XI.; (*b.*) Bihang, Vol. III., 1; (*c.*) Oefversigt, for 1875; (*d.*) Meteorologiska Jakttagelser, Vol. XV.—From the Royal Swedish Academy of Sciences. 8. (*a.*) Windrosen des südlichen Norwegens, von C. de Sene; (*b.*) Jaettegryder og gamle Strandlinier i fast Klippe, by S. A. Sexe; (*c.*) Beretning om den internationale Meterkommissions möde i Paris, 24th Sept.—12th Oct. 1872; (*d.*) Seven treatises by H. Mohn, reprinted from the Transactions of the Christiania Academy of Sciences for 1872-74; (*e.*) Etudes sur les Mouvements de l'Atmosphère, par Guldberg et Mohn, première partie; (*f.*) Two treatises by C. M. Guldberg, reprinted from the Transactions of the Christiania Academy of Sciences for 1872; (*g.*) Four treatises by Sophus Lie, reprinted from the Transactions of the Christiania Academy of Sciences for 1873.—From the Royal University of Norway at Christiania. 9. Journal of the Linnean Society: (*a.*) Zoology, Vol. XIII., No. 67; (*b.*) Botany, Vol. XV., No. 88.—From the Society. 10. Annual Report of the Geologists' Association, for 1876.—From the Association. 11. Compte rendu de Société Nationale des Sciences Naturelles de Cherbourg, 1877.—From the Society.

The following communications were then read:

I. *Notes on the Various Methods of Water Analysis.* By JOHN HUNTER, Esq.

My intention was to have laid before the Society to-night a note explaining the different methods at present employed of analysing water, and to have criticised these processes; and further, to have diagramatically shown the various ways in which analyses are formulated on being reported.

As this, however, is the last meeting of the session, I presume there will be a considerable amount of work to be got through, and consequently I have cut my task down to a mere fraction of what I had undertaken; and moreover, my duties of late have been so numerous that my time has been more than duly occupied, in consequence of which I have been unable to overtake the work which was necessary to enable me to make perfectly clear the many points I intended grasping.

There are, as is well known, the two great and rival processes for examination of water, namely, the Frankland and the Ammonia process; but as to give my experiences of, and to criticise fairly these two processes, would occupy the whole evening, I will confine my remarks mainly to the latter system, which is the now well-known process of my friend, Professor Wanklyn, of London.

Many scientists are of opinion that there are but two methods of water analysis, but in thinking so they are in error, because waters have been for many years analysed, and analysed correctly too—at least by some chemists—so far as their analysis went; but there is another and a greater process, superlatively great in its primitiveness and in its being absurdly erroneous, which I shall designate the X process.

This process, or rather the mode of stating results obtained by it, I will first bring under your notice, after which I shall, as I have already promised, make a few observations upon the Wanklyn process, and the balance of my water experiences I will carry forward to session 1877-78.

First, then, the mineral constituents of a water residue, as ascertained by this X process, are stated with an almost mathematical constancy as regards relationship of acids to bases, the calcium present being invariably delegated to carbonic acid and to sulphuric acid. Now, thus associating the metals is, under certain circumstances, pardonable; but there is always in the reports to which I refer the parenthetical explanation that "carbonate of lime" is "chalk," and that "sulphate of lime" is "stucco," while we know perfectly well that in 90 per cent. of the water residues that are examined there is neither chalk nor stucco in their composition. The next item in this X process formulæ to which I must take exception is "chloride of potassium;" this salt is not only invariably found by the process of which I am now speaking, but it is so in such minute proportion as to be beyond the power of chemistry, as at present known, to estimate; indeed, to my knowledge, "chloride of potassium" invariably appears in the report as a constituent of the residue, and that whether or not such a compound exists therein. There are other items to which I could with equally good grace take exception, but all of these I will pass over, save the last, which is that of organic matter and nitrates. I may explain this item is the loss which a water residue suffers on being exposed to a red heat. Now, such a method of stating a result obtained in such a way may not only be misleading, but may, indeed will most probably be, quite erroneous, because it is quite well known that when nitrates are simply ignited, they are not by any means all volatilised; and if, as is almost certain to be the case, the nitric acid which is present is combined with such a base as sodium, then, although the acid be decomposed, the base still remains, but, be it granted, in another relation; thus it is clear that the loss on ignition of a water residue can be *no* measure of the amount of nitrates present. The same objection holds good as regards organic matter; and I may sum this part of the subject up by stating that a water residue may suffer considerable loss by being exposed to a red heat without even a trace of *organic matter* or nitrates being present.

The determining the organic constituents of a water is, however, a most important point—in fact is *the* most important, and in the hands of analysts who are abreast of the times, receives by far the most attention. As can easily be understood, the *quality* rather than the quantity of organic matter in water is the great question to settle; and, thanks to Professor Wanklyn, chemists are now in possession of a process by which they can readily and very *certainly* determine that; and to this process I will now direct my remarks.

The ammonia existing in water, whether in the saline or albuminoid form, can be estimated with beautiful exactness; and not only can the amount of these nitrogen compounds be ascertained, but also, as was very clearly shown by that excellent paper read at our last meeting, the origin or nature of these can be also made known.

This part of the process, viz., determining whether the nitrogen which is present in a water is of animal or of vegetable origin, has been taken exception to, because it does not show whether the organic nitrogen is in a decomposing state; this objection is quite untenable, because if the nitrogen is undergoing oxidation, there will be present in the water the products of the change, and these will exist either as a *nitro*-compound or as ammonia.

There are a few, but so far as is known *very* few, compounds of nitrogen which do not yield the whole of their nitrogen to potassium permanganate, and there are one or two that yield a distillate which, on being nesslerised, gives a white precipitate instead of a brown colour; but this reaction, instead of condemning the process, in my opinion recommends it; because the abnormal reaction suggests at once that there is present something even more objectionable than sewage contamination. I have experienced such a case, and, so far as I am aware, the reaction which I somewhat accidentally discovered has not before been noted, wherein a water supply had been polluted with carbolic acid; the distillate from this water was slightly opalescent, and on being nesslerised yielded a white precipitate which, of course, masked the ammonia reaction; but at the same time, this very unusual occurrence necessitated an inquiry as to the cause, with the result, as I have just indicated, that carbolic acid was ascertained to be present.

Another objection which has been made to the ammonia process is, that the distillates, after being nesslerised, are liable to be affected by ammonia in the atmosphere, and in consequence thereof too high results obtained; this objection is, I am perfectly satisfied, quite groundless; for if the merest trace of ammonia be introduced after the nessler solution has been added, the whole contents of the nesslerising tube become almost instantly opalescent; indeed, I may say I have had nesslerised distillates standing in an atmosphere which was by no means free from ammonia for sixteen hours, without any notable change in the depth of colour taking place. Just a few words regarding this opalescence, and I have done. In preparing standard solutions with which to compare distillates obtained from this ammonia process, very frequently difficulty is experienced in obtaining these standards perfectly clear. This point I have investigated most carefully, and as the result of my observations I am satisfied that the only cause beyond that from washing the apparatus employed with other than perfectly pure distilled water is, that in delivering the standard ammonia into the tube a small quantity of the ammonia gets on the glass and drains into the tube after the nessler reagent has been added. As a preventative against such a result being obtained, I would recommend adding first the standard ammonium chloride to the tube by means of a pipette, then filling up to the graduation with water—I mean, of course, chemically pure water—taking care to pour it over that point which has been touched by the pipette, to remove the drop. With these precautions ammonia standards can invariably be prepared with their colour perfectly bright, and free from any trace of opalescence.

II. *On some Sections in the North-West Highlands, Examined during the last Summer* (1876). By JAMES BRYCE, Esq., LL.D., F.G.S.

(Owing to the death of the lamented author, who read the above paper from short notes, a detailed account of his most recent views on this subject cannot now be furnished.)

III. *On Certain Birds collected by the late Captain (Rear-Admiral) P. P. King in the Straits of Magellan between the years* 1826-27. By JOHN GIBSON, Esq.

A survey of the Straits of Magellan was made in the years 1826-27 by Captain Philip P. King in the ships "Adventure" and "Beagle," belonging to the Royal Navy, and that officer collected specimens to illustrate the zoology of this hitherto little known region. He made a list of the birds thus collected, briefly describing and naming those he considered, with the lights he had on board the "Adventure," as new to science. This list, along with the birds, was sent to Mr Vigors, at that time *facile princeps* among ornithologists, who published Captain King's paper in vols. iii. and iv. of the *Zoological Journal.* A considerable proportion of the birds described as new were found to be actually so, and these have retained the names given them by their first describer.

During a recent re-arrangement of the general collection of birds in the Museum of Science and Art, I had occasion to consult Sclater and Salvin's splendid work on "Exotic Ornithology" regarding the species of South American coots, and found the following passage by way of preface to the description of one of these species: "In a letter addressed to Mr Vigors, and subsequently published in the fourth volume of the *Zoological Journal,* the late Captain King gave some very short and insufficient descriptions of supposed new species of birds discovered during his survey of the Magellan Straits in 1826. Amongst the birds thus characterised as new to science were two coots, named by Captain King *F. chloropoides* and *F. gallinuloides.* In order to ascertain positively what species were designated by these names, it would be necessary to inspect the typical specimens which, if ever sent home to this country, have unfortunately disappeared. It is only therefore by a process of guess-work that we can refer *F. gallinuloides* of King to *F. armillata,* and his *F. chloropoides* to the present bird, *F. leucopyga.*" Now it so happened that the coot, whose specific name I was in search of, had an old parchment label attached to one of its legs, with "Captain King, Straits of Magellan," written on it; and on consulting the register of the old College Museum it appeared that a collection of birds from the Straits of Magellan had been presented to the Museum by Captain King in 1831. It occurred to me very naturally that the unnamed coot might prove to be one of the two typical specimens which, according to Messrs Sclater and Salvin, had "unfortunately disappeared;" and on comparing it with the certainly brief and insufficient description given in the *Zoological Journal,* I became convinced that it was King's type of *Fulica gallinuloides.* He states that in his specimen "the throat is partially marked with white, which character, however, may be but temporary, the bird being evidently a young individual." This mark, though probably useless as a means of identifying a species, is manifestly of importance in seeking to identify an individual specimen, and the museum specimen agrees in possessing this white marking on the throat. Premising that in this specimen we have the *F. gallinuloides* of King, an examination of it leads me to the conclusion that it cannot be referred to the *F. armillata* of Vieillot, as suggested by Messrs Sclater and Salvin. It is, in my opinion, an immature specimen of Strickland's coot (*Fulica leucoptera*), a figure of which is given in the "Exotic Ornithology." According to Messrs Sclater and Salvin, "this species is readily distinguished from all its South American congeners by having the ends of the first five or six secondaries next adjoining the primaries tipped with white, and in the museum specimen six of these feathers are thus tipped. In the British Museum hand-list of birds, *F. gallinuloides* appears as a synonym of *F. armillata*, with a query attached; if the view here taken be correct, it should now appear as a synonym of *F. leucoptera*. The latter appears to be a rare species, as at the time of the publication of the hand-list already referred to there was no specimen of it in the British Museum, and the authors of the "Exotic Ornithology" were indebted to Dr Hartland of the Bremen Museum for the loan of the specimen from which their figure was taken. The number of specimens presented by Captain King to the College Museum appears to have been about twenty, at least that is the number of stuffed birds now exhibited as from him, and many, if not the most of these, appear to me to be the individual specimens referred to, briefly described by Captain King in his letter published in the *Zoological Journal*. Of those named by him as new, and which were found to be so, the following occur in the collection presented by him to the museum: *Athene nana*, King; *Syrnium rufipes*, King; *Picus Magellanicus*, King.

Captain King also described as new the Steamer duck, under the name *Oidemia Patachonica*. It had, however, been previously described, so that *O. Patachonica* is now a synonym. The individual on which he founded his description was stated by him to measure forty inches in length. Referring to this, Dr Cunningham, who lately visited the straits as naturalist on board H.M.S. "Nassau," and who made a special study of the Steamer duck, says, "The average length of the adult bird may be stated as about thirty inches, and I do not think that I ever met with specimens measuring more than three feet from the unguis to the tip of the tail, so that I am inclined to believe that the specimen mentioned by King as forty inches in length was of exceptional size." The museum specimen is from King's collection, and agrees very closely with his description both as regards colour, markings, and measurement, with the single exception of the length, which, instead of forty, is exactly thirty inches. This remarkable difference of ten inches in the length, while the other measurements agree, suggests the probability of some mistake—a slip of the pen or a printer's error—by which forty may have been substituted for thirty, and of course this view would be put beyond doubt if the museum specimen is the individual on which King founded his *Oidemia Patachonica*. King further describes what he considered a new species of duck under the name *Anas specularoides*, and his description agrees in every particular with the specimen which he presented to the College Museum, and which was labelled by the late Professor Jameson as the *Anas specularoides* of King. In the British Museum hand-list of birds, *A. specularoides* is given as a synonym of *Anas chalcoptera*, Kittl.; but if our specimen be the actual individual described by King, it appears to me to belong to the species *A. cristata*—a bird which, according to Cunningham, is the duck most commonly met with in the Magellan Straits, always excepting the Steamer duck already referred to. The specimen has a slight crest, which is not mentioned in King's description, and which, from its insignificance, may have been overlooked by him, and this crest is a feature in the male of *Anas cristata*, Gm. I have not, however, been able to procure either a figure or description of *Anas chalcoptera*, of which *A. specularoides* is said, in the British Museum hand-list, to be a synonym; but if my surmise should, on further investigation, prove to be correct, then King's name would become a synonym of *A. cristata*, Gm.

IV. *On a Species of Lepisma, supposed to be Undescribed.* By JAMES SIMPSON, Esq. Communicated by JOHN GIBSON, Esq.

About two months ago I happened to be in the engine-room of a large baking establishment in this city, when I observed a rather strange insect move in somewhat spider-like fashion from one crevice in the wall of the building to another. I had not seen anything like it before, and felt anxious to know what it was. Accordingly I set to work to hunt it out, and was successful in capturing the object of my curiosity. The engineer was summoned, and shown the specimen. He informed me that he had seen a great many of the same kind, and for the first time about six months previously. This encouraged me to look further, and on examining a corner close beside the large chimney stalk, where the fuel was piled up, I was delighted to behold about two or three dozen more of the insects. I accidentally disturbed the "nest," and in a moment they set off in all directions. Fortunately, I succeeded in obtaining half-a-dozen before they all got out of the way. These I despatched to Dr Buchanan White of Perth for identification.

Dr White now informs me that they belong to the genus *Lepisma*, and are much larger than the common "sugar fish" (*Lepisma saccharina*). He has not yet been able to determine the species, but there can be no doubt of it being an imported one, and probably may be undescribed. The following is his description :

"*Lepisma*, sp.? Candida, supra brunneo, fusco et nigro variegata; oculis nigris, antennis appendicibusque pallide rubro-fuscis; pedibus albis. Antennis corpore plus quam duplo longioribus; appendice anali centrali corpore ⅓ longiore; appendicibus analibus lateralibus corpore æquilongis. Corpore (præcipue lateribus) setis erectis pallide rufescente-fuscis vestito, Long. Corp. 6½—8 mm."

I have to add that the establishment referred to receives supplies of goods for manufacturing purposes from France, Germany, Holland, Spain, Denmark, U.S. America, Canada, and Australia, so that if the species be hitherto undetermined, and an imported one, it will be no easy matter to trace the origin of it here. However, I am trying to gather all the information I possibly can; besides, I have constructed an apparatus whereby I shall be enabled to closely observe its habits, etc., and, with your permission, I may possibly be able to communicate to the Society something more interesting respecting this very curious animal, and at no very distant date.

V. *Zoological Notes:* (1.) Hippocampus abdominalis, *from Tasmania;* (2.) Lestris Buffonii, *Buffon's Skua.* (Specimens exhibited.) By JOHN ALEXANDER SMITH, M.D.

Hippocampus major.—A fine specimen of this very large species of *Hippocampus* was exhibited, for which Dr Smith was indebted to Richard Bell, Esq.

Lestris Buffonii, Buffon's Skua.—This rare bird was in the plumage of the first year. The central tail-feathers, which afterwards become very long, were only projecting slightly beyond the rest of the feathers of the tail. It was shot on Rule Water, Roxburghshire, in the beginning of September 1875, and was fully described by Mr Robert Gray in the *Proceedings* of the Berwickshire Naturalists' Club.

The Society then adjourned to the third Wednesday in November.

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

ONE HUNDRED AND SEVENTH SESSION, 1877-78.

Wednesday, 21st November 1877.—David Grieve, Esq., F.R.S.E., F.G.S., President, in the Chair.

The following gentlemen were balloted for, and duly elected as Resident Members: Alexander Galletly, Esq., Curator, Museum of Science and Art, Edinburgh; Robert Etheridge, jun., Esq., F.G.S., Geological Survey of Scotland, Edinburgh; Edward C. Joass, Esq., 1 Rankeillor Street; James A. J. Smith, Esq., Surgeon, 49a Albany Street, Leith.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Zoological Society of London: Transactions, Vol. IX., Part 11; Vol. X., Parts 1, 2. Proceedings, 1876, Part 4; 1877, Parts 1, 2.—From the Society. 2. Proceedings of the Royal Society (of London), Vol. XXVI., Nos. 179-181 (March 1 to May 31, 1877).—From the Society. 3. Journal of the Linnean Society—Zoology, Vol. XIII., Nos. 68-70; Botany, Vol. XVI., Nos. 89-91.—From the Society. 4. Proceedings of the (London) Geologists' Association, Vol. V., Nos. 1, 2 (Jan. and Ap. 1877).—From the Association. 5. Proceedings of the Academy of Natural Sciences of Philadelphia, 1876, Parts 1-3. —From the Academy. 6. Oversigt over det Kongilige Danske Videnskabernes Selskabs Forhandlinger, 1876, No. 2, and 1877, No. 1. Also, Tyge Brahes Meterologiske Dagbog, 1582-97: udgiven af det Kgl. Danske Videnskabernes Selskab.—From the Society. 7. The Canadian Journal of Science, Literature, and History, Vol. XV., Nos. 5, 6.—From the Canadian Institute. 8. Transactions of the Manchester Geological Society, Vol. XIV., Parts 9-13. —From the Society. 9. Transactions of the Royal Scottish Society of Arts, Vol. IX., Part 4.—From the Society. 10. Transactions of the Edinburgh Geological Society, Vol. III., Part 1.—From the Society. 11. Proceedings of the Philosophical Society of Glasgow, Vol. X., No. 2 (1876-77).—From the Society. 12. Proceedings of the Berwickshire Naturalists' Club, Vol. VIII., No. 1.—From the Club. 13. Registro Meteorologico del Observatorio Central del Palacio Nacional de Mexico, May and June, 1877.—From the Ministry of the Interior, Mexico. 14. Report of the Smithsonian Institution, Washington, for 1876.—From the Institution. 15. U.S. Survey of the Territories, under F. V. Hayden: (1.) Survey for 1867-69; (2.) Survey of Wyoming, 1870; (3.) Survey of Montana, 1871; (4.) Survey of Colorado, 1874—in all, 5 vols., 8vo. (*a.*) Cretaceous Vertebrata, Vol. II., by E. D.

Cope, 1875; (*b.*) Invertebrate Palæontology, by F. B. Meek, 1876; (*c.*) Geometria Moths, by A. S. Packard. Also, Miscellaneous Publications, Nos. 1, 4, 5, 6.—Presented by the Department of the Interior, through F. V. Hayden.

The following address, by David Grieve, Esq., the retiring President, was then delivered: *

Gentlemen,—In opening to-night the one hundred and seventh session of this Society, I may be permitted to say that it is also the fiftieth year of my connection with it, during which long period I have seen it under various phases of prosperity and adversity. I do not know of any older living member than myself, and thus cannot help looking upon this Society with somewhat paternal tenderness. Such being my position, I am strongly tempted to touch a little on its past history; but having already pretty fully exhausted this subject in a letter written to my friend Dr M'Bain, and published not long ago in the Society's *Transactions,* I shall not at present trespass on your time in regard thereto, further than to observe that the Royal Physical Society has done good service in its day to science, and has numbered amongst its Fellows many of the most distinguished scientists of our country.

Before proceeding with some very general remarks, I have an obituarial duty to perform. It is usual for the President to notice in his address such prominent members who may have died during the recess. On the present occasion two names only occur to me as having departed since we last met; these names are, Mr George Logan, Writer to the Signet, and Dr James Bryce, F.G.S.

Mr Logan held an important office in the General Register House of this city. In his earlier life he was a well-known legal practitioner of Edinburgh, and took a very active part in general politics on the Liberal side. Some years afterwards, and when he had entered upon the legal office to which he had been appointed, having then more leisure, he gave himself more to the cultivation of science. He joined this Society, I believe, about the year 1848, and subsequently

* Since the delivery of this address it has been considerably curtailed by the author for the sake of brevity.

was chosen its Treasurer, which office he filled for many years, and took an active part in the Society's business. For the last few years, however, owing to feeble health, he has but seldom attended our meetings, and now he has passed away ripe in years, to the regret of his family and numerous friends.

Dr Bryce's death occurred under very melancholy circumstances. In the month of July last he had gone to the Highlands on a geological excursion. Passing through Inverness, he had reached Foyers, a place well known for its waterfall, and started early in the day, walking to the Pass of Inverfarigaig for the purpose of examining the rocks there. He was not seen again until his dead body was found much mutilated at the foot of a precipice at that place, from the top of which he had evidently fallen. Dr Bryce was a native of Belfast, but went early in life to Glasgow, where he was occupied as one of the teachers in the High School of that city. About three years ago he retired from his profession and came to reside in Edinburgh. The doctor, besides taking an interest in, and being versed in other sciences, was an advanced and talented geologist, and since he joined our Society, which was only recently, he has contributed to its *Transactions*, or at least he read a paper last session which I recollect led to much friendly and animated discussion. Had he lived, there was every promise that he would have taken an active and lively share in its business meetings. On that account alone we have much cause to regret his untimely death, but our deep sympathy with his family, on whom such a great and unexpected calamity has fallen, must here be feelingly expressed and recorded.

The subject of the following address is a sketch or general inquiry and review of the progress of science during the last fifty years, with a hasty and comparative glance backwards at the work of the preceding half-century. Considering the large field to be gone over, this review must necessarily be very superficial and incomplete, but still, with all the brevity and incompleteness of the sketch, I have considered that it might not be unprofitable to occupy an hour or so in looking at the present through the light of the past.

Progress of Science.—Few persons, I think, will refuse to assent to the remark that science and art have made great progress within the last fifty years—far more rapid progress, indeed, than during the preceding half-century. If I speak of physical science alone, to which my observations will chiefly apply, on inquiry we shall find, that the army of workers and writers have multiplied since the earlier period of time at least tenfold; and if we examine their works and the *Transactions* of the various scientific societies, and consult the numerous science journals, it will be seen that the quantity and quality of the work done is highly creditable to the workers, and, with few exceptions, the papers form permanent records of science conquered. Tens of thousands of facts have been laid down, scientific stones, if I may so call them, wherewith to build scientific edifices in all time. And what it is gratifying to know is, that the supply of such facts, instead of diminishing, is daily increasing. Lest it may be thought I speak too generally, I shall give in detail some particulars regarding the statistics of publication in the science department in which I am myself more immediately interested, viz., Geology, under its various headings during the year 1874:

Works and papers on stratigraphical and descriptive geology,	800
Do. on volcanic phenomena,	52
Do. on denudation and glacial phenomena,	55
Do. on rock formation,	10
Do. on cosmogony,	11
Do. on applied and economic geology,	84
Do. on petrology,	108
Do. on meteorites,	19
Do. on mineralogy,	262
Do. on palæontology,	407
Maps and miscellaneous,	243
Making a total of	2051

treatises and papers published in the year mentioned. This list comprises works printed in various parts of the globe, but chiefly in Germany, France, America, and this country.

I am indebted for the information here given to a most useful annual, viz., the *Geological Record,* a work first published in 1875.

If this be the result in one branch of natural history only, who can estimate the present extent of authorship, not only over the wide range of general science, but over the still wider area of art and the economic history of the world.

Period 1777 *to* 1827.—It would be interesting as well as profitable could we contrast the number and quality of the works on science published a hundred years ago with those of the present age, but the materials for decision are scanty, and only warrant a very limited judgment.

The great leading reviews, the *Edinburgh* and *Quarterly* notably, which gave such an impulse to learning, were not in existence at the first-mentioned period, and so we are left to turn for information to the volumes of the *Annual Register* and the magazines of the day, to glean what we can on the subject, and we, indeed, can gather but very little grain to reward our research. A few names of authors stand out boldly like giants among pigmies. As a rule the minor authors were heavy, unimpressive, and dull, abounding in generalities, and wanting in that breadth and incisiveness which characterise most works of later years.

In 1777 the text-books of what is now termed the science of biology were the works of Linnæus and Buffon. Cuvier forty years later gave to the world his "Regne Animal," which superseded Buffon, and which, to a certain extent, is still an authority. Later still, in 1825, Cuvier published his work, "Ossemens Fossiles," the introductory essay to which work, under the title of "Discours sur les Revolutions de la Surface du Globe," was translated by the late Professor Jamieson of Edinburgh, under the title of "Theory of the Earth." In this "we have the grand outline given of a history of the earth, and, with a few modifications, it is that which is held by the most distinguished geologists of the present day. To Cuvier, says a writer, is due the credit of having brought together the scattered facts of mineralogy, chemistry, botany, and zoology, in such a manner as to make them tell the history of the world." Before this, however (1795), our own illustrious countryman, Dr Hutton, published his celebrated work, the "Theory of the Earth." His object was to show that the great number of the phenomena, which, by Werner, were supposed to be produced by the action of water, were, on the contrary, produced by the action of fire. He supposes the globe to have experienced such a degree of heat as to have been reduced to a state of igneous fusion or liquefaction, and that, as the mass cooled, each mineral substance became crystallised, either regularly or in a more confused manner, according to the laws of affinities.

The names of three other famous writers and discoverers of this period occur to me as right to be mentioned. I mean La Place, the voluminous writer on the Cosmos; Lavoisier, the chemist; and Sir William Herschel, the astronomer.

In 1796 La Place gave a popular account of his numerous discoveries in physical astronomy in his "Exposition du Systême du Monde," written with much taste and eloquence. This work "made a sensation in Europe, and widely extended the reputation of its author." This prolific writer and profound thinker died in 1827.

Lavoisier was, perhaps, the greatest chemical philosopher France ever produced. He succeeded in exploding the then fanciful doctrine of phlogiston, and by the combustion of the diamond demonstrated its true nature. This talented man perished at a comparatively early age on the scaffold, a victim of the reign of terror during the French Revolution.

Sir William Herschel, a native of Hanover, originally a musician of some note, was employed in this country as such, but having after a while discarded music for astronomy, he first became famous in this last science by the construction of admirable and powerful telescopes and specula, whereby he made many remarkable discoveries in the heavens. In 1781 he discovered the planet Uranus, first called the Georgium Sidus. "His researches on double, triple, and multiple stars, on nebulæ and clusters of stars, on the motion of the solar system in space, were vast accessions to sidereal astronomy." His death occurred in 1822.

Dr Priestley, the discoverer of oxygen, and of various other forms of gases, must be mentioned as an author of mark of the period under review, together with Dr Black, the discoverer of latent heat, also Henry Cavendish, who determined by experiments the mean density of the earth, and who is also considered by some to be the discoverer of the composition of water. Dr Benjamin Franklin's name should also not be forgotten, by reason of his many learned and ingenious works, and his curious experiments in electricity at this time.

Lamarck, Jussieu, and Geoffrey St Hilaire, are names of well-known French writers who deserve notice. Count Rumford, an American by birth, should also receive a few words. His experiments chiefly related to heat. He established, for the first time, the fact of the unlimited production of heat from a limited quantity of matter, by the expenditure of mechanical power in friction, a fact subversive of the long prevalent hypothesis of a subtle fluid as the cause of heat. This fact seems to have given the first idea for the development of the comparatively recent but now pretty generally received doctrine of the "CONSERVATION OF ENERGY." Count Rumford died in 1814.

Many other distinguished names might be cited as having flourished during the earlier period of this review, but the foregoing representative men in physical science I think sufficiently illustrative.

If, as I have said, the chief writers at this time were not numerous, they were, at least, profound thinkers, were willing, earnest workers, and their discoveries were all more or less of an important and salient nature.

The small number of works published may in some manner be accounted for when it is taken into consideration that little encouragement was given to writers by publishers, who were then a very limited class. Most frequently authors themselves had to undertake the expense of their books, and thus run the entire risk of sometimes heavy loss. The truth is, the people had not then acquired a taste for science. The works, too, were often published in ponderous and consequently repulsive volumes. In those days there were no little handy text-books nicely and profusely illustrated with diagrams or pictures to tempt the uninitiated to drink at the fountain of science. These little books now-a-days sown broadcast are seed producing abundant fruit, whetting the appetite and gradually enabling the mind to appreciate and digest treatises of a more abstruse and solid character.

A word on the earlier metaphysicians. Descartes, Malebranche, Spinoza, Leibnitz, and Locke lived a century before the time of which I speak, but their doctrines were still continuing to prevail, and to be discussed. David Hume was dead only one year, and Emanuel Kant, Thomas Reid, Dugald Stewart, and Thomas Brown, were all alive after 1777, the last three having filled chairs in our Scottish universities, and whose fame as metaphysicians spread over all Europe.

Period 1827 *to* 1877.—Three celebratad names occur to us as bridging over the union of the two half-centuries, these men having lived and flourished in both. I refer to William Hyde Wollaston, Sir Humphry Davy, and Michael Faraday, all chemists, but more than that, distinguished philosophers in a general and extended sense.

Wollaston was the discoverer of the metals Rhodium and Paladium. His researches were numerous, not merely confined to chemistry, but to electricity and optics. Mineralogy also felt the benefit of his labours. In electrical science he showed the identity of galvanism with frictional electricity. He was besides the inventor of numerous valuable philosophical instruments. Wollaston died in 1829.

Sir Humphry Davy's name is familiar to all Englishmen of the present generation. The discoveries which established his fame were the decomposition of the fixed alkalies by galvanism and the metallic nature of their bases, to which he gave the names Sodium and Potassium. Davy died in 1829, at an early age. His fame is identified with the chemical chair of the Royal Institution, his immediate successor being

Michael Faraday. He was one of the greatest physical philosophers of the nineteenth century. In regard to the following expressive sentence regarding his labours I am under obligations to a recent biographer, who says: "His (Faraday's) researches have had few parallels in the history of science as regards the magnitude and interests of the results obtained. They are surpassed by none others as specimens of pure inductive inquiry, and evince an ardent love of philosophic truth, wholly free from the jealousy which too often distorts the search after it. He was an eminent example of genius submitting itself to the strictest laws of philosophical inquiry." Faraday's experiments have demonstrated that electricity, galvanism, and magnetism are but modifications of the same force under different circumstances. He discovered magnetic electricity, arrived inductively at its principles, enumerated the laws of its phenomena, and elevated it to the dignity of a science. He condensed many gases, supposed to be permanent, into liquids, and destroyed the distinction until then received between gases and vapours. Mr Faraday was the author of a multitude of works on chemical and physical subjects, all of which subjects are treated with rare ability.

Two other names which made their mark on the times must be mentioned; they were chemists also; the one a Swede, Berzelius, and the other the famous John Dalton.

John Jacob Berzelius was the first who gave modern analytical chemistry that exactness on which its value depends. He co-operated with Dalton in establishing the atomic theory, and determined the equivalents of the elements with great exactness. He was a voluminous writer, and acquired great celebrity as a public lecturer. He died in 1848.

John Dalton was the author of the atomic theory, and which has been found to be invaluable as a precise and brief exponent of the relations and values of the chemical constituents, expressed by a simple form of notation, and which is in general use at the present time. Dalton died much honoured and lamented in 1844.

The following *savans* have died within the last few years, and have left notable works for the benefit of posterity; their names are not mentioned in any order: Sir John Graham Dalyell, Professor John Fleming, Professor Edward Forbes, Louis Agassiz, and Alex. von Humboldt, naturalists; Dominic François Arago, physical discoverer; Sir David Brewster, discoverer in optics; Professor James David Forbes, physicist; Sir John Herschel (son of Sir William), astronomer; Justus von Liebig, chemist; Sir Jas. Y. Simpson, discoverer in anæsthetics; Sir Charles Lyell, Sir Roderick Murchison, Sir Henry de la Beche, Professor John Phillips, and Hugh Miller, geologists; Sir William Hamilton and John Stuart Mill, metaphysicians.

It may be considered somewhat prolix this enumeration of names, but the writings of these distinguished men throw such a flood of light on the history of the period that I cannot with propriety omit to point to them as strikingly representative men of the time. As regards living authors and cultivators of science I name them not. I only say to my hearers, *circumspice.*

To criticise the works of the authors named, considering our limited time, would be quite inappropriate, but this is the less necessary, however, as I take it for granted that every one here is familiar with current scientific literature, and the short sketches I have given of the philosophy of the past will serve to freshen their memory, and be sufficiently indicative to enable my hearers to form their own opinion as to the comparative progress of science during the earlier and the later periods of the century under review.

I think, from what has been said, we may safely assume that science has made a rush forward, and that, in the present day, its annals exhibit an importance and lustre which history has not chronicled as existing at any previous period of time. It is a legitimate subject of inquiry, therefore, to ascertain if by any means sufficient reasons can be shown for so satisfactory a result.

I shall consider the subject under two heads, viz., first, popular science; and second, advanced science.

Popular Science.—At no time in the history of the world has the educational machinery been so complete for teaching and indoctrinating, I had almost said cramming, the masses of the people with knowledge, as in the present day. To one who can look back as I can fifty or sixty years to the days when the miserable chap books (now looked upon only as curiosities) were the chief circulating literature among the industrial classes, the transition from comparative darkness to light is surprising. The change is striking as well as gratifying, and I am continually asking myself if this illumination will continue to go on steadily increasing, or after a time subside, have a period of decadence, and resolve itself again into another dark age. History tells us of a high state of civilisation and intelligence existing three thousand years ago, which became in time dormant, and finally altogether extinct. History is said to repeat itself, but however this may be, I prefer to dwell, not on the gloomy, but on the bright side of the picture. I shall take up such an imaginary position, from which I can look forward to a time in the future so effulgent that, on glancing back to the present age, it would seem as having been only the Eocene, the dawn of popular learning.

Let us ask the question, How has this evolution of light from darkness so pleasingly burst upon us? Are the causes as evident as the effects? I answer in the affirmative. I do not hesitate to name what, in my opinion, are some of the leading causes; they may be cited as follows: first and foremost the concession of constitutional, political, and social liberty, freedom of the press, the action of applied science in perfecting art, the reflex action of art in furthering science by its improved machinery, as, for instance, the steam printing press, lithographic, photographic, automatic, and other processes; appliances of light, heat, electricity, and steam; sanitary improvements, removal of taxation on newspapers and on paper, cheap postage, railways, and telegraphs, all these have had their influence less or more in advancing popular science. The foundation of normal schools for the training of teachers has also resulted in the introduction of a better and higher educated class of public instructors. Philosophical and mechanical institutes, in which popular lectures are delivered by trained teachers and by amateur lecturers (peers of the realm as well as commoners taking part), have also greatly assisted in the advancement of public education, and the outcome has been a healthy and growing desire and taste on the part of the people for scientific information, as evinced by the many cheap periodicals at present current and in increased demand.

Early in this half-century, about 1830, I think, the Society for the Diffusion of Useful Knowledge was established on a very broad basis. It had a large and influential committee, composed of men of all shades of opinion, but which were recognised by all as occupying the foremost rank in the world of science. This committee had for its chairman Lord

Brougham, then Lord Chancellor of England, and for its vice-chairman Lord John Russell (now Earl Russell), a cabinet minister, thus stamping with Government patronage this memorable society.

In 1832 it commenced to publish a magazine—the *Penny Magazine*—very popular in its day; and although its articles were of a miscellaneous character, a great many of them had relation to science. In the preface to the first volume there are one or two passages worth quoting. These sentences are as follows: "It was considered by Edmund Burke about forty years ago, say 1792, that there were 80,000 readers in this country." "In the present year, 1832, the sale of the *Penny Magazine* was 200,000. It therefore may be fairly calculated that the number of readers of one single periodical will amount to a million." I pause here to remark that this computation of Edmund Burke gives us a clue to the general intelligence afloat at the time when this inquiry commences, viz., 1777. Eighty thousand general readers then, what is the number in this year of grace, 1877? Who can tell? Certainly nearly millions must stand for thousands.

The society had been accused of monopoly, which it repudiated. "It is true," said the society, "that former Governments had granted monopolies to some individuals, but it was with the intent, not of cheapening and promoting the circulation of printed matter, but by keeping up the price to diminish it. In those days the Government were afraid the people should learn *to think*." In answer to some again who asserted that general education is an evil, it was said: "The people will not abuse the power they have acquired to read, and therefore *to think*. Let them be addressed in the spirit of sincerity and respect, and they will prove that they are fully entitled to the praise which Milton bestowed upon their forefathers, as being a 'nation not slow and dull, but of a quick, ingenious, and piercing spirit, acute to invent, subtle and sinewy to discourse, not beneath the reach of any point that human capacity can soar to.'"

During the last few years people have gone more out of doors and into the fields to study nature. Botanical societies and field clubs have done much to foster education in natural history. In mechanics' institutes and some grammar schools this branch is made part of the curriculum of study, and in several of the Government departments, a certain amount of knowledge in geology and botany is required before candidates can pass their examination. This requirement will ere long probably be extended, and for this and other reasons it is highly desirable that the elements of natural history should be taught in all our public seminaries.

Advanced Science.—This branch of the subject must now for a few minutes occupy our attention.

Have the higher and dogmatic branches of physical science really advanced within the period of this inquiry? Some doubt it, at least affect to doubt it. My own opinion is that great progress has been made in all branches of science. The numerous ably-conducted periodicals amply bear out this result. From the voluminous record of facts and observations continuously being arrayed and discussed in a thoroughly systematic manner by trained experts in the various branches of science, we see the advancement in regular marching order—the precision of details, the breadth and freedom of speculation, from which the fanciful is carefully eliminated, the recorded results, are all admirable in their way. If we turn from the journals to the floating treatises, and then to the many able monographs, as for instance those of the Ray Society, the Palæontographical Society, the illustrated works of Louis Agassiz and others, we must be satisfied that never was there before a regiment of so able and so highly-qualified writers engaged on genera and species, or, to speak more widely and properly, on science at large.

In the course of the last half-century, chemistry has added some thirty new substances to the list of elementary bodies, and the greatly-improved methods of analysis have done much service to other branches of science, as for instance mineralogy. Till a comparatively recent period the constituent parts of a mineral were, except in some few instances, entirely unknown, leaving them just to be guessed at; now all this is changed. No new specimen is ever placed on the shelf of a public museum at random. The integrity of its name may always be depended upon as being guaranteed by test. In sanitary appliances, and in a hundred other ways, chemistry has been increasingly improving its processes and consequently its usefulness.

Fifty years ago and still more recently, geology was not recognised as a science. Now it has its endowed chairs in our universities and is one of the most lively and progressive of the whole circle of the sciences. In anatomy and physiology, and in zoology and botany, great improvements have taken place in physiological as well as morphological treatment.

The higher mathematics, too, have attained an excellence and completeness never before attained. The formulæ, instead of, as in former times, being simply ingenious calculi, marks of exalted scholarship, have now become of the highest practical utility, being, so to speak, the bones and sinews, the very life blood of most of the sciences.

As regards instruments auxiliary to science, I desire to say a word in reference to one of them only, viz., the microscope. A hundred years ago the microscope was only a toy, now it is a most invaluable scientific instrument. Its range of usefulness comprehends the whole world of matter, organic and inorganic. In the examination of animal and vegetable tissues it is indispensable. In chemical testing, in many cases, it is equally so. The revelations exhibited to us in the microscopical journals, and the experts themselves who make the observations, are equally the objects and subjects of our continual wonderment and admiration. An unseen world, in all the beauty and glory of minute and perfect development, has been vouchsafed to human knowledge by the possession of this instrument. The service rendered and to be rendered to science by it can never be properly calculated.

As to other kinds of aids to advanced science—co-operative aids I may call them—I shall say a few words. I mention first the British Association for the Advancement of Science. Many have no kind words to say of it, but there can be no doubt it is and has been most useful in many ways. It is a gathering of learned men (and within a parenthesis also some unlearned) from all parts of the earth to hold council together on scientific subjects. On the strength of the proverb which says, "As iron sharpeneth iron, so a man sharpeneth the countenance of his friend," the association is both a pleasant and useful reunion of philosophers in this sense. The presidential addresses are sometimes supposed to be a little heretical, and stir up the wrath of our clerical friends, but these gentlemen after a while mostly calm down and their anger ceaseth, simply because most frequently they find that they have been more frightened than hurt. These addresses are in general masterly discourses, and are looked forward to by the scientific public with much interest. Besides the papers which are read in the sections, interesting reports on scientific subjects are brought up annually by committees appointed in the previous year. Many of these reports are exceedingly valuable. But another, and the last but not least, useful feature of the association I shall mention is, that it dispenses a great deal of money for the prosecution of important scientific investigations which otherwise could not be accomplished for want of private means.

The great societies, such as the Royal, the Linnean, the Geological, Geographical, Botanical, Chemical, and Zoological, and some other societies, are all great aids in their way to the promotion and furtherance of science in its advanced stages, as their *Transactions* abundantly testify.

I should have liked, had time permitted, to have made reference to some of the prevalent speculative doctrines of the day in relation to matter, and more particularly in regard to two of them now in great vogue, viz., the CONSERVATION of ENERGY and the so-called law of CONTINUITY, but, as it is, I must forego my wish.

A word or two should also be said on the doctrine of EVOLUTION, and which is so much the subject of discussion at the present day. It is simply a revival of the doctrine of Descartes, broached by him in the seventeenth century, afterwards supported by Buffon, De Maillet, and notably by Lamarck. With the exception of these writers the subject had dropped out of sight for nearly two hundred years, when the world was surprised in 1851 by its re-introduction by the author of the "Vestiges of Creation." Latterly Dr Darwin has been the great apostle of the doctrine. I am not a convert to Evolution, nor yet to the doctrine called Darwinianism, but I cannot help paying a passing compliment to Dr Darwin when I say that he deserves the thanks of the scientific public for his indefatigable industry in collecting and publishing the multitude of wonderful facts and stories (most of them formerly unknown or unheeded) with which his many interesting and charming volumes abound.

This is certainly an age of deep and important inquiry, the general scope of which I readily admit to be enterprising and sound, but what I consider to be an exception to this, although some may think otherwise, I consider it a duty to point out.

Some minds seem to be agitated with a restless desire to penetrate into the unseen mysteries of the *inscrutable.* For example, we are gravely, I had almost said grotesquely, told by some philosophers of the day, that "when we think, that is, when the mind thinks, there is a vibration given to the brain, and that that vibration *thrills* through the *whole universe.*" Also, that when a feather or even a grain of sand falls to the earth, the same thing happens. Able and talented writers have as well, by mathematical demonstration, endeavoured to prove the *immortality of the soul,* and have even gone the length by the same method of fixing the exact *locality of Paradise,* and the Great First Cause.

I do not intend to enter into any argument on such points; this is neither the time nor the place to do so. I merely hint at what I consider to be erratic and exceptional scientific positions. Neither do I deny the accuracy of such speculations, because it is impossible to do so, as I hold it to be equally impossible to prove their truth by any manner or amount of probation, which would be satisfactory to the matter-of-fact ratiocination of the present day. In short, such a style of speculation is simply, in my view, a convertible term for conjecture, and can never attain a higher standing point in true science, notwithstanding the ingenuity of the gifted authors of the hypotheses. Such hypotheses I hold to be aberrations from the *true* line of philosophical treatment, simply because the authors referred to go on the assumption of the *illimitable* power of human reason. Now, human reason, I hold, has its limits, as well as everything else which is sublunary has its limits.

The mind of man has never yet reached or succeeded in exposing to view the arcana of the spiritual and immaterial world, nor is it likely to do so, and it is a pity, therefore, that useful talent should be wasted in attempting what, in my opinion, is such a Sisyphian-like task.

To conclude, I have given some idea of the means by which science in these days is being encouraged and promoted. Every year is fertile in new discoveries and subjects of inquiry. One year we have the wonders of the spectroscope displayed; another year, the motive power of light exhibited, as illustrated by the radiometer; and betimes again, controversial discussions as to spontaneous and sporadic generation abound. Sound is discoursed upon, its properties of transmission and its record, as illustrated by these wonderful instruments, the telephone and phonograph, and so on. In short, a multitude of new subjects are continually being evolved to stimulate the mental energies and inquiries of willing workers in most branches of science. "Light calleth unto light for more light," and in the excavated mass of rubbish turned up, brilliants are often seen to scintillate. In the search for gold gems are displayed, undreamed-of treasures. To speak without metaphor, in the search after truth, unsuspected happy results frequently reward the ingenious and plodding student. Let me say, finally, that much of the excellent work of the present day is attained by co-operation, by the sub-division of labour, and not a little by concentration of thought and labour—say, for example, by the restriction of inquiry to a single botanical, entomological, or other genus at a time, and by patiently working it out in all its specific details. Various other work is thus also more satisfactorily accomplished. This, of course, infers a certain amount of enthusiasm and abnegation, but I consider enthusiasm to be the very *primum mobile* of all scientific labour. Nothing can be done well or successfully without it.

On the motion of Professor DUNS, D.D., seconded by JAMES

M'Bain, Esq., M.D., R.N., a cordial vote of thanks was awarded to Mr Grieve for his able address.

The following Communications were then read :

I. *Ornithological Notes:* (1.) Surnia nyctea, *Snowy Owl;* (2.) Crex porzana, *Spotted Crake;* (3.) Rallus aquaticus, *Water Rail;* (4.) Larus Sabini, *Sabine's Gull.* (Specimens exhibited.) By John Alexander Smith, M.D.

(1.) *Surnia nyctea*, the Snowy Owl.—This very fine specimen of the snowy owl—an adult male—was shot on the 27th October last, at Lochmaddy, North Uist, the property of Sir John Orde, Bart. of Kilmory. Mr Keddie informs me that its stomach was quite empty. This large white owl more or less spotted with brown is well known as an occasional visitor from the north of Europe or America. Dr Edmonston believed it might occasionally breed in Shetland, and thought he had found one reliable instance of its having done so. It is stated to have bred on the islands of Unst and Yell, Shetland. It is a rarer bird on the mainland of Scotland than in the islands to the north and west, where it has been more frequently captured. Mr Gray informs me that it may almost be considered a regular spring visitor to the Hebrides, and it is believed these birds have occasionally come from North America, like many other occasional visitors, being carried by gales of wind out of the line of their more ordinary migration. I am not aware of any instance of this bird being supposed to have bred on the mainland of Scotland. Indeed the only one recorded, as far as I am aware, was published in the *Zoologist* for 1856, and repeated again in the natural history appendix to the recently-published, amusing, and interesting "Life of a Scotch Naturalist," Thomas Edward, Banff, by Samuel Smiles; but I fear this solitary case requires a little more confirmation. Perhaps our Secretary, Mr Gray, may be able to tell us something of the true state of matters in regard to it.

(2.) *Crex porzana*, the Spotted Crake.—Two specimens of this bird are exhibited, the larger, the male; and the smaller, a female. They were shot on the property of Sir George H. Leith, Bart., at Loch Lomond, towards the end of September last. The bird is one of our regular summer visitors, and is not very common, Mr Gray says, especially in the west of Scotland. It is late in leaving us compared with many others of our migratory birds. In his "Birds of the West of Scotland," Mr Gray states that he had no authentic instance of its having been taken in the west, north of Renfrewshire. These examples may therefore be of interest as having occurred a little farther to the north.

(3.) *Rallus aquaticus*, the Water Rail.—I may mention that an allied bird to this, the water rail, seems to have occurred, or at least to have been taken, in quite unusual numbers this autumn (October). Mr Small, birdstuffer, has kindly sent for exhibition with these spotted crakes, a specimen or two of the water rail. He has had various water rails sent him from the neighbourhood of North Berwick, Portobello, etc., etc., and also from the district round Loch Lomond.

(4.) *Larus Sabini*, Sabine's Gull.—The next bird I have to exhibit is a very rare visitor to the British Islands, to which my attention was kindly called by our Secretary, Mr Gray, who wrote to me that Dr Crombie, of North Berwick, had asked him to look at a little gull he had sent to Mr Small. On examining it he found it was an immature specimen of Sabine's gull, the only British example he had seen. "It was," Mr Gray writes, "shot by a fisherman on the 2d of October, about two miles out at sea, off North Berwick; and Dr Crombie informs me it was flying in company with a small flock of kittiwakes. Judging from "Harting's 'Handbook,' the present instance is the twenty-fourth of the occurrence of the species in Britain, and the third in Scotland." This bird is so named after Captain Sabine, R.A., who discovered one of its breeding places in 1818 in the Arctic regions, which are its true home. It also occurs in winter along the northern coasts of North America. Like the snowy owl already mentioned, it may have come to us from America, being blown out to sea by gales of wind from the usual course of its winter migration. It has been described by Mr William Thompson as noticed in the neighbourhood of Belfast; and one or two have since been observed in the north of Ireland, generally in the month of September. A few specimens have been recorded by Mr Yarrell as taken in England, and on the Continent of Europe. Dr Saxby has recorded the capture of two specimens in Orkney. In the appendix to Mr Edward's Life, already referred to, he states that he had "an exciting chase after one, but failed to capture it." But I fear this instance must be considered as at least very doubtful.

The bird now exhibited, Mr Small informs me, is a female, and it is apparently in the immature plumage of a young or first year's bird. In the gulls the plumage of the adult male and female are nearly alike, the female being smaller in size. It is the only instance of its capture off the mainland of Scotland, as far as I am aware; and besides its great rarity, it is of especial interest from its state of plumage. I may mention that the adult bird in summer has the head dark ash, nearly black, and the back dark ash grey, or lead colour, lighter than the head; with the under parts white. This young specimen has the front of the head nearly white; the back of the head and upper parts blackish grey, mottled with brown, the feathers edged with lighter; the under parts, with the exception of the sides of the breast, which are also blackish grey, being white. The primaries of wing generally black; the secondaries white; the tail forked and white, with a black bar across its extremity.

Mr Robert Gray said, as Dr Smith had referred to him in regard to the statement of the snowy owl having bred in Banffshire, he might mention that he took the trouble of carefully investigating the whole matter at the time, and was convinced that it was a complete mistake, and that the bird described was really nothing else than the common white barn owl (*Stria flammea*); which, he might however say, was, he believed, a rather rare and little known bird in that particular district of country.

II. *Exhibition of Specimens:* (1.) Aquila chrysaëtos, *Golden Eagle;* (2.) Dromaius Novæ-Hollandiæ, *Emu.* (Specimens exhibited.) By R. H. TRAQUAIR, Esq., M.D., F.G.S.

Dr Traquair exhibited two recent additions to the ornithological collection of the Museum of Science and Art. The golden eagle, a female, was a remarkably fine specimen, and had been caught in a trap, a few weeks previously, in Ross-shire. The emu was a young bird bred in Scotland by Mr R. Bell of Billholm, Dumfriesshire, and presented by him to the Museum.

III. *On the Successful Rearing in Scotland of the Emu* (Dromaius Novæ-Hollandiæ). By JOHN GIBSON, Esq.

The emu has been already successfully reared in the Gardens of the Zoological Society, Regent Park, and also in one or two private parks in England; but to Mr R. Bell of Billholm, Dumfriesshire, the credit belongs of having raised the first Scottish brood. The old birds were purchased by him from Mr Jamrach, in October 1875, and placed together in a paddock at Billholm; but owing to the persistent persecution to which the female was subjected by the male, as it afterwards proved to be—for it is impossible to distinguish the sexes in the emu by the plumage or other purely external character—they were separated, and remained so throughout the winter of 1875-76. On being brought together again, in April 1876, they contrived to live on tolerably good terms with each other; but nothing occurred till February of the present year to satisfy Mr Bell that the birds were of different sexes. At that time the gardener found three eggs deposited in a corner of the field; and shortly after, all doubt on the question of sex was removed by his observing the pair *in coitu.* For about six weeks the hen continued to lay an egg regularly every third day, then, and for a short time only, at intervals of four or five days. Altogether there were nineteen eggs laid, the first being observed about the middle of February, the last on the 10th of April. For the most part the eggs were laid during a pretty severe frost, which it was feared might have destroyed their vitality. Eleven of the eggs were placed in a rude nest, formed for them in the corner of the field, with a bower of spruce branches placed over it. Unlike most other birds, it is the male emu alone which sits upon the eggs. This, in the present instance, it began to do on April 1st, ten days before the last egg was laid. During each of the first four days he scattered all the eggs around him outside the nest. On the 5th of that month, however, he began to sit close, and continued so to do till the 28th of May, or fifty-eight days in all. During this protracted period, although closely watched, he was only observed to leave the eggs three times, and that but for the space of two or three minutes, which he spent in running round the paddock. Food and water were kept constantly beside him, but Mr Bell believes that during these fifty-eight days he went absolutely without food. He was also observed to turn the eggs regularly in the nest. The male and female remained in the same enclosure during the first few days of incubation, but as the chief anxiety of the female seemed to be to get at and to destroy the eggs, it was found necessary to separate her from her mate during the remainder of the period. Of the eleven eggs sat upon, one, on the point of being hatched, was unfortunately broken by the foot of the parent bird, two were addled, other two disappeared, and six were successfully hatched. The young were at first covered with coarse down, arranged in alternate white and blackish-brown stripes, while the head was prettily mottled. Four of them were much darker, and the white more tinged with brown, than the other two, the latter, of which the specimen exhibited is one, were also somewhat smaller, and Mr Bell suggests that these differences may prove to be sexual distinctions. The down was supplanted by feathers, first on the head, which by the 2d of August was nearly as black as it now is, and it gradually disappeared after that date from the other parts of the body. At the tips of most of the feathers, in the specimen shown, the remains of the down may yet be seen. Regarding the habit and disposition of the young emus, they are, as I gather from Mr Bell, exceedingly shy and suspicious; when anything is thrown to them to which they are unaccustomed, they will advance and retire several times before touching it. Their curiosity, however, is exceedingly great. They are remarkably playful, and seem to have considerable powers of imitation, thus: when some lads got into the paddock, and began performing somersaults, the young emus were observed to throw themselves on their backs, in the vain attempt to imitate the unfeathered bipeds. Dr Bennett, in his "Gatherings of a Naturalist in Australasia," notices the same faculty of mimicry in adult emus. At times the young emus form themselves into a group, and begin what, without any great stretch of the imagination, might be supposed to be a war-dance; they then, as if moved by a sudden impulse, take to running, and career round the paddock at the top of their speed, only desisting when utterly exhausted and gasping for breath. The specimen exhibited was supposed to have broken its leg while rushing headlong through a narrow gap in a hedge which divides the paddock, having probably come in collision with one of the hawthorn stumps. It was killed on October 16th, being then four and a half months old, and standing two and a half feet high. The others, now nearly six months old, stand about a foot higher. The male bird performed the entire labour of hatching and rearing the brood, the female, as already mentioned, being placed apart from the male during the period of incubation to prevent the destruction of the eggs. On admitting the female after the brood appeared, the young instinctively sought the protection of the male bird, and not without cause, as the female, actuated possibly by jealousy, evidently wished to do them injury. The cock, however, seemed equally anxious to prevent this, and to punish its mate, and it was again found necessary to separate the couple, the male, however, twice leapt over the intervening fence during the ten days succeeding the hatching, in order to renew the attack on its partner. The affection of the male emu for its young, its tender solicitude for their safety, and its boldness in defending them against all comers, Mr Bell says he has never seen equalled in any other bird.

The young are equally attached to him, and in the great difficulty which is consequently found in what may be called their weaning, lies at present the chief chance of failure in rearing them to maturity. In order to allow the male and female to come together for the approaching breeding season, the young have been separated from their male guardian. Ever since, they have been inconsolable; they eat little, and instead of occupying at night the shelter prepared for them, they remain both day and night at the side of the paddock nearest the portion occupied by the old male. It is to be feared that the rigours of winter may prove too much for them should they continue in their present despondent mood. The young utter a whistling cry, while both parents, and not the female only, as has been commonly supposed, utter a sound not unlike the muffled beating of a drum, known as *booming*. They are enormous feeders, but by no means particular as to kind or quality. The young eat herbage like their parents, also bread and biscuit, crumbs mixed with lettuce, and other vegetables. They cannot, however, digest raw Indian corn or oats, these passing through them unchanged. With regard to the rearing of the emu in Scotland, I may also mention that Mr Paterson of Restalrig Park informs me that he has had four emus in his park for seven or eight years past. In one season the two females laid thirty-three eggs in a single nest. No attempt, however, was made to sit on them. During other seasons a smaller number of eggs has been laid with a like result. He has now parted with one of the pairs, in the hope that the remaining male may be induced to sit next season.* Regarding the feasibility of introducing the emu into the poultry yards of this country, it is important to note the exceeding hardiness of these birds. Mr Paterson, in speaking of his four emus, says: "They are very hardy, going about in summer and winter without shelter of any kind, disdaining all artificial covering, and generally seeking shelter for the night under a thick thorn tree." The fact is all the more remarkable when it is remembered that the emu is a native of the tropical and

* The author has just heard (June 1878) that this season Mr Paterson has succeeded in raising a brood.

sub-tropical parts of Australia, and shows that it possesses in an eminent degree the power of suiting itself to altered conditions—a power of the highest importance where the questions of acclimatisation and domestication are being considered.

IV. *Notes on the Manx Shearwater* (Puffinus anglorum). By Robert Gray, Esq., F.R.S.E., etc.

The author, after referring to the various haunts of this bird in Britain, known to naturalists fifty years ago, but now entirely deserted, expressed an opinion that some great breeding place of the species must exist in the island of Eigg. Early in August of the present year he had taken ample notes on the bird during a yachting cruise round the Western Hebrides, and had observed immense flocks in the neighbourhood of that island. On one occasion, while the sea was very rough, he had observed a flock of seven or eight hundred riding on the waves—many of them birds of this year—which, as the yacht approached, rose in a body, and flew round the vessel several times in most graceful circles before again settling on the water. One or two larger and much darker birds were observed in the flock, which the author took to be the greater shearwater (*Puffinus major*). After an interval of ten days he had again seen similar flocks on passing the island; but although shearwaters had been observed almost daily during the cruise, from the Sound of Mull to Cape Wrath, in no other quarter did they occur in such numbers. The author also adverted to the circumstance that the Manx shearwater was now a regular visitant to the Firth of Forth in the autumn months, and that he had seen large flocks swimming on the sea close to the Bass Rock for two successive seasons. In these flocks he had observed from fifteen to twenty specimens of the greater shearwater.

Wednesday, 19th December 1877.—J. FALCONER KING, Esq., F.C.S., President, in the Chair.

The following gentlemen were elected Office-Bearers for the Session:

Presidents.—J. Falconer King, Esq.; Ramsay H. Traquair, M.D., F.G.S.; Professor Duns, D.D.
Council.—R. Scot-Skirving, Esq.; John Alexander Smith, M.D.; David Grieve, Esq., F.G.S.; John Hunter, Esq.; W. Drinkwater, Esq.; and Robert Etheridge, Jun., Esq., F.G.S.
Secretary.—Robert Gray, Esq., F.R.S.E.
Treasurer.—E. W. Dallas, Esq.
Honorary Librarian.—Rev. James Kennedy, M.A., B.D.
Assistant Secretary.—John Gibson, Esq.
Library Committee.—James M'Bain, M.D., R.N.; Thomas Robertson, Esq.; R. F. Logan, Esq.; Robert Gray, Esq.; F. W. Lyon, M.D.; and James Anderson, Esq.

The following gentlemen were balloted for and elected as Resident Members of the Society:

Philip B. Gibb, M.A., 14 Picardy Place; Sommerville Grieve, Esq., Salisbury View, Dalkeith Road; John Murray, F.R.S.E., "Challenger" Office, 12 Teviot Row; Dr Jackson, R.A., Leith Fort; Charles Prentice, Esq., C.A., 55 Castle Street; and Dr J. W. Barry, 23 Duke Street.

As Corresponding Member—Thomas Edward, A.L.S., Banff.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Proceedings of the Royal Society [of London], Vol. XXVI., Nos. 182, 183. —From the Society. 2. Ethnography of the Hidatsa Indians, by Matthews. Bulletin of the U.S. Geological and Geographical Survey of the Territories, Vol. II., Nos. 2, 3, 4; Vol. III., Nos. 1, 2, 3; Second Series, Nos. 4, 5, 6. Bulletin of the Entomological Commission, Nos. 1 and 2. Supplement to Fifth Annual Report of the Survey for 1871 (Report on Fossil Flora). List of Elevations, by Gannet. Coues' "Birds of the North-West," 1874.—From the Department of the Interior, U.S. Government. 3. Journal of the Linnean Society—(1.) Zoology, Vol. XIII, No. 71, and Vol. XIV, No. 73; (2.) Botany, Vol. XVI., No. 92.—From the Society. 4. Videnskabelige Meddelser fra Naturhistorisk Forening i Kjöbenhavn, for Aaret 1876.—From the Society. 5. Proceedings of the Boston [U.S.A.] Society of Natural History, Vol. XVIII., Parts 3 and 4.—From the Society. 6. Canadian Journal of Science, Literature, and History, Vol. XV., No. 7.—From the Canadian Institute, Toronto. 7. Boletin del Ministerio de Fomento de la Republica Mexicana, Tomo 1, 1877.—From the Ministry of the Interior, Mexico. 8. Distribution of the Brachiopoda in the Oolitic Strata of Yorkshire, by W. H. Huddlestone and John F. Walker. —From the Authors.

The following communications were read:

I. *Note on the Occurrence of the Red-breasted Lark* (Sturnella militaris) *in Central America.* By ROBERT GRAY, Esq., F.R.S.E., etc. (Specimen exhibited.)

A few months ago I received from my friend, Dr Robert Macdowall, resident in Panama, the bird which I now exhibit, and which had been killed in the neighbourhood of his residence. It was sent to me for identification, and in the absence of such notes as I had hoped to be able to lay before the Society from the pen of Dr Macdowall, I merely submit the specimen for inspection, with a few remarks on the recorded instances of the supposed occurrence of the species outside its natural habitat—the coast of Chili—from which it has hitherto been known to wander southwards only round Cape Horn as far as the Falkland Islands.

Mr Baird states in his work on North American birds, that "a single specimen of the red-breasted lark was obtained in San Francisco by Mr R. D. Cutts of the Coast Survey from a collector, who asserted positively that it had been shot by him in San Francisco county. It is likewise mentioned in the 'Voyage de Venus' (Zoologie, I., 1855, 203), as having been shot at Monterey by Dr Neboux, surgeon of the expedition. There is still some uncertainty, however, as to whether it be really entitled to a place in the fauna of the United States, as Mr Cutts may have been deceived by his informant, and the indications of the zoologists of the 'Venus' as to the existence of other species of vertebrata in California are certainly erroneous, owing, doubtless, to accidental transposition of labels." From these remarks by Mr Baird, whose work is one of the most recent on North American ornithology, it will be judged that the *Sturnella militaris* was admitted by him with great hesitation. It is not included in the late Mr Cassin's "Birds of California and Texas," and Dr Elliot Coues, in his "Key to North American Birds," published in 1872, disposes of the species by saying, "It does not appear that the red-breasted lark (*Trupialis militaris*) was ever taken in this country. It is a South American species resembling ours, but with red in place of yellow."

Mr Salvin, who has written many important papers in the *Ibis* on the ornithology of Guatemala, Honduras, Nicaragua, and Costa Rica, the results of close personal research, has informed me, through Professor Newton of Cambridge, that this bird is not found in any part of Central America; that it belongs to the south-west coast—Chili, etc.—but goes round Cape Horn, as has been already said, as far as the

Falkland Islands. Northwards from the last-named locality its place is taken, especially in Buenos Ayres, by a nearly-allied species, *Sturnella defilippii* of Bonaparte, which differs from the western species in having *black* axillaries in place of white. It is right, however, to state that specimens of the true *S. militaris* were obtained by the United States' Exploring Expedition as far north on the east coast as the Rio Negro.

The present specimen is interesting, not only as having occurred on the Isthmus of Panama, but as affording evidence in favour of the reported occurrences in California, about which strong doubts have existed; and I have, therefore, pleasure in bringing it before the meeting as one of those small facts which enable the naturalist to trace correctly the distribution of a species.

II. *On the Occurrence in Scotland of the Squacco Heron* (Ardea comata, *Pallas*). By Robert Gray, Esq., F.R.S.E., etc.

Shortly after the concluding meeting of last session had taken place, I happened to be in the shop of William Hope, birdstuffer, George Street, when my attention was drawn to the bird now on the table. It had been sent in by the Duchess of Buccleuch with a special message from Her Grace that particular care was to be taken with the bird, as it was a Scotch killed specimen, and had been sent to the duke as a great rarity. As no specimen of the squacco heron had ever been found in any part of Scotland before, I at once made inquiry about the bird, and have since been informed that it was shot at Dalmahoy, in the parish of Ratho, and given to the duke by the late Lord Morton. It is to be regretted that the exact date of its occurrence cannot now be ascertained, His Grace being unable to say in what year he received the specimen. It, as you will observe, is in beautiful and most perfect plumage, like many of the specimens that have already been found in Britain. This bird is the twenty-fourth that has been killed in the British Islands—all the others, with a very few exceptions, having been obtained in the southern counties of England. The first was recorded in the minutes of the Linnean Society for 1797, as having been shot at Boyton. A second example was taken in Norfolk in December 1820. No others would appear to have been met with until 1834, when two were procured in the same county. Subsequently, and at irregular intervals, various specimens have been obtained in Hampshire, Dorsetshire, Devonshire, and Cornwall.

The squacco heron seems to be widely distributed in Africa and Western Asia. It is abundant in Egypt, where it has been observed of late years by Captain Shelby, who remarks that many of the specimens which he shot had been feeding on locusts. It is also mentioned by Dr Tristram as an inhabitant of the Great Sahara, and by Anderssen in his "Birds of Damara Land," where it abounds in the lake region, feeding on insects and frogs. It is a well-known bird on the Zambesi, and is plentiful in the Transvaal, besides being an inhabitant of Madagascar. On all the shores of the Mediterranean the species may be said to be common, and it is, doubtless, from such localities that all the stragglers hitherto found in Britain have come.

Anderssen describes the iris as pale yellow, the bill of a transparent whitish horn colour at the tip, the base of the upper mandible is bright greenish-yellow, and this colour extends to the base of the nostrils; the under mandible is also greenish-yellow; the tibia, tarsus, and toes are dusky-green, lightest on the tibia and the upper part of the tarsus; the under surface of the toes is yellowish. This description supplies a correct idea of the colours, which, of course, cannot be observed in a stuffed specimen.

The natural haunts of the squacco heron are marshes, margins of seas, lakes, and rivers, and in such localities it subsists on small fishes, reptiles, crustacea, and insects.

I am indebted to the Duke of Buccleuch for permission to exhibit the specimen at this meeting.

III. *Note of a Small Lizard,* Psammadromus Hispanicus; *also a large species of* Sirex; *both recently taken alive at Kinleith, near Currie.* By JOHN ALEXANDER SMITH, M.D. (The specimens were exhibited.)

My friend Mr William Bruce, one of our members, brought me these interesting specimens; they were got this summer, at Kinleith Paper Mills, and as this pretty little lizard, with its two parallel light-coloured stripes along each side of its greyish back, turns out to be a Spanish species, we may naturally conclude that both the lizard and the fly were brought to this country among the esparto grass, great quantities of which are imported, both from Spain and Africa, by Mr Bruce, to be used in paper-making. The workman who first noticed the little lizard running about, and captured it, being familiar only with our common water-newts, concluded that the best way to keep the fragile little creature alive was to get a bottle, fill it with water, and put the lizard into it, and was rather astonished to find that instead of prolonging its life, he had actually drowned the poor little land lizard.

Sirex sp.—Mr R. F. Logan informs me this insect belongs to this genus, but he does not know the species. It is a large hymenopterous insect which has a long ovipositor, well seen in this pretty black and yellow ichneumon-like fly, with which it deposits its eggs in holes in old trees, etc.

Both the lizard and the fly are therefore in all probability simply species accidentally brought to this country, like many others, by man in the course of ordinary commerce; few of which meet with circumstances sufficiently favourable to prolong their existence here, and in this case, as they were introduced from a warmer climate, in all probability the cold of winter would soon have killed them both, could they have survived the summer. They show one of the ways by which new species of animals may be introduced into our country, and this, of course, may on some occasions involve results of an important character.

We all know the interest and even fear excited throughout the whole country by the expected chance of the introduction into it in any way of merely a very small insect—a beetle, but in this case the fearfully destructive Colorado Beetle, *Doryphora decemlineata,* which in countless multitudes has been traversing the great continent, and laying waste the potato crops of America. Our Government officials have promptly taken up the matter, and a watch has been set at every port to protect us, if possible, from this small but very formidable invader, an enemy at once to our potato crops, and therefore really to one of the great food supplies of the country. A skilled naturalist and entomologist being at once sent to investigate on the first rumour of the beetle's appearance, my old friend our member and former president, Mr Andrew Murray, was sent from London to Liverpool to examine and report as to its supposed occurrence there. I regret much to say Mr Murray has since died in London—a loss at once to natural and economic science, as the first of his South Kensington Museum Hand-books—"Economic Entomology and *Aptera,*" by Andrew Murray, F.L.S.—prepared by the order of the Lords of the Committee of Council on Education, amply testifies. Mr Andrew Murray also formed, I believe, the valuable, interesting, and important collection of economic entomology in relation to agriculture, preserved and exhibited in the Bethnal Green Museum, London.

Wednesday, 16*th January* 1878.—Professor Duns, D.D., President, in the Chair.

The following gentleman was balloted for, and elected as Resident Member of the Society: Archibald Gray, Esq., 13 Inverleith Row.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. The Journal of the Linnean Society—Botany, Vol. XVI., No. 93.—From the Society. 2. Transactions of the Manchester Geological Society, Vol. XIV., Part 14.—From the Society. 3. Bollettino della Società Adriatica di Scienze Naturali in Trieste, Vol. III., Nos. 1, 2.—From the Society. 4. Die Naturgesetze und ihr Zusammenhang mit den Prinzipien der abstrakten Wissenschaften. Zwei Theile. von Dr Hermann Scheffler.—Presented by the Author. 5. Boletin del Ministerio de Fomento de la República Mexicana, for September and October 1877.—From the Ministry of the Interior, Mexico. 6. Medical Examiner, Nos. 48-50, Vol. II.—From the Publishers.

The following communications were read :

I. *On the Power of Rainfall in Denudation, as illustrated by the Ravages of the Flood of August* 28, 1877, *on the Ochils, from Tillicoultry to Muckhart, beyond Dollar.* By ANDREW TAYLOR, Esq.

The August of 1877 exhibited on the east of Scotland most of the strange meteorological phenomena of that abnormal year in its weather relations. There were fifty-eight and a half hours less of sunshine than in average years. The temperature in Scotland was greatly below the average, and there was a very large rainfall seen over the width of eastern Scotland, though local in its manifestations, and extending in Edinburgh to betwixt 200 and 300 per cent. above the average. The month closed in the east of Scotland in showers, and on the 28th the casualty noted in our title occurred, distracting the attention of the readers of the daily newspapers from Eastern war complications by the ruin of roads and bridges, the temporary blocking of the local railway, and the sad loss of two lives it occasioned. Some concomitant geologic phenomena attending this flood deserve a more permanent record.

Mr Buchan has shown in a paper, read subsequently to this one, that the observations of rainfall by the observers of the Scottish Meteorological Society demonstrate the physical features of Scotland affect its rainfall. The area of flood ravages was confined to those six or seven miles, from the pool of Muckhart to Tillicoultry, where the Devon turns almost at right angles from its eastern windings to join the Forth. The Ochils here take that steep wall-like aspect which is their prominent characteristic from the railway carriage on the way to Stirling. Several small mountain streams descend the steep gradients almost at right angles to the course of the Devon, as at Tillicoultry, from 2094 feet at the Law Hill, to the 200 feet contour line which follows the course of the Devon from Muckhart, and it was down these burn courses most of the damage was done. It had rained all the previous evening, and on the early morning of the 28th August, the hills over the eight miles of their flanks specified appeared covered with foam; it thundered and lightened the while, and the sleepers along the burnside at Dollar were awakened by harsh rasping sounds of huge boulders grating, capsizing, and breaking, and above all the thundering noise of a head wave rushing down from the hills. This lasted but a quarter of an hour, though it appears to have been the agent of change along the line of the flood's action.

At Tillicoultry the mountain stream runs down a street to join the Dollar at Glenfoot. There are several factories along its course. The street was covered with good sized boulders which impeded carts a month after the flood. Here it was that a manufacturer was swept away, and drowned in the vain attempt to save two of his workers.

At Harvieston House, about a mile above Tillicoultry, a small stream descends almost in a straight line from the King's Seat, 2111 feet, to the 200 feet contour line; it carried mud, water, and *débris* down in its mad course, and, on reaching the turnpike road, carried off the bridge fording it, besides knocking down a well-built stone wall, and thus rendering the turnpike impassable. A little above this the torrent made a new channel in the well-nigh perpendicular hill side, making a scarp twenty feet broad, and removing the surface soil of a depth of five feet down into the valley.

But it was at Dollar where the flood made its most interesting geologic lessons on a large scale with considerable municipal damage, though happily with no loss of lives. The Dollar Burn is like the central portion of the letter Y on the Ordnance map, running into the Devon below the town. The left fork is the Burn of Sorrow, and the right the opposite streamlet from Whitewisp Hill; both touch a contour line of 2000 feet. Castle Campbell is situated at the junction of the two forks of the letter. It was along the upright stem, beginning at the Gloom Hill, that the flood effected its ravages. These are delineated in detail in the accompanying plan on the 26-inch Ordnance Survey map, prepared at my request by Mr John Cram of Dollar. It should be premised that the physiography of the Ochils here is not of the steep wall-like character near Harvieston. The lower beds of the carboniferous system begin to rest on the hills, giving a shelving character different from the abrupt scarps of the porphyrites. The surface beds are first the alluvial soil, then a thick stratum of gravel and boulders. In the valley of the Devon there are a succession of beds of clay, boulders, sand, and gravel extending to a considerable thickness.

Mr Cram thus refers to the figures on the plan:

"Figures I. and II. are excavations made by the burn in its banks. Along the greater part of I. a high mound of earth had been thrown up as a defence and covering for the pipes conveying the water to the town. The embankment and pipes were alike carried off, and the earth scooped out to a considerable depth.

"III. and IV. are large deposits of shingle and boulders. The ground was formerly covered with sward, and partially grown with wild rose-bushes. These have been buried by a deposit of varying depth, in some places as much as four feet. This long bank of conglomerate has since been removed. The boulders had evidently been taken by the flood waters from the boulder clay. Some were porphyrites found on the Ochils, but most were boulders of quartz, chlorite, slate, and other travelled stones. Many were of great size. One was at least three tons in weight.

"At V. and VI. the stream has carried off parts of its banks, but not to any considerable depth. The 'Dam' set down here has now been removed, and exactly in its place stood a bridge in connection with the Glen footpath. The bridge was borne away by the torrent as were several others farther up.

"VII. indicates the place where you will remember an inroad has been made into a potato field. The water-course as indicated in the map has now been filled up with gravel, represented by dots, and the water finds its way by a course in that part indicated in the map as a field.

"At VIII. the footpath has been carried away, as well as the garden wall, but the damage was kept at a minimum by roots of trees.

"At IX. and X. the carriage-way on either side of the burn has been washed away; at X. completely so.

"At XI. the road has been straightened, and two double villas built since the issue of the map. Here the burn carried off the carriage-way, and completely demolished the whole front of the upper double villa. It also partially undermined the corner of the adjoining one.

"At XII., XIII., XIV., XV., XVI., XVII., and XVIII., considerable slices have been removed from the banks.

"At XIX., where the railway crosses Dollar Burn on an iron bridge, an immense deposit of gravel and large stones completely gorging the passage under the bridge, and burying it entirely from sight, was laid down. On making inquiry of the railway official whose duty it was to superintend the removal of this heap as to the probable quantity removed, he informed me that 470 waggon loads were removed to various places along the line, and that he considered a waggon load might be estimated at between five and six tons. Reckoned at five tons, this would give 2350 tons removed at once, but in addition to this quantity two large heaps were wheeled to a convenient distance at the side, estimated to contain sixty waggon loads. These two taken together would thus amount, at this moderate estimate, to 2650 tons."

The palpable evidences of the flood shown on the plan are no longer visible. Roads have been repaired, the conglomerate embankments are now removed from the upper glen; and the twin villa has been rebuilt with a foundation this time on the thick clay below the yielding gravels. The burn is now confined in a regular causeway of dressed stones, which, though it may add comfort to the dwellers on its banks, has destroyed its once charming sylvan beauty. The municipal repairs consequent on this hour's torrent cost over £2000 sterling.

The Cowden Burn is the next affluent into the Devon, about two miles north-east of Dollar. The torrent down it swept away the bridge carrying the Kinross road across it, as well as a good part of the neighbouring embankment. It did damage to the extent of £350 to the mansion-house policies of Mr Christie, through which it passes.

The little brooklet of Baldie's Burn rises almost beneath the Common Edge Hill, 1500 feet high, which looks down on the sudden twist to the north-west which the Devon makes in its course near the Pool of Muckhart. This was the farthest course of the ravages of the flood; but nowhere were better evidences seen of its extraordinary power. The brooklet can be stepped over during most of its course, and but in two places, its descent partakes of the precipitous. Where it crosses the Muckhart road is a wright's workshop with dwelling house, and two labourers' cottages, and a triangular space of ground covering about a quarter of an acre. This was covered by stones and boulders, some placed one above another, and many a foot and half in longitudinal diameter; while the gardens were silted over with gravel and the houses flooded. The bridge withstood the shock, though with difficulty. Higher up the hill above Westerhall steading is another flat, and on it an island of large boulders some twelve feet long was suddenly formed. The ravages of the flood occurred at the same hour as the disasters of Tillicoultry and Dollar.

The peculiarity of this flood was the short space in which the damages were effected. The head wave which cut out thirty feet of roadway at Dollar, and made the great embankment, lasted only a quarter of an hour; and the normal state of things was resumed in about an hour after. The power of the flood did not depend on the rainfall. Mr Coyne, C.E., superintendent of the Edinburgh Waterworks, states that in 1876 a sudden spate at Harperrig reservoir did great damage, carrying off walls and embankments. It lasted an hour, and as the rainfall is measured by the resident keeper, it is known that much heavier falls have since occurred with no damage to the city property. Given a rain cloud of sufficient height to strike the Ochils at 1500 to 1000 feet, then there is sufficient hydraulic power to lift thousands of tons of gravel, sand, and boulders.

Our records of seasons like that of 1877 are very incomplete. Wet seasons may follow those of extreme cold, like that of 1875, or that of 1831. Very considerable alterations may thus have been formed at the base of these hills without any change of the present order of things in the historical period. Thus the ancient deltas at Menstrie, Alva, and Tillicoultry, figured and referred to by Mr Milne Home in his "Estuary of the Firth of Forth," as ancient raised beaches, may have been formed by some such sudden phenomena. Also many of the upper sands and gravels (the series extends some seventy feet deep in the Devon valley) may have been caused by such sudden spates. The phenomena of the Devon and its affluents are comparable to the mountain torrents on the Italian rivers flowing from the Alps.

These streams bring down great quantities of *débris*, but do not cut out, but fill up. It cuts out the gravel and sand below boulders before it carries them along, and heaps them up as in the Dollar conglomerate bing. The largest stones are carried the least distances, remaining at the summits of the water-courses; the gravels are carried farther out, but sands mark the extremity of the torrential force. The stones there are turned on their axes with great force and noise. They thus acquire a centrifugal force, which causes them, to leap on larger layers, and deposit themselves atop of them, as at Dollar and Baldie's Burn. All this stops below the first limits of the gravel. The force of the torrent, whether real or effective, is proportionate to the square roots of the heights. The rivers receiving those mountain torrents do not appear to increase their contents by their sudden discharge into them. This may be on account of their increased rapid flow. The Devon was in no way apart from its ordinary quiet aspect, either on the morning or throughout the day of the floods.

Wednesday, 20th February 1878.—Dr R. H. Traquair, F.G.S., President, in the Chair.

The following gentlemen were balloted for and elected as Resident Members:

Professor Archibald Geikie, F.R.S., University of Edinburgh; A. B. Brown, Esq., 1 Rosebery Crescent; John Horne, Esq., F.G.S., Geological Survey Office, Victoria Street; John Christie Deans, Esq., M.A., S.S.C., 40 Castle Street; David John Surenne, Esq., 6 Warriston Crescent; Rev. John Macrae, Parish Minister of Hawick, Roxburghshire; William Robertson, Esq., Actuary, 55 Castle Street; and as Non-Resident, Norman Prentice, Esq., Civil Engineer, Otago, New Zealand.

The following Donations to the Library were laid on the table, and thanks voted to the donors:

1. Nova Acta Regiæ Societatis Scientiarum Upsaliensis, 1877.—From the Society. 2. Coues on Fur-bearing Animals (No. 8 of "Miscell. Publications," by U.S. Geol. Survey, 1877). Also, U.S. Geol. and Geogr. Survey of Colorado and adjacent Territories, 1875; and, Preliminary Report of the Field-Work of the U.S. Geol. and Geogr. Survey of the Territories, 1877.—From the U.S. Government. 3. Proceedings of Geologists' Association [London], Vol. V., Nos. 3 and 4.—From the Association. 4. Boletin Meteorológico del Observatorio Central, Marzo, 1877.—From the Ministry of the Interior, Mexico. 5. Description détaillée des Paratonnerres établis sur l'Hôtel de Ville de Bruxelles en 1865: exposé par Melseus.—From the Author. 6. Medical Examiner, Vol. II., Nos. 103-106, inclusive.—From the Publishers.

The following communications were read:

I. *Notice of a Recent Visit to the so-called Tropical Forest Remains of Hampshire, at Bournemouth.* By David Grieve, Esq., F.G.S.

My attention was first attracted to this Tertiary deposit while inspecting the Loan Exhibition at Kensington in 1876. On this occasion several cases of beautifully preserved leaves from Bournemouth were exhibited by Mr J. S. Gardner, F.G.S., a gentleman who has directed much attention to this subject, and who, in connection with the Loan Exhibition and the Geologists' Association, delivered a most interesting lecture on these Hampshire fossils, which is very fully reported and illustrated in three consecutive numbers of *Nature* for January 1877.

Having leisure last autumn, I spent two or three days at Bournemouth, and went over the ground which Mr Gardner describes as the "Tropical Forests of Hampshire." I was successful in gathering upwards of one hundred dicotyledonous leaves, some of which I now exhibit to you. I thought they might prove interesting, as we have but little of the Tertiary formation in Scotland; indeed, the only place I know where similar leaves have been found is in the island of Mull, but found under different conditions, the leaf beds there being intercalated with volcanic rocks, and are attributed to the Miocene period, and so posterior to the Hampshire fossils, which, for good reasons, I think are referable to the Lower Eocene period.

Seeing, as I have stated, that the subject has already assumed a published form of a somewhat exhaustive character, I shall content myself with referring members who feel interested in the subject to Mr Gardner's details and speculations, confining the brief remarks I have to make to a few general observations.

The whole line of coast, extending to about two miles on each side of Bournemouth, that is to say, four miles from Poole Harbour on the one side, to Christchurch on the other, is encompassed with steep cliffs composed chiefly of fine and variously coloured clays. The finest kind is that near Poole, which is a pipe-clay, and is extensively excavated, and of much mercantile value for making pottery. The clay in which these leaves are found is considerably coarser than the last mentioned, and is generally of a cream colour; it is contained in silted pockets, and crops out here and there at uncertain distances in the cliff, and is evidently of fluviatile origin. These clays are all overlain by the Bracklesham and Barton beds of the Eocene period, so that these leaf beds are necessarily of the same period.

The Bournemouth flora seems to consist principally of trees or hard-wooded shrubs. There are also ferns, fungi, and coniferæ, several kinds of palm; also *cactus, Stenocarpus, Eucalyptus*, etc., which indicate, if not quite a tropical, at least a much warmer, climate than at present exists.

Many of the trees of our own day, such as the oak, beech, maple, chestnut, willow, laurel, etc., are plentifully represented in these beds, and the curious thing is that such trees should be mixed up with monocotyledons, such as the *Pandanus* reed, and fan and feather palms, which too are found in abundance.

I have not as yet named any of the specimens I have got, for the reason that I find identification very difficult as between existing genera and species—doubt in many cases must always exist in consequence of the similarity of the leaves of very diverse species. It cannot be even said that any of these Tertiary leaves are precisely the same as the present existent foliage. All that can be admitted is, that there is a striking resemblance to the leaves of trees now growing in our woods and gardens, which any one, on casting their eye over these two small cases, will at once recognise.

I may remark that a similar deposit of leaves to this one exists not far from Bournemouth, viz., at Alum Bay, Isle of Wight, and it is quite possible that some connection existed at a remote period of time between the two localities, although the sea now separates them; but, of course, this can only be a matter for conjecture.

The clay in which these leaves are found is generally of a soft and plastic nature, and it requires to be of a certain degree of hardness before good specimens can successfully be extracted by splitting. If too hard again, the clay is brittle, and the specimens are frequently obtained only in a fragmentary state. Some attention is therefore required in preparing the clay for manipulation. Mr Gardner describes this process, and he, being a regular summer resident at Bournemouth, had ample opportunity and time for selecting perfect and handsome specimens; but a casual visitor of only a day or two, such as myself, must, generally speaking, be content with only second-rate specimens.

The casts only of many of the leaves remain, the fibre having vanished. In not a few cases, however, the fibre is intact in a carbonised state, but when exposed to the air, rapidly crumbles away. The clay itself in which the leaves are held is, when dry, also inclined to pulverise, so that the only way of preserving the specimens is to dip them in a weak solution of isinglass or size.

II. *On the Occurrence of* Colias edusa *in Scotland during the Summer of* 1877. By R. F. Logan, Esq.

Colias edusa is a remarkable insect in this country, on account of the occasional superabundance of its individuals, without our being, hitherto, able to assign any known cause for the sudden increase in its numbers. During last summer this beautiful insect appeared in unusual abundance. In ordinary seasons it is quite unknown in Scotland, while it is rare even in the south of England; but last year it appeared almost over the length and breadth of the land. As the editor of the *Entomologist* remarks, it was "seen in greater or less numbers during June all over the kingdom, from central Scotland to the Land's End." He might have said from *Ultima Thule* to the Land's End, as one was seen in Orkney.

About thirty years ago, a specimen of this butterfly was taken in September near Lamlash, in the Isle of Arran, by Sir Wyville Thomson, who was then a student in Edinburgh. Some years afterwards it occurred in considerable numbers in Annandale, Dumfriesshire. Since then, I believe, no specimens have been recorded as occurring in Scotland till the wet summer of 1877. On the 4th of June Mrs Alexander Fraser, the wife of the Royal Scottish Academician, took a magnificent specimen at the foot of the Eildons, near Melrose. On the 14th June I saw another flying swiftly along the edge of the railway at Seafield, near Leith; and on the 1st July I caught a worn specimen on an azalea at Spylaw, Colinton. These are the first Edinburghshire specimens on record, the insect not being included in the list of Midlothian lepidoptera submitted to this Society, and published in the *Naturalist* in 1852 by Dr Lowe and myself. On the 19th June a specimen was seen, as I have already mentioned, in the island of Harray, Orkney. Numerous specimens occurred in Dumfriesshire, Kirkcudbrightshire, and Berwickshire, and it is also recorded from Galloway and Perthshire. In the first week of October Mrs Fraser caught another fine specimen on the coast beyond Port Seaton, being, no doubt, one of the second or autumnal brood, resulting from the eggs of the June specimens. At the same time it occurred again in Galloway, and numerously in Berwickshire, and on Gullane Links, East Lothian, as I am informed by Mr Shaw of Eyemouth.

It is rather a difficult problem to solve, the sudden and simultaneous appearance of such a conspicuous insect as *Colias edusa* all over the country. Although an insect of strong and rapid flight, and of somewhat migratory habits, the theory that they all came over from the Continent is, I think, quite untenable. It is evident, from the freshness of many of the specimens, that they were bred in this country, and in the districts where they were caught. I have long had an idea that this insect might be imported with agricultural seeds; and I see that Mr W. G. Gibson of Dumfries, in a communication to the Entomological Society of London, suggests "that its occurrence might be accounted for by the large importation of foreign clover." Here at first sight is a feasible solution of the mystery. The larva feeds, among other plants, on clover. The eggs would naturally be deposited by the butterfly on the flowers and seed heads, and might thus be imported along with the clover seed which, being always sown on the surface of the soil, the young larva would have no difficulty in making its escape from the eggshell, and would find itself surrounded by appropriate food in the young sprouting clover. Unfortunately for this theory, however, the eggs hatch in the autumn, and the young larva hibernates among its food plant, feeding up in the spring. So we have no alternative but to believe that it is a genuine native of this country, but more liable than most species to be influenced by the changes of our variable climate.

III. *Note on Extirpation of the Kidney in a Cat, and on* Demodex folliculorum *in the Dog.* By Principal Williams, New Veterinary College. (Specimen exhibited.)

1. About a fortnight ago I was requested to remove a tumour, which, it was stated, had appeared on the side of a cat within the last few weeks, and had been caused by the bite of a dog. The tumour was loose, and easily movable under the skin, posterior to the last rib on the right side, causing no inconvenience to the animal.

I made an incision through the skin, when the supposed tumour popped out as it were. It had a narrow pedicle, was removed by torsion, and there was scarcely any hæmorrhage. On examination I found the supposed tumour to be a very fine healthy kidney, and was consequently afraid the operation would prove fatal, but, strange to relate, it has not caused the slightest inconvenience, and the cat is as healthy as ever. It will be interesting to watch the progress of the case, and to find out at a future time whether the kidney were a supernumary or merely a floating one, and, if the latter, to discover if the remaining kidney will have become greatly hypertrophied.*

2. The *Demodex folliculorum*, of which I now hand round a drawing, is an entozoon very commonly met with in man, and causing those pimples on the nose, vulgarly called "mawks," but seems to cause no inconvenience beyond lessening the beauty of "the human face divine," induces in the dog an incurable, and finally, a fatal form of skin disease called "follicular scabies," and this it does by burrowing deeply into the brain follicles with its head looking inwards, propagates slowly but surely, and is so deeply imbedded as to be beyond the reach of remedial agents.

IV. *Notes on some Raised Beaches of the West of Scotland, with Illustrations.* By William Ferguson, F.L.S., F.G.S., F.R.S.E., etc.

The following paper touches some of the modern geological changes exhibited in the neighbourhood of Glasgow, and embraces some topics which may perhaps be regarded as belonging more to archæology than natural science, but which, nevertheless, have some bearing upon the geological question.

My attention was more specially directed in the year 1850 to the modern changes of surface on the Firth of Clyde. In digging a drain in Sauchiehall Street, Glasgow, in the autumn of 1850, at a spot about twenty-five paces to the west of the Wellington Arcade, the workmen after going down about four feet came to a bed of pure peat, one foot thick, and below that they dug four feet through beds of sand containing shells (*Trochus ziziphinus*). In one shovel-full of sand thrown out there were as many as five or six. Here we have a portion of a deposit plainly showing that the sea, or at least an arm of

* *Note.*—The cat from which the kidney was extirpated is alive and well at the time this goes to press, months after the operation.—W. Williams.

it, occupied at one time the spot where Sauchiehall Street now is. From this it is evident that some change has taken place in the relative levels of the sea and land.

One or two more proofs of this may be given, confining ourselves, however, to the Clyde for illustrations.

In Arran the road from Brodick to Corrie, and so onwards round the north end of the island, occupies a flat and level but not broad space of ground, a little elevated above the level of the sea, and backed by a series of cliffs of considerable vertical height. These cliffs are full of caves, evidently formed by the action of waves at one time beating against them. Furthermore, the flat surface of the level between the road and the foot of these cliffs is due to the rolling action of the waves. I once visited this place (1849), and obtained from a ditch in what was then a field waving with corn a series of shells. They were broken and worn, but when it is remembered that when they were found at some distance from the sea, and at a much higher level than the sea ever reaches now, they are not without interest.

The next illustration I refer to is the island of Little Cumbrae, at one extremity of which (the whole island being little more than a great rock) an old town of extreme antiquity is built on the raised beach. Here, as in Arran, the beach is flat and narrow, very little raised above the present level of the sea, and immediately flanked by cliffs rising abruptly from it. I have not landed on this beach, and do not know if it yields fossil evidence of its pristine character.

The island of Bute presents us with the same physical confirmation. On entering the Bay of Rothesay we observe the line of contour of the surface presented against the sky and water, and representing a long slope from the hills to near the shore, when it descends abruptly to a flat space, not very broad, before reaching the water.

To the north of Rothesay again towards Port Bannatyne, the hills descend much more abruptly, but between their base and the water the plain is more extended.

Advancing up the Clyde, the same beach is seen on both sides. All along from Gourock southwards, the road to Largs is formed upon it. In some places it is a mere shelf, but in others it attains to a considerable breadth, and it is backed by picturesque cavern-hollowed cliffs. These may be seen very distinctly in the neighbourhood of Wemyss Bay. On the north bank of the Clyde, between Helensburgh and Dumbarton, the same sort of beach may be traced, and here, too, where the soft strata of the Old Red Sandstone stand out in cliffs on the upper side of the road, they are hollowed out in water-worn caves.

As we approach Glasgow the high grounds on both sides of the river recede far inland, leaving spread out between them a rich alluvial plain, which it needs little imagination to recognise as the ancient bottom of some old sea or inlet, and it is curious to meet with names and notices carrying out this hypothesis. Thus, a little way from the town of Renfrew, but on the opposite or north side of the Clyde, and a mile and a half from the river, is a place called Garscadden. In Gaelic, I am informed, *gar* means a point, and *scadden* a herring; and Macfarlane, in his "History of Renfrew," mentions this place as "The Herring Yair." In the "Statistical Account" I find also some notes mentioning certain ancient fishings at Renfrew Quay. In various parts of the flat grounds lying around the town of Renfrew, deposits have been found containing shells of species not now living in this estuary. The confirmation of the country is also corroborative of these traditions of the sea having formerly stood at a higher level than now.

In and around Glasgow itself these ancient sea-levels are distinctly traceable. In Glasgow Green may be noticed two haughs or meadows, one about eleven and the other twenty-six feet above the level of the sea. The appearance of that part of Glasgow has been much altered of late years. In 1810 a slight swell in the river, or a heavy shower, laid part of this park, called the Low Green, under water.

But keeping in view the improvements which have been made upon the Green, it is yet sufficiently obvious that the shelf along the river below the High Green and the Fleshers' Haugh may have been a beach, and the flat expanse of King's Park and the High Green sloping up to Monteith Row another. The second of these levels gives us the line of London Street and the Trongate, and may be traced in this way a considerable distance.

Mr Robert Chambers has described the terraces of Glasgow at great length.

In addition to the evidence of these ancient sea-margins we have the authentic records of the discovery of shells in the clays and sands of which many of them are composed.

Thus, at various points in the parishes of Paisley and Renfrew shells have been met with, as at Oakshaw and Bellahouston.

They have been found in some of the brickfields of Annfield (east of Glasgow) by Mr John Craig; and by the same person in various other places at 40, 80, 100, and 360 feet above the sea-level.

In cutting the Paisley Canal about four miles from Glasgow, twenty-two species were observed; again, on the shores of Loch Lomond, at Dalmuir on the Clyde, on the shores of the Kyles of Bute, and in many other places.

The former existence of the sea, or at least of a branch of it, of greater extent than at present, in the neighbourhood of Glasgow, is borne out by the discovery of canoes embedded in the soil at various depths.

The first canoe was dug out of the foundations of the original church of St Enoch's in 1780. It was lying flat and filled with sand and shells. In the bottom was sticking a celt, or stone hatchet, of bloodstone, and in good preservation. It is highly polished, and the place where the band fastening it to the handle passed, is marked by being rough.

The second boat was found in 1781, when digging the foundations of the Tontine Buildings in the Trongate.

The third and fourth in 1825, the former when opening London Street, and the latter in digging a drain in Stockwell Street. The position of the London Street boat was vertical, the prow being uppermost, as if it had sunk stern foremost. It was also filled with sand and shells.

In 1847 and 1848 no fewer than four (Nos. 5 to 8) of these canoes were discovered within a few yards of each other at Springfield on the south side of the Clyde, nearly opposite to Napier's Dock. They were lying about 100 feet from the margin of the river, and rested on a bed of gravel fifteen inches thick. Above them was a bed of loam, nine or ten feet thick, surmounted by sand. The entire depth of the situation of the canoes below the surface was seventeen feet, being just about the present low-water level.

A ninth canoe was discovered about 1852 at some little distance down the river opposite Kelvinhaugh.

These canoes are formed generally of one piece of wood, and are merely trunks of trees hollowed out. Some of them, however, are fashioned with a little more care, and have a square stern of separate boards let into grooves in the main log.

I believe that since 1852 several more of these canoes have been exhumed, but I have not been able to obtain the particulars of their discovery.

I must now offer, in conclusion, some remarks on the period of the changes indicated by these various phenomena, as well as upon the appearance which the locality of Glasgow may have presented when such beaches as that of Sauchiehall Street were formed.

First of all, I must clearly distinguish between the period when these raised beaches were formed, and that in which the canoes came to be embedded. For this latter it seems to me to be enough to require that both banks of the Clyde at Glasgow presented somewhat the appearance at the period to which these canoes refer us, that the same banks from Dumbarton to Helensburgh do at the present day. We find there at high tide a noble expanse of water, but when the tide is low, the inland ocean is converted into a vast plain of mud, obviously the *detritus* carried down by the river. Every flood helps to narrow the fens farthest up, and to add to the mud-banks below; and time alone, in addition to the causes now in operation, is all that is required to convert the wide area of shallow water into rich alluvial soil. The process has only been a little more rapid on the site of the Green and the lower parts of Glasgow and neighbourhood. Let us imagine then that in these early ages the flat lands now adjacent to the river, much of which has been heightened artificially, were low plains covered with water at high tide, and we have both the occasion for the use of the canoes and the element on which they floated. Any sudden flood swamping them is sufficient to account for their being embedded in the mud and gravel which formed the bed of that ancient estuary.

Wilson, the author of "Pre-historic Annals," gives us (pp. 27 and 40) a graphic account of what may be supposed to have been the early appearance of the country in those parts of Scotland, and the character of its first inhabitants.

That the great geological changes of the level of the sea are carried back into an antiquity very much greater than the period to which authentic history reaches, is very sufficiently proved by the oldest civilised remains of which our country can boast; I mean those of the Romans. These are rather numerous in the neighbourhood of Glasgow. There is a Roman camp at Camphill, near Langside; a prætorium or station of a prætor at Oakshaw Head, near Paisley; a Roman bridge at Duntocher; and the site of the last fort upon the Roman Wall of Antoninus, or Graham's Dyke as it is commonly called. This site is now occupied by the ruins of a modern fort called Dunglass Castle.

What I desire to particularly call attention to is, that, "when both walls were built, they were erected with reference to a sea-level at either end corresponding very nearly if not entirely with that at present existing in both the Scotch and English estuaries."

If Dunglass was the site of the terminating fort on the west coast, its situation almost on the level of the present surface of the water affords a proof that the level of the sea is not lower now than it was in the year 140, or 1738 years ago.

If then two thousand years has seen such a slow rise as merely to convert a swamp into dry ground, without almost raising it at all, except where that is done through artificial means adopted by man, how shall we calculate the epochs necessary for the formation of the numerous beaches found at so many different heights from the present sea-level up to 360 feet? But even this is not all. There are terraces covered by the sea. And this introduces us to a new element in the computation, namely, that the movements have been downwards as well as upwards, thus increasing indefinitely the already almost inconceivable vastness of the time necessary for these processes. And yet, as I have already stated, this is but the modern period, and in reference to the preceding eras of geology, may be said to be but of yesterday.

From the foregoing remarks we may conclude that there was "a time when the Firth of Clyde was a sea several miles wide at Glasgow, covering the site of the lower districts of the city, and receiving the waters of the river not lower than Bothwell Bridge." And we may imagine that at the time when the beds of sand, which I have already referred to, were being laid down in the hollow of Sauchiehall Street, the waters of this noble estuary eddied around the various eminences which mark the physical geography of Glasgow. Garnet Hill would stand out conspicuously, a rounded island of mud, separated by a narrow and not deep channel from Blytheswood Hill. A broader and deeper current would flow on the side towards the hill where Port Dundas now stands, finding its way into the main channel somewhat farther westward, while to the south, the wide expanse of water would sweep on towards the southern hills with perhaps Camphill and Hillhead, and the other knolls on the south side of the river, appearing as islets here and there. The scene would wear more the aspect of a land-locked bay or inland sea than of an estuary.

V. *On Species of* Rhadinichthys *from the Coal Measures.* By Ramsay H. Traquair, M.D., F.G.S.

In a paper recently communicated to the Geological Society of London,* I proposed to establish the new genus *Rhadinichthys* for the *Palæoniscus ornatissimus* of Agassiz, and those species which are allied to it in certain points of structure. The fishes which may be included in this genus are of comparatively small size, the largest (*R. ornatissimus*) attaining a

* "On the Agassizian Genera, *Palæoniscus*, *Amblypterus Gyrolepis*, and *Pygopterus*" (*Qu. Journ. Geol. Soc. London*, xxxiii., 1877, pp. 548-578).

length of ten inches, but the others are for the most part much smaller. The following definition was given in my paper in the *Quarterly Journal:* "The body is comparatively slender, the suspensorium is very oblique, the jaws are armed with a row of incurved conical laniaries, outside which there is a series of smaller teeth; the principal rays of the pectoral fin are as in *Pygopterus* and *Oxygnathus,* unarticulated till towards their terminations. The dorsal is situated rather far back, nearly opposite the anal, and the caudal body-prolongation is comparatively delicate."

Besides including in *Rhadinichthys* the *Palæoniscus ornatissimus* and *P. carinatus* of Agassiz, and the *P. Wardi* of Young, I also directed attention, as probably belonging to the same genus, to the *P. Alberti* of Jackson, and more especially to his *P. Cairnsii* and some of the other smaller *Palæoniscidæ* figured but not described by the same author from the Carboniferous strata of New Brunswick. And in a paper, read a few weeks later before the Royal Society of Edinburgh,* I gave descriptions of seven species of *Rhadinichthys* from the Lower Carboniferous rocks of the east of Scotland, including, besides the Agassizian species, *R. ornatissimus* and *R. carinatus,* five others new to science, namely, *R. ferox, R. brevis, R. lepturus, R. Geikiei,* and *R. tenuicauda.*†

Recently also Principal Dawson of Montreal has described another species from New Brunswick, which he thinks may probably be the same as that represented in Pl. II., fig. 5, of Jackson's work,‡ but not named. To this species he gives the name of "*Palæoniscus* (*Rhadinichthys*) *modulus,*" and makes the following observation concerning it: "This beautiful and elaborately-ornamented little fish is a perfect model in miniature of that type of Lower Carboniferous Palæoniscids to which it belongs, and which has recently been separated by Dr Traquair in the genus or subgenus *Rhadinichthys.*"

Here Principal Dawson seems either to disapprove or to

* "On New and Little Known Fossil Fishes from the Edinburgh District, No. III." ("Proc. Royal Soc. Edinburgh," 1876-77).

† "Lower Carboniferous Fishes of New Brunswick" (*Canadian Naturalist,* vol. viii., No. 6, 1877).

‡ Report on the Albert Coal Mine, New Brunswick.

misunderstand the object for which the paper was written, which he does me the honour to quote. Regarding as I do the use of subgenera as introducing confusion into the binomial system of nomenclature, which, since the time of its illustrious founder, has worked so well, nothing was further from my mind than to establish *Rhadinichthys* as a "subgenus" at all, much less indeed as a subgenus of *Palæoniscus*, from which it is in fact further removed than from many other genera of the family, as, for instance, *Pygopterus*, which, small though its species be, it strongly resembles in the structure of the pectoral and in the position of the dorsal fin. And I think we may pretty safely assert that if the species of *Palæoniscus* and *Rhadinichthys* were at present living in our waters, no ichthyologist would ever think of considering the latter to be a "subgenus" of the former.

Dr Dawson has been also a little hasty in characterising the species of *Rhadinichthys* as a "Lower Carboniferous" group. *R. Wardi* is a true coal measure species, and, as we shall presently see, it is not the only representative of its genus found in the upper division of the Carboniferous rocks of Great Britain, though as yet the number of species collected from the coal measures is certainly smaller in comparison with those which occur below the horizon of the Millstone Grit. As yet, also, no species has been found to pass from the one division of the formation into the other.

The special object of the present communication is accordingly the description of such species of *Rhadinichthys* from the coal measures of Great Britain as have as yet come under my notice.

1. *Rhadinichthys Wardi*, Young.

Palæoniscus Wardi, Young (name only), Proc. Nat. Hist. Soc. Glasgow, vol. ii., pt. 1, p. 66 (Dec. 19, 1870, published 1875).
,, ,, Ward, North Staffordshire Nat. Field Club, Addresses and Papers (Hanley, 1875), pp. 239, 240.

I am indebted to Mr Ward of Longton, Staffordshire, for the loan of a suite of specimens, the best which I have seen of this species. The most perfect of these measures 4½ inches, but the extremity of the tail being broken off, its original length may be estimated at $\frac{1}{4}$ inch more. The form of the body is rather slender, gradually tapering from the shoulder to the tail pedicle; the greatest depth of the body is contained about five times, and the length of the head a little less than four times in the length of body up to the bifurcation of the caudal fin. The head appears large for the slender form of the fish. The orbit is, as usual, very anteriorly placed, the suspensorium very oblique, the gape enormous, the jaws powerful and armed with formidable teeth in two sets. Of these, the laniaries or teeth of the inner series are slender, conical, and incurved, $\frac{1}{24}$ to $\frac{1}{30}$ inch in length in a mandible of $\frac{3}{4}$ inch, set at intervals of considerably less than their own length, while external to them is a series of closely placed teeth of very small size. The opercular bones are not well preserved, but appear to be of moderate size; eight branchiostegal rays may be counted in one specimen, but they are clearly not all shown. All the external bones of the head, as well as of the shoulder girdle, are sculptured with fine sharp flexuous ridges. The pectoral fins are of considerable expanse, and nearly equal in length the interval between them and the ventrals. Each consists approximately of about twenty-five rays, of which the stronger ones on the pre-axial aspect of the fin are unarticulated for more than $\frac{2}{3}$ of their length. The ventral is seen in one specimen, and appears small and delicate, though its extremity is not preserved; its rays are slender, with distant articulations. The dorsal fin rises far back, being placed nearly opposite the anal, and commencing only a little in front of the latter; it is acuminate in shape, and rather deeply cut out behind; the anal is not so well preserved, but appears similar in form to the dorsal. It is hardly possible to ascertain the number of rays in either, but in both they are slender, bifuracted towards their terminations, and divided by rather distant articulations. The caudal is large and deeply bifurcated, but in no case well preserved; its rays are likewise slender and distantly jointed, the articulations, however, becoming closer in the shorter rays of the upper lobe; the caudal body-prolongation is slender. The scales are of moderate size; their anterior-covered area is very narrow, the keel of the under surface and the articular spine well marked. The exposed surface is ornamented with exceedingly well-marked elevated ridges, passing across the scale from before backwards with a slight downward obliquity, and ending in denticulations of the posterior margin. These ridges tend constantly to become broken up into isolated tubercles, or, conversely, the ornament may be described as consisting of raised tubercles, tending constantly to a linear arrangement, and to coalescence into ridges.

Remarks.—*Rhadinichthys Wardi* may be at once distinguished from all the other species of the genus by its peculiar ridged and tuberculated scale sculpture, a form of scale ornament which is exceedingly rare in the entire family of *Palæoniscidæ.* In the general form and proportions of the body it resembles *R. ornatissimus,* though it does not seem to have attained so large a size as that Lower Carboniferous species.

Geological Position and Localities.—Not uncommon in the coal measures of North Staffordshire, especially in the "Ash Coal" shale at Fenton and Longton (collection of Mr J. Ward, F.G.S.); in the coal measures of the neighbourhood of Manchester (collection of Mr J. Plant, F.G.S.); in the shales of the Lanarkshire coal-field (collection of Geological Survey of Scotland).

2. *Rhadinichthys monensis,* Egerton sp.

Palæoniscus monensis, Egerton, *Qu. Journ. Geol. Soc. Lond.,* 1850.

This species has hitherto been known only from detached scales which were figured by Sir Philip de M. Grey-Egerton in 1850, as *Palæoniscus monensis.* The general resemblance which these scales bore to those of *Rhadinichthys carinatus,* Ag. sp., and *R. brevis,* Traq., though their sculpture is much more marked (the scales of *R. carinatus* being in fact nearly smooth), led me long ago to suspect that they were allied forms. It was, however, only very lately, while looking over some fish remains collected by the Geological Survey of Scotland, that I obtained what seems to me to be clear evidence that the place of Sir Philip Grey-Egerton's fish is in the genus *Rhadinichthys.* These specimens, as usual, consist of disjointed scales; one of them, however, shows a considerable portion of a head and some remains of the rays of the pectoral fin, the latter consisting of unjointed rods, thus indicating that the principal rays of this fin were unarticulated till towards their terminations. A specimen in the collection of Dr Hunter of Braidwood is more entire, though unfortunately wanting the head; here, however, the pectoral fin is shown as well as the dorsal and part of the caudal, the position of the dorsal being far back, and the general form of the body slender and tapering.

Description.—The most perfect example (that belonging to Dr Hunter) measures $2\frac{5}{8}$ inches from the root of the pectoral fin to the end of the mutilated caudal; allowing for its deficient parts, the length of the fish could not originally have been less than $3\frac{1}{2}$ inches. The scales of the flank are nearly equilateral, measuring $\frac{3}{16}$ inch in height by about the same in breadth; the articular spine is well marked, the covered area very narrow. The exposed surface is marked in the first place by four or five longitudinal elevations or ridges commencing in prominent denticulations of the posterior margin, and running forwards for some distance on the scale parallel with the superior and inferior margins; the lower ones, however, tending to a slight obliquity. In front of these are a few delicate and closely set grooves parallel with the anterior margin, and at the anterior-inferior angle turning round, and running parallel with the inferior one, so far as the slight upward obliquity of the lowest of the longitudinal ridges affords them space. The scales on the belly are, as usual, low and narrow, posteriorly they also get gradually smaller, and their distinctive sculpture less strongly marked. The pectoral fin appears moderate in size, though its extremity is lost; its principal rays are unarticulated, so far as they are seen. Neither ventral nor anal is visible. The dorsal arises opposite a point $1\frac{5}{8}$ inch behind the root of the pectoral; only a few of its rays are preserved, these being very delicate, and divided by distant transverse articulations. The caudal commences $\frac{7}{10}$ inch behind the anterior margin of the dorsal; this is proportionally a small interval for *Rhadinichthys*, but the very disturbed state of the scales here gives very reasonable ground for belief that the distance has been shortened by distortion. What remains of the caudal fin is much twisted, and only presents us with a portion of its origin, but the rays are seen to be delicate, and their articulations rather distant.

A specimen from Lanarkshire, in the collection of the Geological Survey of Scotland, shows, lying in connection with a heap of the characteristic scales, the impression of a portion of the cranial buckler, and from this impression it is evident that its surface was sculptured with tolerably coarse ridges passing here and there into tubercles. The position of the orbit is clearly shown, below which is found the left maxilla seen from its inner surface, together with the impression of the outer surface of the mandible. The oval margin of the maxilla is set with conical teeth, small, indeed, in the specimen, but large enough considering the small size of the jaw. The mandible is slender and tapering, sculptured with a few comparatively coarse ridges, which, as usual, pass forwards, and also obliquely upwards, meeting the dental margin at very acute angles; its teeth are not exhibited. Some broken remains of the opercular bones are visible, but not in a condition for description. Lastly, behind the mandible are several confused bony rays, the remains of the pectoral fin; these are clearly unjointed, and show that we have here the structure characteristic of *Rhadinichthys, Pygopterus*, etc., in which the principal rays of the pectoral are unarticulated till towards their terminations.

Remarks.—Although the external sculpture of the scales of *Rhadinichthys monensis.* resembles in general character that which also occurs, in various modifications, in other of the smaller species of the genus, yet it has a facies of its own, and, once seen, can be easily again recognised. We must, however, await the discovery of more perfect specimens, before a complete description of the fish can be given.

Geological Position and Localities.—Only from the coal measures, in which it is widely distributed, but apparently not very abundant. The original specimens were found by the Earl of Enniskillen at Rhuabon, in North Wales; it occurs also in North Staffordshire (collection of Mr J. Ward), and in Lanarkshire (collection of the Geological Survey of Scotland, and of Dr Hunter, Braidwood).

3. *Rhadinichthys Grossarti*, Traquair, sp. nov.

Description.—The length of this little fish was probably two inches or thereabout, but as yet no specimen has occurred absolutely perfect. One specimen, wanting the head, in the collection of Mr Grossart of Salsburgh, measures $1\frac{1}{4}$ inch in length; two others in the collection of the Geological Survey of Scotland, one of which wants the head, the other the tail, measure each $1\frac{1}{2}$ inch. The last-named collection contains also a few others still more fragmentary, but all indicating a fish of about the same size. The bones of the head are, judging from their impressions, marked with irregular rugæ; no teeth are visible. The form of the body is very slender, its depth at the ventral fin being, in Mr Grossart's specimen, not quite $\frac{1}{4}$ inch, from which it tapers to a very delicate tail pedicle. The pectoral is not seen; the ventral is small, and consists of a few delicate and rather disturbed rays. The dorsal commences very slightly in front of the anal, and consists of fourteen or fifteen rays, but in the anal I count only ten. Between the latter and the lower lobe of the caudal there is a considerable interval, equalling nearly $\frac{3}{8}$ inch. All these fins are very delicate, with slender, distantly-articulated rays; minute fulcra are observable on the anal of one specimen; the caudal body-prolongation is very slender and attenuated. The scales are moderate, may indeed be called large, in proportion to the minute size of the fish. They are more strongly marked than in *R. monensis*, their ornament consisting of four to six sharply defined straight ridges extending from before backwards, with a slight obliquity over nearly the whole exposed surface, and terminating in denticulations of the posterior margin; in some cases feeble traces of the delicate vertical grooves seen in *R. monensis* are visible just in front of the commencement of the longitudinal ridges.

Remarks.—In its small size, and in the general form of the body, *R. Grossarti* resembles *R. tenuicauda* from the edge coal strata of Scotland (middle group of Carboniferous Limestone series), but it is at once distinguished from it by the sculpture of the scales, which in *R. tenuicauda* are smooth on the flanks, and only delicately striated on the dorsal and ventral margins.

From *R. monensis* it differs in the greater prominence, sharpness, and extent of the longitudinal ridges on the scales, which occupy nearly the whole of the exposed surface, whereas in *R. monensis* these are not very prominently elevated, and a considerable space is occupied by these delicate grooves, which run parallel with the anterior and inferior margins. I have much pleasure in dedicating this new and interesting form to Mr Grossart of Salsburgh, Lanarkshire, to whom I am indebted for the loan of the first specimen which came under my notice.

Geological Position and Locality.—Coal measures of Lanarkshire.

VI. *Note on the Occurrence of* Adiantites Lindseæformis, *Bunbury, in Strata connected with the Main Limestone at Braidwood, Lanarkshire.* By R. Etheridge, Jun., F.G.S., etc.

The subject of the present note, *Adiantites Lindseæformis*, Bunbury, was originally described by the late Mr J. W. Salter, from notes supplied by Sir Charles Bunbury, and published in "The Geology of the Neighbourhood of Edinburgh." * The type specimens were found by Mr R. Gibbs, collector to the Survey, in the Lower Carboniferous shales (Calciferous Sandstone) of Slateford, near Colinton, and the species is exceedingly characteristic of that division of the Calciferous Sandstone series, known as the Wardie Shale group; indeed, until a year or two ago it was thought to be exclusively restricted to that horizon. However, in 1874, amongst a collection of fossils, kindly lent to the Geological Survey by Mr A. Patton, of East Kilbride, I recognised a specimen of a variety of this species obtained by Mr Patton from a bed of shale overlying the Calderwood cement stone, of the Lower Carboniferous Limestone group, at the Kirktonholm Cement Works, East Kilbride. About the same time Mr James Bennie obtained a fragmentary specimen at another locality in the same district, Burnbrae old quarry. I gave a short account of these discoveries to the Botanical Society of Edinburgh in

* *Mem. Geological Survey Gt. Brit.*, No. 32, Scotland, 1861, p. 151.

January 1875.* This completes the history of *Adiantites Lindseæformis* to this date, so far as I am acquainted with it.

In the autumn of 1876 Mr Bennie and myself were engaged working out the fossil contents of an interesting series of beds exposed along the shore of the Firth of Forth at Abden to the east of Kinghorn, when we were much gratified at finding one or two small specimens of *A. Lindseæformis*, in a bed of shale under the first limestone, east of Kinghorn, in company with a copious marine fauna, and a few other ferns, chiefly sphenopterids. As in the previous instance, this horizon is also in the L. Carboniferous Limestone group.

I now come to the more immediate object of the present communication, to place on record a second occurrence of the species in Lanarkshire. A short time back, I paid, in company with Dr Traquair, a very pleasant visit to Braidwood, to inspect the Braidwood collection of fossils, brought together by Drs Hunter and Selkirk, by the former of whom we were most hospitably entertained. Amongst some fine plant remains from the Carboniferous Limestone, I was much pleased to find a specimen of our old friend, *A. Lindseæformis*, obtained by Dr Hunter from the shale below the Main (Hurlet) Limestone, again an horizon in the Lower Carboniferous Limestone group.

All the specimens I have enumerated from the marine portion of our Carboniferous system appear to be in a much less satisfactory state of preservation than the generality of those from the Lower Carboniferous rocks. Although there is some slight difference displayed in the form of the pinnules in the series of specimens, yet I think they all belong to the one species. I do not see any decided points which can be seized upon as separating one from the other, at any rate to no greater extent than that of a variety, certainly not of a specific nature. The pinnules in the specimens from the marine beds are apparently more elongated than in examples from the Wardie shales; but on examining a number of the latter, I find the form assumed by the pinnules of the former is to be found in the terminal pinnules of the Wardie shales' form. It may perhaps be necessary hereafter to distinguish

* *Trans. and Proc. Bot. Soc. Edinb.*, 1875, xii., pt. 2, p. 229.

the form of *A. Lindseæformis* found in the marine series by some varietal name. At present, however, I think it best to retain them all under the one designation, *A. Lindseæformis* (Bunbury).

Of the previously-mentioned horizon, at which *A. Lindseæformis* has been found in the strata connected with the Marine Limestones, that on the shore of the Forth at Abden appears to be the lowest. The limestone at this locality, overlying the bed of shale in which the fern occurs, is believed by Mr Bennie and myself to be still lower than the Gilmerton or No. 1 Limestone of the Midlothian field, which is usually considered to be the equivalent of the Main or Hurlet Limestone. If such is the case, then Dr Hunter's discovery at Braidwood will be the next in upward succession, the shale below the Main Limestone, and that of Mr Patton at East Kilbride, the highest in the marine series of our Carboniferous system. Expressed in tabular form in descending order, thus:

L. Carboniferous Limestone Group.	1. Shale above Calderwood Cement Stone (*Lingula* Limestone of Carluke), ...	Kirktonholm Cement Works, East Kilbride.
	2. Shale below Main Limestone, .	Braidwood.
	3. Shale below a limestone beneath the Midlothian No. 1 Limestone (= the Main or Hurlet Limestone), ...	Shore of Firth of Forth, at Abden, near Kinghorn.
L. Carboniferous, or Calciferous Sandstone Series.	4. Wardie Shales, . . .	Slateford and other localities.

VII. *On a New Form of Phosphorite found at Kichinev, with Analysis.* By Thomas W. Drinkwater, Esq., L.R.C.P., F.C.S., Member of the Society of Analysts, etc., Lecturer on Chemistry at the Edinburgh School of Pharmacy. (Specimen exhibited.)

The form of phosphorite I exhibit this evening is an unusual one, and, I believe, as far as my geological knowledge serves me, has been found in a somewhat unusual situation.

I am sorry to say I have not been able to furnish myself with all the information I could desire, as the friend from whom I received the specimen is again in Turkey, and I have consequently been prevented from communicating with him. The specimen was found with others in great abundance in spherulitic segregated masses in the Lower Silurian rocks, embedded—and in the opinion of several geologists who examined specimens *in situ*, they had either been segregated from surrounding rocks, or they were metamorphosed coprolitic masses. The latter supposition is however improbable, as I can find no trace of organic structure in them, besides all the specimens have a spheroidal structure, and are each distinct from the other.

They were found on the banks of the Dniester. A small band of Lower Silurian rocks extends for a short distance on either side of the river, and it is in these rocks they are embedded.

On referring to the *Quarterly Journal of the Geological Society* for August 1875, I found a paper by Messrs Davies and Hicks, in which they describe a form of phosphorite found above the Bala Limestone. This form was also found in concretionary masses, but was compact and not fibrous as the one is which I now exhibit. Dr Voelcker's analysis showed 40-60 % of tricalcic phosphate. They had fragments of *Lingula* in their structure, and are undoubtedly of organic origin.

A short time since Professor Dawson described the occurrence of phosphorite in the Cambrian rocks of Canada, but they differ in several points from the form I show you.

I made an analysis of a piece of the fractured portion, which was as follows:

Loss on ignition,	1·86
Lime,	45·82
(P_2O_5) Phosphoric anhydride (= Trical. Phosp. 78-87),	36·18
Oxide of iron,	1·02
Magnesia,	2·47
Silica,	5·68
Alumina (Co_2), etc.,	6·97
	100·00

Having such a small portion to work on of course prevented my taking a good average sample.

The discovery both of a new form and of a new field of phosphates is interesting both in a scientific and commercial point of view, as these mineral phosphates are now so largely used in the manufacture of artificial manures, for which purpose they are treated with sulphuric acid, which transforms the insoluble tricalcic phosphate into soluble monocalcic phosphate, and forms what is known in the agricultural world as superphosphate of lime.

Many of these minerals, although containing a large quantity of phosphoric acid, are unsuitable for making a first-class manure, on account of the excessive amount of iron with which they are contaminated. This, on storing, causes the manure to "go back," as it is technically called; that is to say, a portion of the soluble phosphoric acid is acted on by the iron and rendered insoluble.

This specimen, however, contains only a small percentage of iron, and at the same time the P_2O_5 is in abundance, and appears in every way suitable for manufacturing purposes.

I have not touched on the geological interest attached to the specimen, as I must confess my inability to do so. I have put together all the information I could gather regarding its chemistry, hoping to elicit some remarks from our geological members, whom I trust it will interest.

VIII. Mr R. Scot-Skirving read a paper on the so-called species of Wild Goose, *Anser paludosus*.

Wednesday, 20*th March* 1878.—J. Falconer King, Esq., President, in the Chair.

The following gentlemen were balloted for and duly elected as Resident Members:

James Duncan Smith, Esq., S.S.C., 30 Buckingham Terrace; Robert Carmichael, Esq., Student, University of Edinburgh, 13 Waverley Place, Leith; William Alexander M'Laren, Esq., W.S., 12 Chester Street; Rev. James Stewart, Parish Minister of Wilton, Roxburghshire; Peter Sievewright, Esq., Actuary, 12 Danube Street; Robert Clark, Esq., F.R.S.E., 7 Learmonth Terrace; Alexander Somervail, Esq., 73 George Street; John R. S. Hunter, Esq., LL.D., Daleville, Braidwood, Lanarkshire; Joseph T. Gray, Esq., M.A., 14 Findhorn Place; Thomas White, Esq., S.S.C., 114 George Street; Mitchell Thomson, Esq., 7 Carlton Terrace.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Acta horti Petropolitani, Tom. V., fasc. 1.—From the Imperial Botanic Garden of St Petersburg. 2. Kongliga Svenkska Vetenskaps-Akademiens: (1.) Handlingar, Vols. XIII.-XIV., Part 1; (2.) Bihang, Vol. III., Part 2; (3.) Ofversigt, No. 33; (4.) Meteorologiska Jakttagesler, Vol. XVI.—From the Swedish Royal Academy, Stockholm. 3. Edinburgh Astronomical Observations, Vol. XIV., 1870-77.—From the Lords Commissioners of Her Majesty's Treasury, through Professor Piazzi Smyth. 4. Boletin del Ministerio de Fomento de la República Mexicana, Tomo I., Núm. 76-86, inclusive.—From the Central Meteorological Observatory, Mexico. 5. Journal and Proceedings of the Royal Society of New South Wales, Vol. X., 1876. Also, Annual Report of the Department of Mines, New South Wales, 1876.—From the Society. 6. (1.) U.S. Geol. Survey of the Territories, 1877, Vol. XI; Monographs of North American Rodentia, by Coues and Allen; (2.) Bulletin of the U.S. Survey of the Territories, Vol. III., No. 4.—From the Department of the Interior, U.S.A. 7. Proceedings of the Royal Society [London], Vol. XXVI., No. 184.—From the Society. 8. Transactions of the Royal Society of Edinburgh, Vol. XXVIII., Part 1.—From the Society. 9. Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger, 1877, No. 2.—From the Society. 10. Journal of the Linnean Society—Botany, Vol. XVI., No. 94.—From the Society. 11. Jahresberichte des Vereins für Erdkunde zu Dresden, Band XIII. and XIV. (1877).—From the Society. 12. Estudios sobre la Flora y Fauna de Venezuela, por A. Ernst.—From the Author. 13. Transactions of the Manchester Geological Society, Vol. XIV., Parts 15, 16.—From the Society. 14. Fifth Supplement to the Catalogue of the Edinburgh Select Subscription Library.—From the Library. 15. Medical Examiner, Vol. II., Nos. 107-111, inclusive.—From the Publishers.

The following communications were then read:

I. *Some Remarks on the Breeding of the Snowy Owl* (Surnia nyctea) *in Norway.* By JOHN A. HARVIE-BROWN, Esq.

In 1871, Mr Alston and myself visited the district of the Fille Fjeld and Sogne Fjord in Norway for the purpose of collecting birds and their eggs. We have not published in a connected form the results of our expedition, but notes upon various species observed by us will be found in Dresser's "Birds of Europe," both from Alston's journals and my own. Dresser makes mention of the "clutches" of snowy owls' eggs hereafter mentioned (*v.* "Birds of Europe"); but I have thought, in absence of a more recent subject to write upon, that the collector's detailed notes upon these nests may not prove uninteresting to members of this Society. Mr Robert Collet, the ornithologist of Norway, with whom we had the pleasure of making acquaintance when in Christiania, has also noticed these specimens in his "Remarks on the Ornithology of Northern Norway."

After we left Norway we engaged our assistant and "*tolk*" (interpreter) in that country to collect eggs for us, and he did so with considerable success, especially during the summer of 1872, obtaining several "good things," and forwarding them to us at the end of the season. Before they arrived, we had various letters from our Norwegian collector concerning his different successes. The first notice we had of snowy owls breeding so far south (an unusual occurrence, as a gentleman to whom we had an introduction, Herr Dr Printz, well known as a good Norwegian ornithologist, had informed us, that only once had its nest been found so far south, viz., in Wang and Waldorsfjeld), was a letter from Lysne merely including it in a list of collections he had made, and dated 13th June 1872; but in his next letter he supplied us with full particulars as follows:

"In my letter of the 13th June, I told you that I had got hold of a nest of the 'snowy owl' (*S. nyctea*). On the 1st of June old Lars went up to the mountains towards the Suletind, and met with those birds just below this mountain: in the evening he brought me four eggs, and told me they were 'af den hvide ugle' (of the white owl). I, who believed all, took the eggs, and was as pleased as I could be. Next day I blew them, cleaned them out and inside, but found them rather similar to those of the Bjerg ulv (*i.e.* eagle owl, *Bubo maximus*), particularly one of the eggs; but I could not say anything, because old Lars had told me what they were.

"On the 16th I was told that the snowy owls were still below the Suletind, and I took Lars with me in order to try to shoot them. On the way Lars told me they were the most difficult birds to get near, which was all true in every respect. Lars had frightened them almost out of their skin the day before. I could not get them near, and had given it all up; told Lars that there was no use, and that I would go home. Lars seemed anxious to have another shot (he had had already four), and I sat on a hill to wait for him. Just as I sat looking through my glass, the hen placed herself on the top of a small hill, and I saw her lie down as if on a nest. This was *new steam,* and in less than five minutes I stood by her *bed,* in which were seven eggs (*sic*), quite different from those of Lars. I think they are the finest eggs I ever saw—very big, and as white as snow, while Lars' eggs are cream-coloured, with small brown spots all over, and not so big. Lars did not see me take the nest, and I did not tell him till we got home, when he was rather put out."

So much for the first nest obtained by Lysne himself.

The nest above referred to as taken by Lars contained, as we have seen, four eggs. These are much smaller, more oval, and apparently stained or speckled with a pinky or purplish dye, caused, I believe, by the damp reindeer moss or other lichen on which they were laid. As Lysne describes them, they are "cream-coloured (or dirty white, J. A. H. B.), with small brown spots all over, and not so big."

The spotting is not however caused by true marking, but is simply caused by dirt getting apparently into the grain, or irregularities of the texture of the egg.

In all, Lysne procured five nests of eggs in 1872. The situations of these nests were as follows:

1. *S. nyctea.*—7 eggs, 17.6.72, O. J. L. *ipse.* "Nest on a low hill" (*v.* collector's "Note-book").
2. *S. nyctea.*—4 eggs, 1.6.72, by L. E. "Nest merely a hollow in ground on top of low hill" (*op. cit.*).
3. *S. nyctea.*—5 eggs, 9.7.72, O. J. L. *ipse.* "The nest was placed on the top of a low rock, and merely a hollow in the reindeer moss."
4. *S. nyctea.*—4 eggs, 13.7.72, O. J. L. *ipse.* "The nest was placed at the side of a hill on a rock."
5. *S. nyctea.*—4 eggs, 23.7.72, O. J. L. *ipse.* "Nest on a hill."

Of the third nest Lysne says: "Eggs hard set. Both birds seen, but they were very wild. Colour of the eggs not so pure a white as those of 17th June. At the time the eggs were taken out of the nest they were the dirtiest eggs ever seen." Of the fourth nest he relates: "Had a shot at the hen and wounded her. Eggs hard set." And of the fifth nest he writes: "By aid of Lars, who had seen the eggs and nest before, but would not take them before I was present, as the eggs differ a great deal from any egg of the kind we have seen! Nest on a hill near the Sule-vand. Both birds flying about very wildly." These are also dirty and smaller than the fresh set of the 17th June, but are undoubtedly of this species.

Of the above five sets, sets 3, 4, and 5 are in E. R. Alston's possession; set 1 in Feilden's and my collection; set 2 in collection of Rev. C. M. Jones, Connecticut, U.S. One of Alston's sets went to Dr Crowfoot of Beccles, Suffolk. In all there were twenty-three eggs, one of set 5 having been broken.

The measurements of six of the eggs are as follows:

2 in.	4 lines	by 1 in.	8	lines,	in mus.	Dr Crowfoot.
2 ,,	2 ,,	by 1 ,,	8	,,	,,	,,
2 ,,	4 ,,	by 1 ,,	6½	,,	,,	E. R. Alston—almost pyriform.
2 ,,	3½ ,,	by 1 ,,	7½	,,	,,	Feilden and Harvie-Brown—round oval.
2 ,,	1½ ,,	by 1 ,,	6½	,,	,,	Rev. C. M. Jones—regular oval.
2 ,,	1½ ,,	by 1 ,,	6	,,		same set as second last mentioned. Last laid egg of the set, smaller, and more oval than the others of the same set.

I was informed by another party of the unusual numbers of lemmings (*Lemmus Norvegicus*) in 1872, it having been a regular lemming year, which accounted for this unusual irruption of the snowy owl and of the rough-legged buzzard (*Archibuteo lagopus*) so far south as 61° N. lat. Even in 1871, when Alston and I collected in Norway, lemmings were far from scarce, and we caught and preserved various specimens.

In the *Ibis*, 1865, p. 335, the first nest obtained in the Scandinavian peninsula, as far as known, with the exception of those recorded by Herr Lilljeborg Corfvers (K. Vet-Akad, Forhänd, 1844, p. 212), is taken notice of, as having been obtained by Wheelwright—the old bushman—from some Lapps.

II. *On Hereditary Transmission.* By F. W. Lyon, Esq., M.D.

It is an interesting thing to wander through a picture gallery hung with portraits of the ancestors of an ancient family, and seek to trace out among them some resemblance either to those who lived in a former generation or flourished at a later age. I was, for several years, the resident physician in a very old and wealthy family in one of the western counties of England. The house was built in the time of the fourth Henry; the estate and it came into the possession of the present family in the reign of Elizabeth, and they have lived in it from that time until now. There is a grand old hall there hung about with arms and armour used by the retainers of the old family, and a gallery filled with their portraits. There is one portrait there—it is that of the inheritor of the property in Elizabeth's time—on which I used frequently to look with much interest from the peculiar character of the eyes. I will not venture to describe them beyond observing that they not only looked at you, but, as it were, into you. There is not in that gallery a single portrait with a similar eye. The portraits of two sons hung by the side of the father, but they have not the father's eye. The portrait of the father of the present proprietor is there also, but he has not the eye of his ancestor, but curiously enough the present proprietor has the eye of the ancestor, to whom I have referred, as distinctly marked as if the eyes in the portrait had been painted for his eyes. It always appeared strange to me that a feature so peculiarly and distinctly marked should have slumbered, as it were, through so many generations, and have cropped up now. There is the portrait of a lady painted by Sir P. Lely, which, if the dress were altered, would be an excellent likeness of the eldest daughter of one of the brothers of the present proprietor; and one of a gentleman of the time of George II. resembles most markedly a son of a sister of the same gentleman—here there are family likenesses issuing both on the male and female side. I know a family, the father of which had the lobe of each ear peculiarly formed, it was quite flat, as if one had taken a ball of putty and squeezed it flat between two boards; he had a son and three daughters, the eldest daughter alone had her father's ears. The son married, had a daughter, his first-born, then a son; the son had exactly the ears of his grandfather. A very old friend of mine, now no more, had at times a very peculiar expression of the mouth, so singular that no one could fail to observe it. He had a *liason* with a lady, and the result was a son. The child was ill. I was asked by my friend to see it; while examining the child, I observed that he had at times the exact expression of mouth to which I have referred in my friend. I was not acquainted with the lady before, but she, doubtless, knew of the friendship between the gentleman and myself, and as he had had some misgiving of the lady's good faith—in other words, he doubted his paternity—which she might think he had told me also, said to me, "Who do you think baby is like?" "Oh," said I, "I do not know; I always think all babies are alike." I saw that boy several months after in his father's house, and saw the same expression of mouth, and said to my friend, "There is no doubt, in my mind, of that being your child, he has that occasional remarkable characteristic expression of your mouth." I was examining a man in Guy's Hospital one day. On feeling his pulse, I found a ridge of bone like the union of an old fracture about the lower fourth of the radius. I said, "You have broken your arm some day." "No," said he, "that lump was always there. My daughter has exactly the same." She was by the bedside visiting her father. I found in her arm a repeat of that I had observed in her father's. Mr Wordsworth showed, at the Medical Society of London in January last, six persons belonging to one family, with an abnormal position of the crystalline lens in each eye—they were the mother, two of her sons, and three of their children. The mother stated that her father and her grandfather were all similarly affected; if this be so, there are ten cases occurring in five generations. They all complained of being short-sighted, and on examination by the ophthalmoscope the edge of the lens was visible in the pupil.

A man named Zerah Colburn, a native of Vermont, N. America, came to London in the early part of the present century, and was publicly exhibited for an extraordinary power he possessed of arithmetical calculation from memory. He had five fingers and a thumb on each hand, and six toes on each foot. He was examined by the late Sir Antony Carlisle, and made the subject of a communication to the Royal Society, and published in the *Philosophical Transactions* for 1813. Sir Antony has traced there Zerah's genealogy to his great-grandfather, adding that they do not possess any knowledge of ancestors beyond that time.

The genealogy is curious as showing the reproduction of this redundancy of parts, issuing alike from the male and female side. The great-grandfather, a normally-formed man, marries a woman with an excess of fingers and toes on her hands and feet; they have issue, a daughter, whose feet and one hand have an excess of toes and fingers. She marries a man with the normal number of fingers and toes; they have four children, each one having more or less an excess of toes and fingers. One of these, a man with hands and feet formed exactly like his grandmother (five fingers and a thumb on each hand, six toes on each foot), marries a woman with normally-formed hands and feet; they have eight children, four of whom have hands and feet with a normal number of fingers and toes; the remaining four have an excess. The hereditary propagation of peculiarities is a curious subject, and all family resemblances, however trifling they may appear to ordinary persons, are interesting to the physiologist. Whether they may be received at any time in a medico-legal question as indications of value in assisting to determine a disputed title, or the possession of an estate, I know not, but I do think they are valuable. If I found some peculiarity in a person resembling that of one from whom he was claiming a descent, and my opinion was asked about the question, I should have no hesitation in expressing an opinion, that to my mind there was but small doubt of the certainty of his descent.

GREEN——KENDALL.
A man normally formed. | She has 5 fingers and a thumb on each hand, and 6 toes on each foot.

ABIGAIL, daughter.
One hand natural, the other and both feet like her mother.

Ten other children, all of them having 5 fingers and a thumb on each hand, and 6 toes on each foot.

DAVID COLBURN, a man normally formed. marries ABIGAIL GREEN.

ABIAH COLBURN.
5 fingers and a thumb on each hand, and 6 toes on each foot.

A SON.
One hand normal, the other, 5 fingers and a thumb; one foot normal, the other, 6 toes.

One Son and one Daughter with 5 fingers and a thumb on each hand, and 6 toes on each foot.

ABIAH COLBURN——a woman normally formed.

GREEN COLBURN.
One foot normal, the other with 6 toes; 5 fingers and a thumb on each hand.

BETSY C.
Hands and feet normal.

ZIBINA COLBURN.
5 fingers and a thumb on each hand, 6 toes on each foot.

Twins.

DAVID.
Hands and feet normal.

JONATHAN.
5 fingers and a thumb on each hand, 6 toes on each foot.

ZERAH.
5 fingers and a thumb on each hand, 6 toes on each foot: the calculator.

MARY C.
Hands and feet normal.

ENEAS C.
Hands and feet normal.

III. *On the Skull of a Narwhal* (Monodon monoceros, *Linn.*), *with two fully-developed Tusks.* By JOHN GIBSON, Esq.

The author, after referring to the dentition of the Cetacea in general, and of the narwhal in particular, drew attention to the occasional presence in the male of two fully-developed tusks. That these are of rare occurrence may be gathered from the fewness of the bidental skulls which are known to exist, notwithstanding the assertions of whaling captains that they occasionally see such specimens from their ships. The appearance to which they refer may, as has been suggested, be due to the presence of two male narwhals in close proximity to each other, their tusks alone being visible above water. According to a recent authority, there were in 1871 only nine authentic specimens known in Continental collections, four of which were in Copenhagen. In Great Britain there were only two—a complete skeleton, with bidental skull, in Cambridge University Museum, the right tusk of which measured 6 ft. 1 in. in length, and 8¾ in. in girth at the outer edge of the socket; and the left tusk, 6 ft. 7 in. in length, and 9½ in. in girth. The shorter tusk had evidently been broken at the tip, so that probably the tusks had been originally of about equal length. The other British specimen was that of a young narwhal in the Hull Museum, in which the left tusk measured 20 in. in length, and the right tusk ½ in., exclusive of the portion within the skull. During a recent visit to the museum in Dundee, the author had his attention drawn to a splendid bidental skull which had been shortly before presented to that institution by Captain Graville of the "Camperdown," who had obtained it in the seal fishery grounds off the coast of Greenland. The following are the measurements of this, the only specimen of the kind in Scotland, for which I am indebted to the kindness of Mr J. Maclauchlan, the curator of the Dundee Museum:

Total length of skull, exclusive of tusks,	1 ft.	10¾ in.
Greatest breadth across squamosals,	1 ,,	3 ,,
Breadth at narrowest part where the tusks are exserted,	0 ,,	5¾ ,,
Length of left tusk,	6 ,,	1¼ ,,
,, right tusk,	5 ,,	7½ ,,
Girth of left tusk at edge of socket,	0 ,,	7⅜ ,,
,, right ,, ,,	0 ,,	6⅞ ,,

The tusks at their external origin are only 1⅜ in. apart, but they widen out to nearly a foot at the tips. The right tusk, which is a few inches shorter than the other, has been broken at the tip like the Cambridge specimen, so that the two tusks were probably at one time of equal length. The spiral markings in both tusks go from right to left. A drawing of the skull was exhibited, as also examples of the rudimentary tooth of the narwhal, kindly lent by Mr C. W. Peach.

IV. *Exhibition of Permo-Carboniferous Polyzoa, collected by Captain H. W. Feilden, R.A., during the late Arctic Expedition under Captain Sir G. Nares.* By ROBERT ETHERIDGE, Jun., F.G.S.

Mr Etheridge gave a brief outline of the literature of Arctic Palæozoic Polyzoa, referring in particular to the works of Count von Keyserling, Mr J. W. Salter, and Dr F. Toula. The more important characters of the species exhibited were dwelt on, and their relation to previously-described forms pointed out. They appeared to be a mixture of Carboniferous and Permian representative forms, such for instance as *Ramipora Hochstetteri*, Toula, previously found only in the Permo-Carboniferous rocks of Spitzbergen, with *Polypora grandis*, Toula, from the same horizon and locality; *P. biarmica*, v. Keyserling, from Petchora Land and Nova Zembla, with lastly a peculiar and interesting species, *Fenestella Arctica*, Salter, described in Belcher's "Last of the Arctic Voyages," from Depot Point. Other and less interesting examples were also exhibited and briefly described. The locality is Feilden Isthmus, lat. 8 2 43 N.

V. *On the Occurrence of Prismatic Structure in the Stones of Scottish Vitrified Forts.* By Professor DUNS, D.D., New College.

It is not intended in this paper to enter at large into questions relative to the age, or the builders of the vitrified forts of Scotland, or even as to their use and the mode and materials of their vitrifaction. These topics, still to a great extent speculative, lie rather in the department of archæology than in the branches embraced by this Society. The object I have chiefly in view is to direct attention to the phenomena of prismatic structure, so definitely characteristic of many of their stones. I bear in mind throughout that this is not the first time the subject has been under the notice of the Society. But it seems to me of some importance that a fuller record should be made of the phenomena there referred to, than the note given in on that occasion, the more so that a somewhat full suite of examples are now at hand to illustrate remarks.

In 1777, Mr John Williams, who describes himself as a "mineral engineer," published a pamphlet entitled, "An Account of some remarkable Ancient Ruins lately Discovered in the Highlands of Scotland." Williams, while referring to some forts of less importance, chiefly describes that of Knockfarrel, Ross-shire. "Wishing a name," he says, "to add authority to his paper," he wrote to Henry Howe, Lord Kames, very quaintly: "My Lord,—Above a year ago, a copy of my paper concerning vitrified forts was sent to London to be disposed of to the booksellers, but they looked upon it as a fiction. The subject is both singular and extraordinary. However, I have advanced nothing in my narrative but what is strictly true, except such passages as are professedly conjectural. I offer the public this brief specimen of the ruins of the vitrified forts and drystone conical structures. . . . As your lordship's name is so well known in the literary world, a few lines from your pen will add authority to my paper, and remove the discouragements to publication, which arise from my being so little known." Lord Kames wrote the next day: "Sir,—I think it is every man's duty to do justice to merit, whether he have a name or not in the literary world. And, as far as my evidence can go, I give you leave to say to the world that I have long known you to be an honest man, and that your veracity may be depended on. I willingly add my opinion that your discovery of buildings cemented by fire is a curious fact that ought to make a figure in the history of art. The vitrified forts you mention must have been erected before mortar was known in Scotland; and it is a notable instance of the extraordinary shifts people were reduced to in the infancy of the arts. This discovery of yours will serve to detect an error that several ingenious naturalists have fallen into, of burning mountains found in Scotland, verified, they say, by the burnt remains still to be traced. I suspect that these remains are no other than the *débris* of the vitrified forts you mention."

The only remark called for here concerns the opinion that the forts must have been erected before mortar was known. Most writers who have referred to these forts, in the course of the last hundred years, have repeated this opinion of Lord Kames; but the inference is not warranted. All that the employment of vitrifaction entitles us to say is, that it was found most suitable for the locality where the fort was erected. Mortar may or may not have been used contemporaneously with this process. The value of Williams's pamphlet is enhanced by the publication in the appendix of a description of "Craig Patrick," by James Watt, and a letter to Williams from Black the chemist. Watt says of the materials, that they "greatly resemble the cinders or clinkers produced in a lime-kiln, being in some parts a vitrified, spongy mass, with a glossy surface; and, in other places, when it has been broke into for a small depth, you may see calcined, though unvitrified, matters mixed in large pieces among the spongy slag. It is evidently the native rock vitrified; and the granite parts seem to be the only ones which have come into fusion, and have formed the slag." Black points out the fusible quality of whinstone and granite, of coarse limestone, of "pudden stone" and sandstone, when they contain certain proportions of iron. He adds, "As the whole country was anciently a forest, and the greater part of it overgrown with wood, it is easy to understand how those who erected these works got the materials necessary for their purpose." Macculloch, in his "Western Isles," describes the vitrified forts, Dun MacSniochain and Dunadeer, as consisting of easily fusible rocks, the former being built chiefly of conglomerate, the latter of stones gathered from the plain containing hornblende in a black variety of granite. Later we are indebted to Dr J. Jamieson for a paper on the vitrified fort of Finhaven, and to the late Dr John Stuart for a summary of opinions concerning the mode of vitrifaction. These may be held to exhaust the literature having direct bearing on the vitrified forts of Scotland. There is not the slightest reference in any of these papers to the prismatic structure in the artificially-calcined stones. About fourteen years ago I was much struck by it when on a visit to the vitrified fort at Finhaven, Forfarshire, in company with the late Mr Crichton, writer, Forfar, on the farm of whose father the fort stood; the Rev. Richard Waterstone, Free Church minister, Forfar, now of Glasgow; and Mr James K. Martin of Bridgehouse, now of Blackburn Mill, Linlithgowshire. At that time the facts of prismatic form were so manifest, that I concluded they must be well known to observers. It was only when a small fragment was shown to the Society, on the occasion referred to above, that it was made clear it was very little known. I then showed some of my Finhaven specimens. So recently, however, as about ten days ago, I found that the late Professor Fleming, my predecessor in the New College Natural Science Chair, had observed the prisms in these stones. When in search of some minerals which had been misplaced, I found the specimens now shown which had been marked by Fleming.

The occurrence of prismatic structure in rock masses is well known. For example, in some of the low trap hills near Torphichen, Linlithgowshire, it can be seen even on the surface of the rock, suggesting a natural kind of mosaic. Almost every fragment broken off by the hammer, and even minute pieces dislodged by weathering, present unsymmetrical pentagons. It is not uncommon in other volcanic rocks, and I have seen it even in coal, at points where a trap dyke penetrated the seam. The correspondence of natural volcanic with recent lavas might be very fully illustrated. I now show to the Society a mass of lava from Etna, showing a very distinct tendency to prismatic structure. If the grain of this, and of another specimen from Vesuvius, be compared with two examples of porphyrite from Dunack, near Oban, the close resemblance will at once appear. And, looking at basalt, it should be remembered that the prismatic structure is not to be traced to crystallisation, but to the fact that compound melted bodies, when cooling, form prisms in a line at right angles to the cooling surface. Of course, the walls of vitrified forts would first be built of rubble without mortar, in the same manner as dry stone dykes. They would in this way contain examples of most, if not of all, the stones in the district where they were erected. On the application of heat all the stones which contain soda, potash, lime, baryta, etc., would slag or vitrify. I think it can be made good that in the case of Knockfarrel, the vitrifying process had been applied to the building at different stages in the rearing of the wall. What, however, seems to me of most value here is, that these forts present appearances which shed a good deal of light on phenomena which every field geologist has to deal with. Thus, the influence of heat on some sandstones met with in the walls of these forts is precisely similar to what meets us in nature. Here is a bit of sandstone from Hailes Quarry in the neighbourhood, which exhibits, in a most marked way, the thin layers of which it is composed. Now, place this alongside of the gneiss from Stonehaven, the specimen from Muchalls, Kincardine, marked by Fleming "gneiss passing into mica schist," and the two or three specimens on the table from the Finhaven vitrified fort, and it will be almost impossible to miss the meaning of these in connection with the influence of heat on the altered specimens, or to mistake the steps of their geognostic history. Again, a close examination of the examples from the several forts shows how deep the prism form penetrates. In one part of a Finhaven specimen minute prisms lie at right angles to the top of the stone, in a way to suggest the impress which a ribbed hemlock stalk, or the parallel venation of the leaf of some low plant, would leave on soft clay. But in another part of the same specimen the prisms present a resemblance in miniature to the deep foliated structure of *Psilomelane*, one of the ores of manganese, now on the table. A specimen from Knockfarrel presents several tiny tiers of prisms, arranged after the manner of the gigantic columns of Staffa and the Giant's Causeway. I was much interested at Knockfarrel in the occurrence, here and there, on the stones of small semi-opalesque blisters. It was difficult to detach a good specimen, but after many careful attempts the specimen now shown was obtained. Are we to look for the explanation of these in the meeting of the silica present in the vegetable matter heaped on the wall in order to calcination, with the potash or the soda in the stones?

The specimens illustrative of prismatic structure now shown to the Society are from Finhaven, Forfar; Knockfarrel, Ross; Dun Mac Nisneachan, Argyle; and Craig Phadrick, Inverness.

VI. *On the Structure of Pycnodont Fishes.* By Dr R. H. Traquair.

In this paper the author gave an account of the peculiar family of ganoid fishes known as *Pycnodontidæ,* and also took occasion to compare their structure in many points with that of the *Platysomidæ.* The latter family, the author maintained, are not related to the Pycnodonts, but are, on the other hand, closely allied to the *Palæoniscidæ.*

Wednesday, 17*th April* 1878.—Dr R. H. Traquair, F.G.S., President, in the Chair.

The following gentlemen were balloted for, and duly elected Resident Members:

William Hamilton Beattie, Esq., Architect, 68 George Street; Alexander Thomson, Esq., Newbank, Trinity; Francis A. Bringloe, Esq., 75 George Street; John Cameron, Esq., S.S.C., 63 George Street; Hypolite W. Cornillon, Esq., S.S.C., 67 George Street; George W. Watson, Esq., 4 Stafford Street; John Maclauchlan, Esq., Principal Librarian, Free Library, Dundee.

The following donations to the Library were laid on the table, and thanks voted to the donors:

1. Proceedings of the Royal Society [London], Vol. XXVII., No. 185.—From the Society. 2. Journal of the Linnean Society—Zoology, Vol. XIII., No. 72; Botany, Vol. XVI., No. 95.—From the Society. 3. Proceedings of the Literary and Philosophical Society of Liverpool, for 1876-77.—From the Society. 4. Transactions of the Geological Society of Glasgow, Vol. V., Part 2.—From the Society. 5. Annual Report of the Geologists' Association [London], for 1877.—From the Association. 6. Annual Address to the Chicago Academy of Sciences by the President [E. W. Blatchford], 1878.—From the Academy. 7. Boletin del Ministerio de Fomento de la República Mexicana. Seccion Astronómica, Tomo I., Núm, 87, 88; Tomo II., Núm. 1-27.—From the Central Meteorological Observatory, Mexico. 8. Medical Examiner, Vol. III., Nos. 112-118.—From the Publishers.

The following communications were read:

I. *Notes on the Marine Denudation of the Friesian Islands.* By Dr Robert Brown.

For some years past I have devoted a few weeks each autumn to an examination of the action of the sea on the Continental shores opposite the British Islands. Either on foot, in row-boats, or by the ordinary conveyances, I have surveyed from this point of view most parts of the coast-line from Holland to Denmark. And though my work is not yet complete, I think that it may possibly be interesting to the Society to hear some of the results of this examination. For this purpose I have selected a few particulars from a good series of notes, some of which I published from time to time in a series of letters to the editor of the *Scotsman*, and which are still lying unprinted in my note-books. This study rendered it compulsory on me not only to examine the actual coast, but to study the numerous records of the different invasions of the sea, and compare the writings of the chroniclers with what we actually see at the present time of the remains of the catastrophes described by them. This I discovered at an early stage of my work was very necessary, in so far that the descriptions which are published in the ordinary works on physical geography—especially English books, without an exception—are not only incomplete, but erroneous and misleading. On the low sandy coast of Germany and Holland the action of the sea is unmarked. Holland is indeed, as all the world knows, simply protected from the inroads of the German Ocean either by dykes or sand-banks, both of which are sometimes broken through. On the shores of the Zuyder Zee the fight between sea and land is especially evident in the ruined ports and "dead cities," once most populous centres of commerce in the Middle Ages, but which are now deserted, owing to the harbours being shoaled up. But it is on the chain of outlying islands that we see the deadly action of the sea most marked.

From the Dutch to the Danish coast, off the mainland, there lies a breastwork of islands. They commence with Texel, near the northern point of Holland, and are continued north by means of Vlieland, Noordvaander, Ter Schelling, Ameland, Scheermounik Oog, Bosch, and Rottum, as the connecting links of the chain. Along the German coast lie in a line, only broken by narrow, intervening straits, Borkum, Juist, Norderney, Baltrum, Langeoog, Spiekeroog, and Wangeroog. Then comes a break in the chain, at the Jahde and the estuary of the Weser, until seaward, and nearly opposite the mouth of the Elbe lies one of the smallest of them all, viz., Heligoland, which flies the English flag. There are no more of them until we reach the Schleswig coast at Husum. Here commences a region of broken islands, the line of continuity being, however, continued northward in Föhr, Sylt, Romö, Manö, Sönderhö, and Fanö, off the Jutland shores. North of the Eider and south of Jutland, the islands are known as the North Friesian group; those off the shores of East Friesland are the East Friesian Islands, while the Dutch ones are sometimes called the West Friesian Islands. All are more or less inhabited by the same race, those ancient Friesians, whose name bulks so largely in early German and Dutch history, and who seem to have had a peculiar liking for settling on the wildest, least accessible, and most maritime regions they could seize. It is only recently that they were agriculturists to any extent, but they have been always seafaring men, and at an earlier date pirates, and, some will even hint yet, when a favourable opportunity occurs "strandlaüfers"—*i.e.* shore-loafers, or wreckers. Indeed, a brilliant law, passed during the Danish *régime*, gave a considerable impetus to knocking the unfortunate castaway mariners on the head. It was ordained that nobody was to possess any right in wreck washed ashore, so long as the owner appeared to claim it. As a matter of course, the owner *did* not often appear on the scene! From time immemorial these islands have been little by little, and sometimes by huge pieces, decreasing in size. The sea is daily nibbling at them, and tossing acre after acre into the ocean from whence they arose. When the tide goes out, far as the eye can see there is laid bare extensive mud flats, at high water only covered by a few inches or at most a foot or two of sea. These flats, which, roughly speaking, represent the land which the sea has overwhelmed, are known as the "Wattenmeer," and figure greatly in Friesian story.

But what the sea takes away from the islands, it is gradually adding to the mainland. Take, for instance, the mainland opposite Sylt, the largest of all these islands. At one time Töndern was a seaport. But it suffered so terribly from inroads of the sea, that a dyke was built along the line of the outer coast. The result is, that the town is now six miles from the sea, and Hoyer is the village nearest the water. But even Hoyer is getting inland. The land destroyed in the Friesian Islands is swept up against this great bulwark, so that when the tide goes out, a marshy, grassy flat, stretching seaward for half a mile, is laid bare. At high water it is covered, but so slightly, that, though a canal has been cut through it, so as to allow boats or light draught vessels to approach the dyke, yet this canal at full tide has only five feet of water in it. By-and-by this "Wattenmeer" will be laid bare at all states of the tide, and then the land will be "marsch," only to be protected from inroads of the sea by building another dyke farther to the west. Eiderstedt was at one time composed of three islands. By a process of dyking, these three are only consolidated into one peninsula. But this wearing away of the islands, though certain eventually to sweep those which are undyked into the sea, is as nothing to the mighty inundations of the past. In addition to the islands named, there are in the southernmost portion of the Friesian group, near Eiderstedt—the south-western peninsula of Schleswig—Oland, Nordmarsch - Langeness, Appelland, Grode, Habel, Behnshallig, Hamburger Hallig, Hooge, Norderoog, Süderoog, Südfall, Nordstrandischmoor, Pohnshallig (almost disappeared), Nordstrand, and Pellworm. All of these are inhabited, some of them only by one family; but with the exception of Nordstrand and Pellworm, none of them are dyked, and hence are frequently inundated, and sometimes covered by the sea. The undyked islets are locally known as "Hallige"—the plural of "Hallig;" and the inhabitants the "Halligers."

Two centuries and a half ago, these Hallige and the other islets in their vicinity did not exist; or, more strictly speaking, they existed, but not in the form of islets. They formed portion of a large island lying off the coast of Eiderstedt, called Nordstrand. At one time it was united to the mainland, and indeed as late as the thirteenth century was alternately united and separated according to the whims of that sea with which it was ever at war. But at the time when our tale begins, it was a large islet, separated from the mainland by a strait—thickly populated by Friesians, speaking their own ancient tongue, and exceeding rich in flocks and herds, mills and farms. They had suffered in times past from inundations, but at the time we speak of, the island was protected on its weakest shores by dykes. So the Nordstranders ate and drank, fiddled and danced, married and gave in marriage, as it was before the flood. In 1216, 100,000 cattle had perished in these islands by inroads of the sea. It was in that year that a great portion of Heligoland was destroyed. But all danger of such a catastrophe was believed to be past. The 10th of October 1634 was a day so remarkably calm, that a foreboding seized the inhabitants that something strange was about to happen. Next day was Sunday, and they were in church. About the middle of the day the sea, which should have been ebbing, rapidly rose, and attained a height unprecedented in the annals of the island. Still they hoped and believed that the dykes would bear the strain. But almost simultaneously these bulwarks gave way, and in a few moments the sea broke in. By ten o'clock at night all was over. The dyke had broken in forty-four places. The sea had divided Nordstrand into the two largest islands, known now as Nordstrand and Pellworm, and the fifteen Hallige which I have already mentioned. Of the population of old Nordstrand, 6200 were drowned, and in addition 50,000 head of sheep and cattle, thirteen mills, and many churches were swept into the sea, leaving in some cases not a trace behind them. The flood was experienced along the whole coast, and especially in the neighbouring "Amt" of Töndern in Sleswig, where great destruction was caused. Altogether in the Cymbrian Peninsula, from Holstein to Skagen in Jutland, it was calculated that upwards of 15,000 human beings perished by this terrible victory of the sea over the land. Some of the Nordstrand people managed to reach Föhr, where their descendants to this day form a considerable portion of the population. But the memory of their advent is still preserved by the peculiar dialect of Friesian which they speak, and by the name of "Wiecklinge" —or "people who have fled"—applied to them by the other inhabitants of the island. Just now, half of the village of Wyk and the whole of Nieblum are peopled by these "Wiecklinge." After the flood had subsided, some of the people returned and commenced the world anew. But others of the new-old islets remained uninhabited until settlers from Holland lighted on them, and immediately, with their usual industry, set to work to dyke them, and generally to extract food out of the sand and mud. Nordstrand and Pellworm especially were affected by these Hollanders. Hence these two islands form an exception to the others, in so far that in them Platt-deutsch, and not Friesian, is the language of the inhabitants.

About the same time, it may be added, the Lyme-fjord in Jutland was opened, so that vessels could sail from the German Ocean into the Kattegat. Husum, which was the mainland market-town for the Friesians before this great catastrophe, was at that time a prosperous city, and even excited the jealousy of Hamburg. It is now a dull enough place, with none to do it reverence.

The undyked Hallige are exposed to the whole force of the sea, and are year by year decreasing; and so are necessarily the inhabitants. In 1847 they numbered, on the fifteen islets, 672 souls; in 1867 they were only 531.

These Hallige and all the other Friesian Islands were once much nearer each other than now. Indeed, the larger ones were at one time a continental mass. Some time in the thirteenth century—the chroniclers relate, though I will not vouch for it—the people from some of the Hallige used to go on foot to church at Föhr when the tide was out. Between Föhr and Nordmarsh-Langeness, the whole strait was laid bare at low water except one place, and across this the people used to pass on a bridge made of a horse's bones which had got jammed into the puddle. In these old Friesian chronicles we find much about the English, though some of the notices are very mysterious. For instance, about the date I have mentioned, Christianity got established among the Friesians, though they were always reverting to the worship of Odin, and more particularly to that of Fossita or Freya (for Fossita was only her priestess) on Heligoland. Then arrived an English architect, or "Baumeister," to erect churches to accommodate the new converts. This gentleman—name unknown—is said to have ridden on horseback from one island to another. All the mediæval historians are full of records of floods—in fact, piracy, floods, and fighting fill the annals over which I spent the wet days and the lengthening nights of last autumn. Everything seems to have been arranged for the future, as in some of the islands is yet the case, with the proviso of "barring floods."

You are often close upon some of these Hallige before they can be seen, so little are they raised above the sea. None of them are more than six feet above the "Wattenmeer" around them; few are elevated half that height. Every year they are wearing away on all sides, except on the eastern shores. Little canals are also being here and there dug into them by the tide, the end of which generally is that the tiny islet splits into two smaller ones, and eventually becomes a mere sandbank, hated by the seamen whose infrequent keels plough this solitary part of the German Ocean. It is calculated, judging from a map of 1713, that the Hallige, taken together, have decreased by one-half in the last 160 years. Two of that period (Kingstness and Hainshallig) have altogether disappeared, and Behnshallig is fast going. The soil on all of them is a rich clayey marsh, except on Nordstrandischmoor. This Hallig, in days prior to the deluge of 1634, formed part of the Moor of Nordstrand, and for long after that event it was covered with blaeberry and heather. But necessity compelled the "Wiecklinge" who fled to it to bring soil from the mainland, and now the old heath is almost covered up with marsh, owing to the sapping of the tide. Under the peat and sand are, however, traces of ditches and the plough, pointing to a period regarding which history has left us no record. Such are the Hallige—strange enough in themselves and in their origin. But the houses built on them, and the people who live in them—a sad race—are still more curious. "*Frisia non cantat*," writes an old historian; and, considering its perilous existence and many misfortunes, it would be rather remarkable if Friesland did sing.

The history of the inhabitants does not, however, come within my limits. I may, however, be allowed to say that these "Hallige" vary in size. Some of these—very few—are so large that they comprise a hamlet of fifteen houses, a church, and even a graveyard. But most of them are so small that one or two houses, with the grass for a dwarf cow or a sheep, is about all that they can afford room for. In all of them the houses are built on "werfts," or artificial mounds of clay, stones, etc., so as to raise the house above the reach of ordinary tides. This is not, however, always possible, and not unfrequently the house is swept away, the inhabitants escaping in their boats when the sea is not too rough. But if the "werft" is not destroyed, they will return and rear their house anew. They are, as might be expected, about the most primitive people in all Europe, but hospitable to an embarrassing degree, and fond of seeing visitors who will risk a voyage and a *wade* to their stray homes in the sea.

The soil of some of the islands is rich, but the people are afraid to disturb it lest the sea shall thereby gain an advantage. Moreover, the Halliger always lives in terror lest he should sow what he would never reap. Few of the islets escape being covered by the sea once or twice a year, but some of the smaller ones are partially inundated every spring-tide. These islets are believed to be sinking, not by the gradual submergence of the land, such as is going on in the shore of Sweden, but by the sea undermining the sandy foundations of the islands, and so allowing them to sink. There is naturally no turf on the Hallige, and if there were, the people would be afraid to dig it. They could not burn up their country. Accordingly, the droppings of their cattle, mixed with clay, and sun dried, constitute their only fuel. And this, like the fodder of their cattle, is carefully stored up in the "loft" of their houses, so as to be out of reach of "Shining Hans," as they call their sleepless enemy—the sea.

After the destruction of Nordstrand, the church of Nordstrandischmoor, with the neighbouring graveyard, was just within the destroyed part of that portion of the island. When the inhabitants returned, they petitioned the Duke of Gottorp (an extinct twig of the Schleswig-Holstein stock who then ruled them) for means to erect their church anew. His Serene Highness graciously gave them permission to have a church and a parson, and, touching the cost of the ecclesiastical establishment, suggested that they should sell the ruins of the old church in order to get funds to build the new one, and that the parson might be paid by the sale of the old tombstones! Submerged churchyards are common all over the destroyed districts. Between the Hamburger Hallig and the mainland there is an extensive old burial ground, where a brisk business is done in fishing up the old tombstones—generally made of sandstone, and of an elaborate description. Indeed, as the strait between the mainland and this Hallig is very shallow, it is proposed to dyke off the water and drain the intervening space, for no other purpose than to allow the tombstones to be recovered with greater ease. Tombstones are indeed used in those parts for the most temporal of purposes. I lived for some time in a house where the doorstep was one of these memorials of the departed islanders. It might be improving, but was, to say the least of it, not cheerful to be daily reminded that "Hier ruhet was gewesen, Henning Eschels, geboren 1623," his three "frauen" and thirteen "kinder." The Friesians, though speaking their own language whilst living, always insist on being treated to a little German when dead. On the western side of Sylt there is also a sunken land, which got so gradually sanded up, that the last time the church was used the congregation crept in by the window, and the parson stood on a sandbank in front of the altar. This was carrying the joke too far. Accordingly, the sea stopped all such nonsense, and in the course of the week took possession of the church and churchyard. For long, however, the steeple stood above the surface, and the bell rang dolefully as the waves beat against it, until it was stolen by some sacrilegious sailors passing by. In the Hallig of Oland the graveyard is on the same werft as the houses.

In 1825 the sea dug out all the coffins, and scattered the bones of the dead. The inhabitants thereupon engaged an old man to collect them, paying him for his trouble by presenting him with the wood of the old coffins. In Gröde during a storm the coffins floated in at the windows of the houses.

That many of these islands will eventually disappear can be hardly doubtful. Indeed, in Friesian tradition, there are many weird tales of sailors returning to their homes after long voyages, and failing to find the Hallige and the werft which they had left.

Heligoland is, perhaps, the most remarkable, and certainly the best known of the Friesian Islands. Every one who has sailed up the Elbe must have noticed it as the first land seen after leaving Scotland. Its red keuper cliffs are very marked, and in frowning cliffs or rock Heligoland differs from most of the other islands, which are, from the greater part, made up of sand. Heligoland is really two islands—the Rock Island and the Sand one. The Rock Island is the one on which the town is built. It is 5880 feet in its greatest length, its circumference is 13,500 feet, its average height 198 feet, while the highest point is 216, and the greatest breadth 1845 feet, the island sloping from west to east. The Sand Island is about 200 feet above the sea at its highest point, but the drifting sand and the constant inroads of the sea make this height rather variable. This "dune" or Sand Island is about a quarter of a mile east of the rock or main island. It is only about half a mile in length, and a little less in breadth. Now, no subject is a more stock one in all books on geology and physical geography than the destruction of Heligoland. We have maps of the island in the Middle Ages which certainly show it very much larger than now. Leaving out of all account the fact that the ancient chroniclers were not in all cases to be relied upon, especially when they were natives of the countries they were describing. I think, after a very careful study of probably everything of any consequence which has been written on Heligoland, and an exhaustive examination of the islands during a stay on them of a considerable portion of an autumn, that there has been an entire misreading of the old historians. Allowing what they say to have been true, it does not at all follow that it was the Rock Island which was so large. On the contrary, I do not think that there is a tittle of evidence to show that the Rock Island was ever very much larger than it is just now, at least in historical periods. It might have extended as far as the rocks under the water—"the foundation of the island," as the natives call them—which can be seen for a few yards from the shore all around it, but no more. On the other hand, there is every ground for believing that the Sand Island was within very recent periods very much larger than it is at present, though the Heligoland tradition that in some remote period it was connected with the Mainland, is very doubtful. Up to the year 1720 the Sand Island was joined to the Rock Island by a line of rock and rubbish, known as *de waal* (the wall), but in that year it was swept away by the sea, and ever since, the distance between the two islands has been increasing. I send a photograph of an old engraving showing the two islands united by *de waal*, which formed such a breakwater against the North Sea, that many ships could take shelter behind it. There seems little doubt that it was on this Sand Island that the numerous churches and other edifices which the old historians, such as Adam of Bremen and Pontanus, tell us of, and that it is the gradual destruction, still going on, of this and not of the Rock Island, which has given rise to the persistent popular, but I think erroneous, impressions on the subject. It must, of course, be acknowleged that parts of the cliffs are every now and then falling. But these encroachments of the sea are trifling, and have been kept a record of from a very early period. Around the shores are many caves and isolated masses of rocks, which are remnants of the ocean's work. But this is what we can see on any part of the shores of countries exposed to the fury of the North Sea. In conclusion, I may add that I have frequently seen it stated that rabbits, by undermining the cliffs, and thus assisting the marine denudation, are rapidly destroying Heligoland. In reply, I can only say, *firstly*, that Heligoland (proper) is not being destroyed; *secondly*, that rabbits are in no way assisting in the work of destruction, for the all sufficient reason, *that there are not now, and never were, any rabbits on Heligoland.*

II. *On the Geology of the Island of Unst.* By JOHN HORNE, Esq., F.G.S. (of H.M. Geological Survey of Scotland).

The island of Unst is the northmost of the group of the Shetland Isles, and measures about twelve miles in length, and about five miles in breadth. It is separated from the adjacent island of Yell by the narrow Blue Mull Sound. The western portion of the island consists of a ridge of high ground called the Vallafield range, running nearly north and south, and more or less parallel with the strike of the underlying rocks; its highest elevation being about 697 feet. As the ridge is followed southwards to Belmont, it sinks in height, and rolls with a gently undulating slope towards the shore. This ridge is planted on the east by a hollow which crosses the island from Burra Fiord to Belmont, in the line of which lie several lochs, viz., the Loch of Cliff, Loch Watlea, and the Belmont Lochs. In the north-eastern portion of the island lies a group of heathery hills, the highest of which is the Saxafiord Hill (938 feet). To the south of this mass, and between Haroldswick Bay and the south end of Loch Cliff, run the Heog Hills, which are upwards of 400 feet in height by aneroid measurement. The ground round Balta Sound, and westwards to Baliasta Kirk, is low lying and cultivated in part, but southwards towards Uya Sound, a distance of four miles, the district is moory, and only a thin covering of turf conceals the underlying rocks. There is a marked contrast between the physical features of the island between Haroldswick Bay and Uya Sound, and those presented in the more elevated tracts. We shall see presently that this is due to a corresponding difference in the lithological character of the rocks in the respective areas. The coast line round the western and northern portions of the island is rugged, forming in places precipitous cliffs, the most imposing being met with in the neighbourhood of the Flugga lighthouse.

Geological Structure.—The Vallafield range, already referred to, consists of different varieties of gneissose rocks, the strike of the beds varying from 10° to 30° to the east of north and west of south. This persistent strike has determined the direction of the ridge of high ground. The same relation between the trend of the ridge-shaped hills and the strike of the strata is observable in the island of Yell, and also in the Mainland; the escarpments of the ridges facing the east, while the gentler slope is inclined to the west. The gneissose rocks are admirably seen in the sea-cliffs and in the streams draining the Vallafield range. The common variety is micaceous-gneiss, consisting of quartz, felspar, and mica; the felspar being very abundant. The mica is sometimes replaced by hornblende to such an extent, that the rock may be more fitly termed hornblendic-gneiss. These metamorphic rocks are intersected with numerous veins of granite and pink orthoclase felspar and quartz. Along the eastern slope of the range the beds dip from 10° to 20° to the south of east, but in many places westerly dips prevail.

The group of hills round Saxafiord, of which the latter hill is the highest elevation, is composed of different materials. They are mostly round dome-shaped masses, with a comparatively smooth contour, and possessing a tolerably thick covering of peat. The rocks consist of thin flaggy micaceous and talcose schists, the strike of the beds being identical with that of the gneissose rocks to the west, viz., from 10° to 20° to the east of north, while the dip is mostly from 10° to 20° to the south of east.

Bands of limestone occur at the south-western margin of these schistose rocks along the line of the Loch of Cliff, while other calcareous bands are noted by Dr Hibbert as occurring at the south-west point of Unst, and in the island of Linga.

The long hollow which extends from Belmont northwards by Loch Watlea to the Loch of Cliff, is approximately the western boundary line between the gneissose rocks of Vallafield and the great mass of serpentine of Heog and Gallow Hills. From thence the line sweeps in a north-easterly direction round the northern margin of the Heog Hills to the Norwich Bay. This rock is admirably seen on the Heog Hills, where it is exposed on the top and flanks of the ridge, weathering with a rusty brown crust. The contrast between the mode of weathering of the serpentine and the gneissose rocks would strike the most casual observer. The Heog ridge presents a bare sterile appearance, the scanty nature of the vegetation being due to the character of the rock. It is now generally admitted by petrologists that serpentine is a truly metamorphic rock, which has been developed by the alteration of some pre-existing mass. It is a hydrated silicate of magnesia of a fine grained texture, and is usually associated with steatite, carbonate of lime, diallage, and other substances. Near the Loch of Cliff, and along the north side of the Heog Hills, I observed several instances of the talcose schists gradually assuming a serpentinous character, and eventually merging into serpentine. It is of importance to note that talc becomes very abundant in places near the edge of the serpentine area as at Norwich Bay. Like the well-known Portsoy serpentine, that of Unst varies in colour from a green to a reddish brown. This variation in colour has been attributed to "the proportion and degree of the oxidation of the iron which it contains." The serpentine of Unst has long been famous for the chromate of iron which it contains, which was first discovered by Dr Hibbert, to whose zealous labours we are likewise indebted for the first description of the geological structure of the Shetland Isles. This ore has been worked in the Heog Hills and near Haroldswick Bay. The chromate of iron is disseminated through the rock, and in places it becomes so abundant as to constitute an important ingredient in it. Nevertheless, this ore occurs after the manner of a vein, the great masses being in the form of what Cornish miners call "bunches," but the name conveys the impression of amplifications on an elsewhere thinner mass. In Unst the vein, as actual chromate of iron, cannot be seen to pass from one "bunch" to the other, but the two sides of the sheathing mineral can be traced. Near Buness also the vein throws off at least one continuous offset, which, maintaining a diverse course, must be held to indicate the vein nature of the larger mass.

To the south-east of the great mass of serpentine occurs the diallage rock of the Ford Hill.

Glaciation.—Abundant proofs are to be found in the island of the intense abrasion to which it has been subjected by ice-action. The planed surfaces of the gneissose rocks on the Vallafield range where the covering of peat has been worn away, and exposed them to view, the mammillated slopes of the Heogs, and the numerous *roches moutonneés* met with in the low lying parts, point to the same conclusion. From the appearance of the *roches moutonneés* in Haroldswick Bay, it seemed to me that the ice which glaciated Unst must have crossed the island from east to west. Unfortunately striæ are not plentiful, which is easily accounted for in the serpentine area, by the rapid disintegration of the rock by the atmospheric waste. In the quarries at Hagdale, near Haroldswick, however, about a hundred yards from the public road, I found a capitally striated surface. The ice-markings point 8° south of west; and from their position with reference to the Heog Hills, it is evident that they must have been produced by some agent acting independently of the isle. Mr C. W. Peach has recorded striæ from the same neighbourhood, running N.N.W. magnetic, which, after deducting 23° for the magnetic variation, is about due east and west.

Boulder clays, Erratics.—The boulder clays met with in the isle are spread out chiefly over the low grounds in an irregular form, and occasionally they assume the drum-shaped arrangement so characteristic of the low lying districts of the south of Scotland. The deposit consists of a stiff, gritty clay, charged with smoothed and subangular stones of various sizes, and occasionally measuring three feet across. Sections of this deposit are to be met with along the shore at Balta Sound, in pits between Buness and the Loch of Cliff, along the Baliasta Burn, at Loch Watlea, near Belmont, and along the shores of Uya Sound. My attention was specially directed to the district between Balta Sound and the Vallafield ridge, in order to determine the carry of the stones in the *moraine profonde.* Fortunately the wide difference between the serpentine and the gneissose rocks was of the greatest service in helping to decide the direction of the ice movement. The evidence from this source fully confirmed the conclusions already arrived at, from a consideration of the *roches moutonneés* and the ice markings. Along the shores of Balta Sound the boulder clay is a tough, blue and yellow, stony clay, packed with stones almost entirely of serpentine. The larger blocks are beautifully striated. On the low ground from Buness towards Baliasta Kirk the same deposit is traceable at intervals, occurring in irregular patches, and possessing the same general character. At the south-east corner of the Loch of Cliff the limit of the serpentine is reached. In a quarry at the roadside near the head of the voe, grey decomposing schistose rocks crop out on the right-hand side of section. Reposing on these rocks on the left side of section, a thin deposit of till is met with, crammed with serpentine stones. Crossing the bridge which spans the Vallafield Burn, a little way above Loch Cliff, at the road side, grey decomposing schists are again met with; and at the north end of section there is an exposure of stiff, stony clay with serpentine stones, while the clayey matrix is formed of the pounded-up schistose rocks which lie underneath. About two hundred yards along the same road running westwards toward a farmhouse, another quarry is dug in stony boulder clay. The most of the stones in this deposit likewise consist of serpentine, with a small proportion of quartz rock and grey schist. About a hundred yards still farther west, at the road side, there is a good exposure of coarse micaceous-gneiss dipping E. 20 S., at an angle of 20°. There is no drift seen in this quarry, but near this point on both sides of the road there are small sections of boulder clay with scratched stones. The small stones, and, in fact, the clayey matrix, are made up of the underlying schists, but the larger blocks about six inches long consist of serpentine. I could find no serpentine in place in the neighbourhood, except to the east of the Vallafield Burn, and it is evident, therefore, that the ice which glaciated Unst must have crossed the island from east to west, rolling its bottom moraine *westwards* from *the area occupied by the serpentine, on to the track of the gneissose rocks.*

We are led to the same conclusion by the evidence furnished by the erratic blocks. In the valley west of Baliasta Kirk, where the boulder clay sections above described occur, blocks of serpentine can be traced at intervals westwards to the col at the head of the valley, draining into Woodwick Bay, on the west side of the island. Near the farmhouse west of the head of Loch Cliff, a triangular-shaped block of this rock is met with, five feet long and three feet broad at the base, and partly concealed. Again, on the hill face, on the south side of this col, blocks of serpentine are found lying on the surface. And so also on the hill slope west of Loch Watlea, and on the ground west of the Belmont Lochs, I observed similar boulders of serpentine.

Lochs and Voes.—The chain of lochs which crosses the island from Burra Fiord to Belmont has been already referred to. The two lakes at Belmont and Loch Watlea are drift dammed lochs, but the Loch of Cliff must have been at one time connected, and must have formed a part of Burra Fiord. The Loch of Cliff, which is about two miles long, is separated from the Burra Fiord, which is about three miles long, by a narrow patch of alluvium. Two little streams from the east and west drain their waters from the hill slopes into the little alluvial flat which has evidently been formed by the sand and gravel brought down by the streams. The line of the old sea-cliff is well marked on the east side of the alluvial flat, which tends to confirm the supposition that Loch Cliff and Burra Voe have been separated at no distant date.

In the island of Unst we search in vain for the great series of gravels which attain such a remarkable development in Scotland. There is likewise no trace of the old sea-beaches which indicate the rise of the land in recent geological times. The drift slopes along the sides of the voes or sea-lochs in Unst and the other Shetland Isles, are admirably adapted for their preservation. It would appear, therefore, that the Shetland Isles did not share in the same earth movements as the mainland of Scotland which gave rise to those marine terraces.

We have seen that in the island of Unst the ice movement took place from east to west, as indicated by the *roches moutonneés*, striations, the stones in the boulder clay, and erratic blocks. This seems to be a remarkable confirmation of the conclusions of my colleague Dr Croll, to which he had been led by a consideration of the size of the Scandinavian ice-sheet, and the origin of the Caithness boulder clay containing marine shells. We have recently been furnished with an estimate of the thickness of the ice in Sogne Fiord during the period of extreme cold by Amund Helland. He estimates the minimum thickness at 6000 feet at that particular point, and when we remember that the average depth of the German Ocean is not much more than 240 feet, we can readily understand how such a mass of ice could never have floated between Scotland and Norway. The ice-sheet would move westwards till it found water deep enough to break up the mass, in other words to the 100 fathom line which lies to the west of the Shetland Isles. We conclude, therefore, that during their primary glaciation the Shetland Isles were glaciated by Norwegian ice.

Further south, in the Mainland, which is by far the largest of the Shetland Isles, all traces of this ancient glaciation have been well nigh effaced by a local ice-sheet, which lingered about the islands long after the Scandinavian glaciers had retreated to their own fastnesses. And this is what might naturally be expected, in spite of the contour of the land, when we consider the high latitude of the islands. Palæontological evidence assures us that the advent of the ice age was not abrupt, but more or less gradual, and the retreat of the glaciers would be marked by the same gradual change. We may naturally suppose then, that during this recession of the great glaciers, a local sheet clung for centuries to the Mainland accumulating a *moraine profonde* peculiarly its own. Then as the climatic conditions gradually ameliorated, this local sheet eventually gave place to small valley glaciers with their heaps of rubbish and perched blocks.

III. *Notes on* Actinia mesembryanthemum, *taken from a Rock Pool at North Berwick by the late Sir John Graham Dalyell in August* 1828. By JAMES M'BAIN, M.D., R.N. (The living specimen and young were exhibited.)

The complete life-history of an animal or plant is the ultimate aim and end of biological science. To attain this end, however, in its entirety is, perhaps, impossible; and it is only by the labour of many observers that a more or less satisfactory approximation to the solution of this interesting problem can be hopefully looked for. A general outline of the life-history of an actinia or sea-anemone, kept in captivity for a period of fifty years, and still alive, surrounded with its progeny of the second generation, is in itself noteworthy, and highly interesting to naturalists. And it occurred to me that the last meeting of the 107th Session of the Royal Physical Society would be a fit and convenient opportunity to exhibit the living specimen, along with several living individuals of the first and second generation.

My first acquaintance with this Actinia was in 1846. It was at that time living in Great King Street, and had been in the possession of Sir John Graham Dalyell for eighteen years. He had then nearly completed his great work "On Rare and Remarkable Animals," and I saw the plates and figures of the actinia in MS. It was never exhibited in public, so far as I am aware, during his life-time. It was shown by Dr Fleming to his class in the New College, with the significant caution, "Oculis non manibus." It went with me to the meeting of the British Association at Aberdeen, 1859, when the late Prince Consort presided, and was exhibited in the zoological section. It was exhibited at a conversazione of the Medico-Chirurgical Society, 1872. And in this room, four years ago, at a meeting of "The Edinburgh Naturalists' Field Club." This is the fifth time only, to my knowledge, the specimen has been exhibited in public. It is highly sensitive to physical impressions; it may be also, for anything I know, to moral ones. To give it the benefit of the doubt, therefore, I hope it will meet a friendly reception. The few remarks I have to make will consist chiefly of observations made on this actinia by Sir John Graham Dalyell, with some additional notes on the birth and number of its offspring since his time.

This celebrated specimen is well known in the world of science, as also to a wide circle of non-scientific friends; and a portion of its domestic life has been recorded by several eminent writers on natural history both at home and abroad. The familiar name of "Granny" has been conferred on it, to which it has long been well entitled, as the facts about to be related in reference to the propagation and perpetuation of the race will sufficiently prove. Its domestic history may be conveniently divided into three parts, corresponding to the periods of time it has been in the possession of each of its three successive custodians.

The first possessor of this actinia was the late Sir John Graham Dalyell—the modern Spallanzani—a well-deserved compliment paid to him by Professor Owen for his original and valuable contributions to the life-history of many of the invertebrate group of the animal kingdom. In Sir John Graham Dalyell's great work entitled, "Rare and Remarkable Animals of Scotland Represented from Living Subjects, with Practical Observations on their Nature," published in 1848, in two volumes, there will be found in vol. ii., chap. x., under "Actinia, the Animal-Flower," an interesting description of the genus. The chapter contains the life-history of the actinia now exhibited, extending from 1828 to 1848, the year in which the work was published. The original observations and experiments made by Sir John Graham Dalyell on it are illustrated by numerous plates and figures, in which the facts observed are faithfully and artistically delineated. Of his first acquaintance with this now celebrated animal, the author makes the following statement: "I took a specimen of *Actinia mesembryanthemum* in August 1828, at North Berwick, where the species is abundant among the crevices of the rocks, and in the pools remaining still replenished after the recess of the tide. It was originally very fine, though not of the largest size; and I computed from comparison with those bred in my possession, that it must have been at least seven years old.

"During two months, and afterwards, it continued in great vigour and of ample dimensions, being at that time delineated in plate 45, vol. ii.

"While considering such animals mature, we must allow that their organisation receives subsequent accessions, nor can I say at what period, certainly a distant one, they cease to grow. Firmly affixed by the spreading base, the disc of this species is expanded above, and begirt by a triple row of tentacula, each extending an inch. Their number augments with age, and hence at the latest period of observation they had amounted to about a hundred in twenty years. The whole are unequally divided among the three rows, the inner row being composed of fewest, but they are the largest. At the external root of the tentacula of the outer row, there is a number of apparently solid tubercles; each, however, is pierced by an orifice, which opens and dilates occasionally, sometime after the animal has fed."

On the variation of colour he remarks: "The colour of this species might mislead the most experienced observer, nor shall I speak too positively on the subject. It appears to me, that, taking the widest latitude, it may possibly range, through the medium of varieties, from liver-brown to fine and vivid vermilion, that the former belongs to the ordinary and more common portion of the tribe, that the specimens so distinguished have purple tubercles, the base surrounded by a purple ring, and that a purple line or patch from the disc penetrates each of the opposite sides of the mouth. On the other hand, those characterised by vermilion colour have pure white tubercles resembling a row of pearls, and are without any other distinctive marks. In the first, or more common variety, the skin of the adult is liver-brown; but in the earlier stages, the colour is lighter, and the surface of the animal is sprinkled with fine, oval, green specks in longitudinal rows, which remain conspicuous for three or four years at least. They are best seen after exuviation; for when the animal has cast his skin the new surface is clearer, whereas they become altogether obliterated with age. The under surface of the base is always green.

Duration of life in this species.—"This actinia must be deemed a long-lived animal. Naturalists, indeed, as if desirous of proportioning the existence of most animals to the transcience of their own observations, are too prone to abridge that to which a longer period is allotted among the humbler orders. The specimen still surviving, cannot be much under thirty years old. Another, which must have been of equal size with it when taken, has lived thirteen or fourteen years in my possession. Therefore, both being yet in great vigour, and likely to survive, the actinia must be judged a long-lived animal."

On reproduction he adds, this species is a genuine hermaphrodite, and also viviparous. It produces its young by the mouth. The body of the parent is then greatly compressed, and to judge by appearances, it suffers in genuine labour. As the half-digested food is disgorged by the mouth—not without an effort—we may presume that in consequence, the young are sometimes disgorged along with it. The specimen having had a copious meal of an embryo skate, taken from the capsule, retained the food during twenty-four hours, when it was rejected, together with a numerous brood of thirty-eight young actiniæ, some of them very large. The period of gestation is long, and apparently arbitrary. Embryos have appeared in the tentacula five months preceding birth; and eight months have intervened between the production of successive broods.

The vessel containing the specimen having been emptied on May 23d, it was replenished within an hour. Then the actinia contracted partly, the tentacula dwindled down, and the mouth projected considerably from the circumscribed disc. Thus did the specimen appear soon after replenishment. Now a large fœtus was observed within the orifice; it advanced slowly, but none of the tentacula were visible; there seemed to be some adhesion of the side, whereon it lay in horizontal position, not by the base. As the young animal was farther advanced, it turned round, but still lay on the side. Four tentacula appeared, next another, and when still on the margin of the orifice, five could be enumerated. It was gradually detached, and having at length hung by a single tentaculum, dropped to the bottom of the vessel on its base. The nascent actinia fixed there almost immediately, and the complement of tentacula seemed, in a few minutes, to be eighteen. It was of large dimensions, and of a dull reddish colour. Parturition here occupied fifteen or twenty minutes.

A tip of a gravid tentaculum was excised from the same specimen on July 25th, and put into a watch-glass with sea-water; and next day a fœtus was expelled from it. It adhered the day after, displaying twelve very irregular tentacula. It fed on the 9th of August, and on the 12th it was delineated in plate 47, figs. 4, 5, and 6. After fifteen months it gave birth to several young, and had a progeny of sixty-four young ones when four years old. An embryo of the actinia, therefore, extracted artificially from the parent may survive uninjured, and prove prolific.

The specimen delineated in plate 45 has given birth to 334 young actinia in the course of twenty years, but has only produced forty-one during the last thirteen years, and in some of the births, only a single individual. A very long period, therefore, sometimes intervenes without progeny, or many young may be produced within a limited season.

Feeding certainly promotes fertility.

Nearly the fortieth part of the 334 young consisted of monstrous animals—by redundancy rather than defect. Not so frequent in its later offspring as among the earlier. One had two mouths of unequal dimensions in the same disc, each mouth fed independently, and the system seemed to derive benefit from either. In three years this monster, which was a fine specimen, displayed its tentacula in four rows, not in three, as in normal specimens; the tubercles were twenty-eight, and of a vivid purple. It had produced twenty-eight young, the first brood when fifteen months old, and it survived within a month of five years (plate 47, fig. 3).

Another form of monstrosity consisted of two bodies united; four of this kind were produced by the same actinia, and survived ten years.

Although the colour of the actinia is not dependent on the season, it is subject to alteration, either from the state of the skin, or from other causes. The aged specimen was rather reddish-brown when taken; it underwent successive modifications; and at that period, 1848, when I conclude it could not be under thirty years old, it was rather of a dull greenish cast, the tubercles blue, the purple ring at the base narrow and faint. From the facility of operations, and particularly from admitting the means of removal in general, by simply pouring the water off most specimens, from their feeding and breeding so readily, this species is peculiarly adapted for the study of the inquisitive naturalist.

Sir John G. Dalyell died in June 1851, and his famous actinia was transferred to the custody of the late Dr John Fleming, Professor of Natural Science, New College, Edinburgh. While under his care two remarkable events occurred in its life-history. The first was serious and alarming. The room in which it was kept, had undergone a process of cleaning and painting; and it was conjectured that some deleterious substance had found access into the glass jar, and that the precious actinia had been poisoned. I was hastily summoned to prescribe, and the actinia certainly appeared to be in a hopeless condition, but by removal to a more sanitary apartment and frequent renewal of pure sea-water, it was soon, happily, restored to its wonted health and safety. The next incident was of a different nature and highly satisfactory. In the spring of 1857, after remaining unproductive for many years, it, in the course of a single night, gave birth to a progeny of 240 living young actiniæ. None of them, so far as I know, ever reached maturity.

This actinia was greatly prized by Dr Fleming. After his death, which occurred on 18th November 1857, Mrs Fleming handed it over to my care, and the actinia is still kept in the same small glass jar in which it lived with its former owners. The Dalyellian actinia has now been in my possession twenty years and five months. For nearly fifteen years after coming under my care, it was unproductive, but in August 1872, it afforded a second surprise, by producing a brood of thirty living young actiniæ varying from a pin-head to six or eight times the size.

On 9th December 1872, it gave birth to nine living young ones, which were exhibited with it at the "Jubilee Chronicon" of the Medico-Chirurgical Society the next evening. Each year since then, it has produced living young varying in number from five to twenty at a birth. The last brood were extruded ten days ago, and are here exhibited.

I compute, that during the last seven years, this animal has given birth to upwards of 150 living young actiniæ. None of them have shown any tendency to monstrosity.

On 22d March 1873, I presented Miss Frances Hope of Wardie with two of the nine actiniæ produced by "Granny" on 9th December 1872, which were exhibited at the conversazione of the Medico-Chirurgical Society. The two actiniæ were put into a separate glass vessel, and fed once a week, sometimes oftener, with small portions of mussel (*Mytilus edulis*), and afterwards supplied with pure sea-water.

This method was persevered in for a period of four years. In the absence of Miss F. Hope, their wants were strictly attended to by Miss Reid, whose careful attention has much conduced to the successful result of the object in view. The experiment was to ascertain whether a well-regulated plan of feeding, and a frequent supply of aërated sea-water to its offspring, produced in her later years, might prove them to be as fertile and productive as they were in the early days of its domestic life. The result has justified the expectation, and rewarded the constant care and attention that has been bestowed on these actiniæ.

On 1st March 1877, a young actinia was observed in the glass vessel, soon followed by others at uncertain intervals, and they now amount to upwards of twenty. Two are here exhibited. The specimens at Wardie, of which these are the offspring, are equal in size to the parent—the colour liver-brown, but brighter than it is at the present time. The tint, however, agrees with her as delineated in plate 45, fig. 1, in "Rare and Remarkable Animals of Scotland," and with the description of the specimen when taken from its native habitat at North Berwick. The brightness of colour, doubtless, depends upon the condition of the pigment corpuscles. Two actiniæ produced by "Granny's" offspring are now subjected to the same careful attention and mode of treatment by Miss Frances Hope at Wardie; and it is anticipated, that at the expiration of four years, perhaps sooner, the experiment may prove equally successful.

It is an interesting sight to see the old actinia during the act of taking food. A bit of mussel or other organic substance, on approaching within reach of the tentacula, is instantly grasped and carried with unerring precision to the oral aperture. The œsophagal portion of the stomach, easily recognised by its longitudinal plicæ, whitish colour, and semi-translucency, is gradually extruded, and the morsel of food slowly disappears. Two brilliant turquoise-like tubercles are now seen at each edge of the oval-shaped orifice of the mouth. They are slightly larger than those surrounding the base of the tentacula, and each has a minute yellow spot at the junction of the œsophagal ring. Whether these pigmentary tubercles are subservient to the function of vision is at present uncertain. The oral aperture is distinctly oval, indicating bilateral symmetry in the actiniæ, as exhibited in living specimens at a meeting of this Society by our late distinguished Fellow, Dr Thos. S. Wright, in 1856, and published in the *Proceedings* of the Society, vol. i., p. 168.

No distinct nervous system has been as yet satisfactorily traced in the actiniæ. The definite movements from the stimulus of food and other agents seem to point to special lines of nerve force, which recent experiments, so ably conducted by Mr Romanes, have shown to exist in their allied congeners, the medusæ. This physiological problem, however, with details of the anatomical structure, histology, and classification, is beyond the scope of the present notes, which are simply meant to record the general outline of the life-history of the Dalyellian actinia from its captivity in 1828 to 1878, a long period of fifty years.

IV. *Note on the Occurrence of the Stockdove* (Columba ænas) *in the South of Perthshire.* By John J. Dalgleish, Esq. (Specimens were exhibited.)

The stockdove (*Columba ænas*), although common in some parts of England, such as Norfolk and Suffolk, where it is found breeding in rabbit burrows, has not, except in one or perhaps two instances, been hitherto recorded from Scotland. The first of these is in a "List of Birds of Caithness," by the late Dr Sinclair of Wick, which was communicated to this Society by R. J. Shearer, Esq., and published in the *Proceed-*

ings (vol. ii., p. 334). The last-named gentleman there states, that all of the birds in the list were obtained or preserved by Dr Sinclair, with a few exceptions noted, among which the stockdove does not appear; but as no date, locality, or other particulars are given, beyond the words, "very rare," placed after the name in the list, this occurrence must be, at the least, considered very doubtful. The only other recorded instance is to be found in Mr Gray's "Birds of the West of Scotland," where, after also throwing an air of doubt around the Caithness specimen, the author mentions—on the authority of Mr W. Reid of Pultneytown, Wick, who had seen the bird—that one was shot at Deerness in Orkney, on 12th October 1861. The above are the only two records which I have been able to find of the occurrence of this bird in Scotland, while both M'Gillivray and Yarrell state that it is not found there.

The two instances which I have now to record are both quite recent, and have taken place in the same locality, viz., in the Culross, or southern district of Perthshire, a detached and purely lowland portion of that country. The first was shot at Tulliallan, in the parish of the same name, by Mr Millar, gamekeeper there, on the 27th of last month, and the other, which is the bird now before you, was shot on my property of Westgrange, in the parish of Culross, by Mr John Livingstone, gamekeeper. The former has, I believe, been presented to the Museum of the Alloa Society of Natural Science. In both cases, these birds were shot when feeding on newly sown grain fields in company with woodpigeons, and as the localities are very near each other, it is possible that they may have been a mated pair. I have not ascertained the sex of the Tulliallan specimen. That now before you is a male. From the slight resemblance which the bird bears at first sight to a young woodpigeon, it is quite possible that it may have occurred more frequently in Scotland without being observed, and, as I understand, that its range is extending northwards, it having, according to Mr Dresser, been found breeding in Northumberland, it may perhaps be looked for as a casual visitor more often in future.

The stockdove, like many of the pigeons, being a bird of at least partially migratory habits, is in Dorset and some of the south-western counties of England only known as a winter visitant.

It usually breeds in the hollow of a tree, and sometimes among ivy; but, as above mentioned, it is in some localities found nesting in rabbit warrens. It nests early, and produces two, sometimes three, broods annually.

V. Dr JOHN ALEX. SMITH exhibited various Ethnological Objects from the Fiji Islands. These were recently received from Fiji by his friend, Mr William Mitchell. They consist of a series of the short wooden clubs with bulbous extremities, and their slender handles ornamented with carving. Specimens of the curious hand-made pottery of different colours, which distinguish Fiji from all the eastward South Sea Islands. Some of these are formed of two or more round, or oval, ornamented vessels joined together, with their handles meeting above; others are simple, and of all sizes and shapes for ordinary purposes. They are glazed when hot with a kind of pine resin. A large wig of human hair. Mr Thomas Williams, the missionary, in his account of Fiji (1858), says the Fijian delights and excels in wig-making, an art which seems to be unknown to the other islanders. Necklaces made of long and narrow-pointed rib-bones, strung together, were also exhibited, as well as specimens of the root of the grog-tree, or intoxicating pepper-tree (*Piper methysticum*), from which the "kava" drink is made.

Also specimens of the beautiful red-spotted crab (*Carpilius maculatus*) from the Pemuto Islands, near Tahiti. It measures 4½ inches across, by 4 from back to front. Etc., etc.

VI. *Note of a Large Common Trout* (Salmo fario?) *taken in the River Tay.* (Specimen exhibited.) By JOHN ALEX. SMITH, M.D.

This large trout was killed in the Tay in Glendochart in July 1877. It had red and black spots, and the abdominal fins bordered with yellow. It weighed 17 lbs., and measured

38 inches in length. The stomach was quite empty. The fish was sent to me for exhibition from Mr Sanderson, taxidermist. His assistant, Mr Keddie, informed me that, many years ago when he was engaged fishing with the net in the mouth or estuary of the river Eden, within the tidal range of the sea, near St Andrews he caught numbers of sea-trout or bull-trout (*Salmo trutta*). He also frequently caught specimens of the common trout, the brown and yellow trout with red and black spots and yellow fins, varying from 2 to 25 lbs. in weight, about the species of which he could not be mistaken, and he says that many of these fish had parasites attached to them; he therefore considers this trout may also migrate to the sea, when it can get the opportunity to do so.

Dr A. Günther, in his "Catalogue of Fishes," divides the common trout into two varieties—the *Salmo fario*, var. *gaimardi*, the northern Scandinavian or Scottish trout, and *Salmo fario*, var. *ausonii*, the more southern European, or English trout. I am not able to say to which of these varieties the fish now exhibited may belong, as I did not get an examination made of it when fresh.

Mr Keddie gave me notes of several large trout; another from the Tay, a common trout, the brown or yellow trout, was taken in April 1875; it weighed 11 lbs., and measured 30 inches in length. Other trouts were the great lake trout, *Salmo ferox*, killed in Loch Rannoch in June 1872; one weighed 17 lbs., and measured in length 31 inches; one weighed 15 lbs., length 32 inches. Another killed in August weighed 11 lbs., length 25 inches. Remains of small trout were found in the stomachs of several of these fish. The varieties of weight as compared with the length show the different states of condition of the fish.

VII. *Note of a Common Heron,* Ardea cinerea, *killed by a Water-rat.* By John Alexander Smith, M.D.

Dr Smith exhibited a specimen of the common heron, which was found dead, on the 6th April 1878, by the side of a small stream in the grounds of the Hirsel, near Coldstream, in the position in which it is now preserved. Its neck and wings are stretched out, and legs extended backwards, and the hinder part of a large water-rat protrudes from its widely-opened bill. The heron had attempted to swallow the large water-rat head foremost, and was suffocated in consequence. Yarrell in his "British Birds" figures one found dead with its beak piercing the head of an eel, the body of which was twisted round the bird's neck, and thus strangled it.

The bird exhibited was stuffed by William Hope, George Street, and is the property of the Earl of Home.

NOTE.—The following paper, read at the meeting of 19th December 1877, was received too late for insertion in its proper place.

Notes on a New Compound of Uranium. By J. HUNTER, Esq.

Any research which adds to our rapidly increasing stock of chemical facts is worthy of every acknowledgment, and the results of that research ought to be welcomed not only by the scientist, but by every one who has any interest in human progress. The discovery, or even a reliable description, of a new chemical compound may imply a new branch of trade; it may create employment for hundreds; and, as has often been the case, it may lead to other and greater discoveries, and thus swell the tide of knowledge, which is day by day sapping the very foundations of empiricism and ignorance.

It is, therefore, with very great pleasure that I bring before the Society a few notes regarding the preparation, and some of the properties, of a new salt of uranium.

Mr Stillman, who, so far as I know, has been the first to describe this new uranium compound of which I am about to speak, appears to have gone to work carefully and conscientiously; and, with one single exception, his *modus operandi* is almost faultless.

First, the preparation. The uranium used in the investigation was in the uranic state as hydrated uranic oxide, containing alkali and other impurities, from which it had, by a series of operations, to be freed, and uranoso uranic oxide obtained in a state of purity. The mixed oxide was then dissolved in sulphuric acid, and the uranic sulphate thus formed reduced to the uranous state by mixing it with water and alcohol, and exposing the resultant solution in a stoppered bottle to the action of the sun's rays. The alcohol—which by this process is itself changed into aldehyde—converts the uranic salt into the uranous form, the solution changing from a rich yellow to a dark-green colour; and from this solution the dark-brown uranous hydrate was obtained by the addition of ammonia. This hydrate, after being thoroughly washed with distilled water, was dissolved in hot oxalic acid; the liquid so obtained, on being slightly concentrated, deposited a dark-green crystalline powder, whose composition was ascertained by a series of very carefully performed analyses to be that of uranous oxalate, which is the chief subject of this paper.

The crystals of uranous oxalate are described as being cubical plates, and homogeneous in character, and their composition is as follows:

Uranous oxide, ...	51·62	51·39
Oxalic acid, ...	33·98	34·30
Water (dried at a temp. of 140° C.), .	14·38	14·38

Their solubility in cold water is one part in 2000, and in warm water it is about one part in 685; but this latter result must be taken with some reservation, because the solution possessed a yellow colour, showing some change in composition.

Our knowledge of uranium and its compounds is not by any means complete; but that that condition should obtain is not to be wondered at, when we have it stated in one of our best works in chemical literature that uranium is completely precipitated from uranic solutions by ammonia. It may, therefore, be pardonable in me if, to-night, I give to this Society a short *resumé* of the principal oxides and compounds of uranium, and their uses.

Uranium was first discovered by Klaproth, and owes its name to the fact that Herschel—for whom Klaproth professed profound admiration and respect—had in the same year, viz., 1786, discovered a planet to which the name Uranium had been given. Prior to this date the most common occurring ore of uranium was considered not as one of that metal, but of zinc; however, at the period I have just mentioned, Klaproth came to the rescue, and brought to light an entirely new element. But even this great chemist was mistaken in so far as he considered what turned out to be an oxide of the metal to be the metal itself, and it was not until the year 1840, or more than half a century afterwards, that Peligot proved what had hitherto been regarded as metallic uranium to be the protoxide (UO). This ore, which is by far the most plentiful one of uranium, is found in Cornwall, in Saxony, and in Bohemia, and is no other than the now well-known pitchblende, which is essentially uranoso uranic oxide.

There are, indeed, a number of ores of uranium (such as uranotantalite, Johannite, Fergusonite, etc.), but the only other important one is uranite, in which the uranium as uranic oxide is in combination with phosphoric acid. I intended to have shown to the Society a piece of metallic uranium, but from the great pressure upon my time, I am unable so to do, to-night at any rate. Uranium—according to the process employed for obtaining it—may be of a brown-black colour, or it may be almost white, and of great metallic lustre; or as in its compact form, it may strongly resemble iron or nickel, but it changes pretty readily on exposure to the air. When heated to a temperature of about 207° C., or about 400° F., it burns with great splendour, forming by that process the uranoso uranic oxide.

(At this stage Mr Hunter exhibited and described nearly all the oxides and salts of uranium, and demonstrated their characteristic reactions with re-agents.)

I have striven for some days past to prepare a specimen of this newly described salt, but unfortunately, although our artificial sources of heat are no doubt very powerful, they do not possess the property which sunlight does of effecting the change—along with suitable re-agents—from uranic to uranous compounds. I am consequently unable to exhibit the uranous oxalate to-night; but if any member of the Society is curious on the subject, I shall be glad to show a specimen at another meeting.

Uranium is not very extensively used in the arts and manufactures, and yet where it is employed it is not easily—if it can be at all—replaced by any substitute. In Germany a pigment containing copper and uranium is used by paper-hanging manufacturers; while in this and in other countries uranium does good service in enamel painting; and in glass-staining, which is not an unimportant trade now-a-days, it is questionable if the same fine tints can be produced from any other material—the protoxide imparting a deep black, and the sesquioxide a beautifully pale yellow colour.

Its tinctorical power, if I may use the term, is also of service in the porcelain factory, where a mixture of pitch-blende is employed in the production of the deep black colour under the glaze. Then in dyeing also, and in photography, uranium salts are more or less called into requisition.

In alluding to uranite, I mentioned that in that ore uranium was in combination with phosphoric acid, and it is somewhat strange that in the estimation of that very acid uranium should be of the most importance to the analytical chemist. In all agricultural countries, and especially old countries such as our own, where high rents are the order of the day, farmers are compelled to purchase large quantities of artificial manures, one of the chief constituents of these being phosphoric acid. In the purchase, then, of these costly manures, analytical chemists are largely employed for determining, along with the other constituents of course, this valuable phosphoric acid; and, strange though it may seem to you, there are some men in this country calling themselves chemists who employ processes for the estimation of this acid which are as erroneous as they are antiquated. This may appear to you a small matter, but I may help you to alter your opinion a little. By the processes to which I refer, an error of 1 to 10 per cent. will most probably occur. Now suppose that 60,000 tons are sold, and that there is an error of even 3 per cent. in the phosphoric acid estimation, that may represent a sum of £18,000, which is simply a loss to the country; and when I tell you that Newcastle alone produces, I believe, considerably more than this 60,000 tons every year, you will easily understand that if we could ascertain the total amount of artificial manure manufactured and sold in this country in twelve months, the amount of money which that would represent would be something prodigious. Thus, gentlemen, science is prostituted! Now, however, these *quasi*-chemists who did not know better, and also those who did or ought to have known better, but would not take the time required by a really reliable process, have no excuse, for—thanks to Klaproth, Peligot, Julet, and others—we have now a process for estimating phosphoric acid which gives rapid and tolerably accurate results—I refer to the volumetric estimation, in which uranium is used in the form of nitrate.

INDEX.

LIST OF FELLOWS.

ORDINARY.

Date of Election.

1856. Anderson, John, M.D., Calcutta.
1872. Anderson, James, 17 Lonsdale Terrace.
1856. Baillie, Rev. Zerub.
1846. Balfour, Professor J. H., 27 Inverleith Row.
1849. Barbour, G. F., Esq. of Bonskeid, 11 George Square.
1877. Barry, J. W., M.D., B.Sc., 23 Duke Street.
1878. Beattie, William Hamilton, 68 George Street.
1875. Bennie, James, Geological Survey Office, India Buildings.
1873. Black, W. T., 2 George Square.
1863. Brett, Alfred, Veterinary College, Clyde Street.
1878. Bringloe, Francis A., 75 George Street.
1878. Brown, A. B., 1 Rosebery Crescent.
1860. Brown, Robert, M.A., Ph.D., 26 Guildford Road, Albert Sq., London.
1852. Brown, William, F.R.C.S.E., 25 Dublin Street.
1876. Bruce, W. P., 18 Athole Crescent.
1878. Campbell, R. Vary, 37 Moray Place.
1878. Cameron, John, S.S.C., 63 George Street.
1878. Carmichael, Robert, 15 Summerfield Place, Leith.
1876. Carmichael, T. D. Gibson, Castlecraig, Dolphinton.
1877. Carmichael, Sir W. H. Gibson, Bart., Castlecraig, Dolphinton.
1858. Carruthers, William, F.R.S., British Museum, London.
1873. Clark, G. B., 5 Blackwood Crescent.
1878. Clark, Robert, F.R.S.E., 7 Learmonth Terrace.
1857. Cleland, Professor J., M.D., University of Glasgow.
1853. Cobbold, Spencer, M.D., F.R.S., London.
1878. Cornillon, Hypolite W., S.S.C., 67 George Street.
1874. Crawford, W. C., 1 North Kelvinside Terrace, Glasgow.
1850. Crole, David, 3 Ramsay Gardens.
1877. Dalgleish, John J., 8 Athole Crescent.
1857. Dallas, E. W., F.R.S.E., George Street.
1853. Dassauville, P. A., Royal Bank.
1869. Davidson, David C., Kingsknowes, Slateford.
1869. Davidson, James A., Kingsknowes, Slateford.
1878. Deans, John Christie, M.A., S.S.C., 40 Castle Street.
1876. Drinkwater, T. W., F.R.C.P.Ed., Laboratory, Marshall Street.
1864. Duns, Rev. Professor, D.D., F.R.S.E., 4 North Mansionhouse Road.
1869. Durham, William, F.R.S.E., Portobello.

Date of Election.

1863. Edmouston, Alexander, 14 Mansionhouse Road.
1877. Etheridge, Robert, jun., F.G.S., British Museum, London.
1874. Ferguson, William, Esq. of Kinmundy, F.R.S.E., 21 Manor Place.
Galbraith, E. L., Pitlochrie.
Gall, Rev. J., 47 Forrest Road.
1867. Gallie, J. B., 58 High Street.
1877. Galletly, Alexander, Museum of Science and Art.
1858. Geddes, John, 9 Melville Crescent.
1878. Geikie, Professor Archibald, F.R.S., Edinburgh University.
1877. Gibb, Philip B., M.A., 14 Picardy Place.
1869. Gibson, John, Museum of Science and Art.
1875. Goldie, John, Register House.
1878. Gray, Archibald, 13 Inverleith Row.
1878. Gray, Joseph T., M.A., 14 Findhorn Place.
1874. Gray, Robert, F.R.S.E., 13 Inverleith Row.
1828. Grieve, David, F.R.S.E., Hobart House, Dalkeith.
1877. Grieve, Somerville, Salisbury View, Dalkeith Road.
1871. Herbert, A. B., 12 London Street.
1858. Home, D. Milne, Esq. of Milne Graden, F.R.S.E., York Place.
1878. Horne, John, F.G.S., Geological Survey Office, Edinburgh.
1863. Hossack, B. H., 33 Charlotte Square.
1874. Hunter, John, Minto House Medical School, Chambers Street.
1878. Hunter, J. R. S., LL.D., Daleville, Braidwood, Lanarkshire.
1877. Jackson, ——, M.D., Leith Fort.
1850. Jenner, Charles, 47 Princes Street.
1877. Joass, C. Edward, 1 Rankeillor Street.
1858. Keir, Patrick Small, Esq., Kindrogan.
1869. Kennedy, Rev. J., M.A., B.D., 17 Melville Terrace.
Kilpatrick, H. Grainger, 104 South Bridge.
1869. King, J. Falconer, F.C.S., Minto House Medical School, Chambers Street.
1858. Laidley, J. W., Esq. of Seacliff, 2 Moray Place.
1868. Lawson, Robert.
1858. Lees, George, LL.D.
1861. Logan, Alexander, Register House.
1850. Logan, R. F., Spylaw House, Colinton.
1849. Lowe, Wm. Henry, M.D., Wimbledon, London.
1870. Lyon, F. W., M.D., Albany Street, Leith.
1855. Macadam, Stevenson, Ph.D., Surgeons' Hall.
1878. Maclauchlan, John, Albert Institute, Dundee.
1878. Macrae, Rev. John, D.D., Hawick.
1857. M'Bain, J., M.D., R.N. (*non-res.* 1849), Logie Villa, York Road, Trinity.
1878. Mackay, James F., W.S., 81 Princes Street.
1878. M'Laren, W. A., W.S., 12 Chester Street.
1878. Matheson, Alexander, M.A., 19 Northumberland Street.
1873. Miller, R. K., 4 Bonnington Terrace.
1862. Mitnish, H. W., M.R.C.S.L.

Date of Election.
1876. Moffat, Andrew, 8 Kirk Street, Leith.
1876. Moinet, Francis, M.D., 13 Alva Street.
1874. Murray, D. R., M.B., C.M., 37 Albany Street, Leith.
1877. Murray, John, F.R.S.E., "Challenger" Office, 13 Teviot Row.
1858. Paterson, Robert, M.D., 32 Charlotte Street, Leith.
1858. Paul, Henry, Melbourne, Australia.
1870. Peach, B. N., Gattonside, Melrose.
1867. Peach, C. W., A.L.S. (*non-res.* 1850), 30 Haddington Place.
1877. Philip, James, 5 Argyle Place.
1877. Prentice, Charles, C.A., 40 Castle Street.
1875. Pryde, James, 359 Sauchiehall Street, Glasgow.
1855. Redpath, Hugh, Grangebank, Morningside.
1868. Reid, Rev. J. Brown, Airdrie.
1858. Rigg, Dr C. M., The Vines, Rochester.
1867. Ritchie, Walter, New Register House.
1870. Robertson, Alexander, 29 Dick Place.
1861. Robertson, Thomas, 57 Frederick Street.
1878. Robertson, William, 40 Castle Street.
1863. Sadler, John, Royal Botanic Garden.
1878. Sang, Edward, F.R.S.E., 2 George Street.
1875. Saundby, Robert, M.D., Saughton Hall.
1878. Sievewright, Peter, 12 Danube Street.
1869. Skirving, R. Scot, 29 Drummond Place.
1877. Smith, James A. J., F.R.C.S., F.R.C.P., 37 Albany Street, Leith.
1878. Smith, James D., 30 Buckingham Terrace.
Smith, John Alex., M.D., 10 Palmerston Place.
1878. Somervail, Alexander, 73 George Street.
1878. Stewart, Rev. James, Wilton, Roxburghshire.
1861. Struthers, James, M.D., 22 Charlotte Street, Leith.
1878. Surenne, David J., 6 Warriston Crescent.
1849. Tasker, Rev. Wm., 32 Gilmore Place.
1851. Taylor, Andrew, 6 South Clerk Street.
1878. Thomson, Alexander, Newbank, Trinity.
1876. Thomson, Andrew, 13 Inverleith Place.
1848. Thomson, Sir Charles Wyville, LL.D., F.R.S., Edinburgh University.
1876. Thomson, John, 26 Queen Street.
1878. Thomson, Mitchell, 7 Carlton Terrace.
1874. Thomson, Robert, LL.B., Rutland Square.
1861. Thomson, W. Burns, St John Street.
1867. Thorburn, Archibald, General Register Office.
1859. Traquair, Ramsay H., M.D., F.R.S.E., Museum of Science and Art.
1858. Turner, Professor W., Edinburgh University.
1862. Waddel, Peter, Claremont Park, Leith.
1874. Walcot, John, 20 Drummond Place.
1872. Walley, T., Principal, Veterinary College, Clyde Street.
1855. Wardrop, James, 16 Carlton Street.
1878. Watson, G. W., 4 Stafford Street.
1878. White, Thomas, S.S.C., 114 George Street.

Date of Election.

1872. Williams, Principal, F.R.S.E., New Veterinary College.
1856. Wilson, Andrew, 21 Young Street.
1875. Wilson, Andrew, Ph.D., 118 Gilmore Place.
1861. Wilson, John, Janefield House, Duddingston.

NON-RESIDENT.

1864. Belairs, George, Caroline Lodge, Duddingston.
Bentham, George, F.R.S.
1862. Bethune, Norman, M.D., Toronto, Canada.
1876. Brown, J. A. Harvie, Dunipace House, Larbert.
1872. Brown, D. J., Glasgow.
1862. Brown, J. Crichton, M.D., London.
1867. Brown, Geo. H. Wilson, Vancouver Island, Columbia.
1862. Cæsar, Rev. W., D.D., Tranent.
1861. Cameron, A. G. H., Lakefield, Inverness.
Carpenter, W. B., M.D., C.B., London University.
1861. Chapman, Thomas, Buchanan Street, Glasgow.
Cleghorn, Hugh, M.D., Stravithie, Fife.
Cormack, Sir John Rose, M.D., Paris.
1873. Dally, Frederick, M.D., 55 George Street, Portman Square, London.
1864. Davidson, Andrew, M.D., Madagascar.
1868. Davies, A. E., F.C.S., Warrington.
1870. Dick, Thomas, Kirknewton.
1858. Drummond, Captain H., India.
1863. Fair, George, M.D., Buenos Ayres.
1863. Galbraith, George L., Loch Tummel Lodge, Pitlochrie.
1859. Grierson, T. B., L.R.C.S.E., Thornhill.
Handyside, P., M.D., College of Surgeons.
1855. Hector, James, M.D., Dunedin, New Zealand.
1851. Heddle, Professor M. Forster, University of St Andrews.
1849. Hepburn, Archibald, Barwood House, Ramsbottom.
1874. Hitchman, Wm., M.D., Liverpool (29 Erskine Street).
1862. Hargitt, Edward, London.
1872. Hoggan, George, M.D., London.
1861. Home, Lieutenant-Colonel George Logan, Edrom, Dunse.
1860. Hunter, Rev. Robert, Nagpur.
1868. Kennedy, Dr John, Elie.
1850. Lawson, George, M.D., Halifax.
1861. Logan, Robert, Carluke.
1871. Lorraine, J. E., London.
1862. Macnab, Professor W., Queen's College, Dublin.
1858. M'Vicar, Rev. J., Moffat.
1862. Manson, George W., Bengal Staff Corps.
1849. Melville, Professor A. G., Galway College of Science.
1870. Middleton, James, M.D., Strathpeffer.
1854. Page, Professor David, LL.D., Newcastle College of Science.
1871. Paterson, J., M.D., Brazil.

Date of Election.

1878. Prentice, Norman, Otago, New Zealand.
1862. Roome, Major Frederick, Bombay.
1856. Sanderson, R. Burdon, M.D., London.
1857. Shields, Robert, Kentish Town, London.
1861. Stevenson, William, Dunse.
1861. Struthers, Rev. John, Prestonpans.
Swift, Herbert M., Whitehall, London.
1861. Thomas, F. W. L., Captain, R.N., Trinity.
1861. Thomson, Murray, Professor, Calcutta.
1860. Valentine, Colin S., Jeypore.
1861. Wanklyn, Professor J. A., London.
1870. Wilson, Robert, "Daily Telegraph," London.
1864. Young, David.

CORRESPONDING.

Andrew, Rev. J., D.D., Newbury, Fifeshire.
1875. Coughtrey, Millen, M.D., Dunedin, New Zealand.
1858. Duncan, Rev. J., Denholm.
1877. Edward, Thomas, A.L.S., Banff.
1870. Fraser, Rev. Samuel, Melbourne.
1861. Gordon, Rev. G., LL.D., Birnie, Elgin.
1871. Grieve, A. F., Brisbane, Queensland.
1852. Howden, J. C., M.D., Montrose.
1874. Joass, Rev. J. M., Golspie.
1874. Jolly, William, Inspector of Schools.
1871. Macdonald, John.
Mushet, David, Gloucester.
1873. Nicolson, Professor Alleyne, M.D., University of St Andrews.
1867. Robb, Rev. Alexander, Old Calabar.
1874. Stewart, Rev. Alexander, Ballachulish.

HONORARY.

1857. Boheman, Professor C. H., Royal Academy of Sciences, Sweden.
1857. Chevrolat, Auguste, Paris.
1857. Dohrn, C. A., Stettin.
1857. Fairmairé, Leon, Paris.
1865. Frauenfeld, George Ritter von, Zoological and Botanical Society, Vienna.
1857. Gerstaecker, A., Berlin.
1857. Guenée, Achille, Chateau-dun.
1857. Javet, Charles, Paris.
1857. Kraatz, G., Berlin.
1865. Kotscky, Dr Theodor, Zoological and Botanical Society, Vienna.
1869. Lütken, Dr, Copenhagen.
1857. Lacordaire, Professor Theodore, Liege.
1857. Lenectere, Marquis de Laferte, Tours.

Date of Election.

1857. Marseul, L'Abbe de, Paris.
1857. Meneville, Guerin, Paris.
1865. Mannsfeldt, Durchlaucht Fürst Colloredo, Vienna.
1858. Motschoulsky, Count Victor, St Petersburg.
1857. Milne-Edwards, ——, Paris.
1857. Macquerys, Emile, Rouen.
1857. Obert, M., St Petersburg.
1857. Reiche, M., Paris.
1858. Schlossberger, Dr, Tubingen.
1857. Zeller, P. C., Silesia.
1857. Zetterstedt, J. W., University of Lund, Sweden.

LIST OF SOCIETIES

WITH WHICH "PROCEEDINGS" ARE EXCHANGED.

Royal Society [of London].
Royal Society of Edinburgh.
Royal Scottish Society of Arts.
Zoological Society of London.
Linnean Society.
Geologists' Association [of London].
Edinburgh Geological Society.
Philosophical Society of Glasgow.
Manchester Geological Society.
Literary and Philosophical Society of Manchester.
Botanical Society.
Berwickshire Naturalists' Club.
Canadian Institute (publishing the Canadian Journal of Science, Literature, and History).
Academy of Natural Sciences of Philadelphia.
Smithsonian Institution, Washington.
California Academy of Sciences.
Orleans County Society of Natural Sciences.
Royal Society of New South Wales.
Det Kongelige Danske Videnskabernes Selskab.
Christiania Videnskabs Selskab.
Kongliga Svenska Vetenskaps-Akademie.
Naturhistorisk Forening i Kjöbenhaven.
L'Academie Royale des Sciences, etc., de Belgique.
La Société Nationelle des Sciences Naturelles de Cherbourg.
Die Kaiserlich-Königliche Zoologisch-Botanisch Gesellschaft in Wien.
Koninkligke Natuurkundige Vereeniging in Nederlandsch-Indië, in Batavia.
Società Adriatica di Scienze Naturali in Trieste.

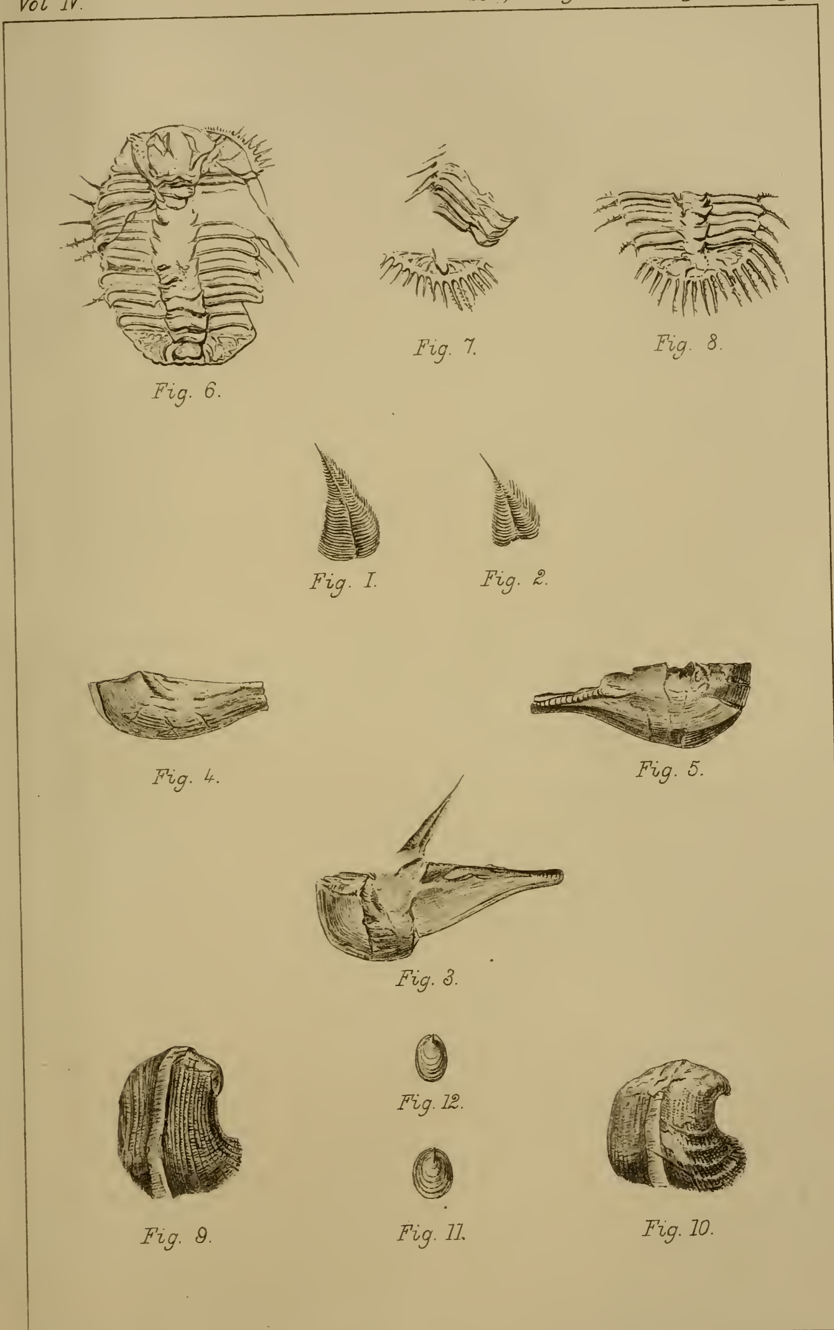
M'Farlane & Erskine, Printers, Edinburgh.

CHART OF LYME BAY (ADMIRALTY).

Shewing Course & action of Wind Waves in its denudation & formation of Chessil Bank.

J.W. Black delᵗ, Edinburgh.

PLATE II.



B. N. Peach, del^t McFarlane & Erskine, Lith^rs Edin^r.

GIRVAN SILURIAN FOSSILS.

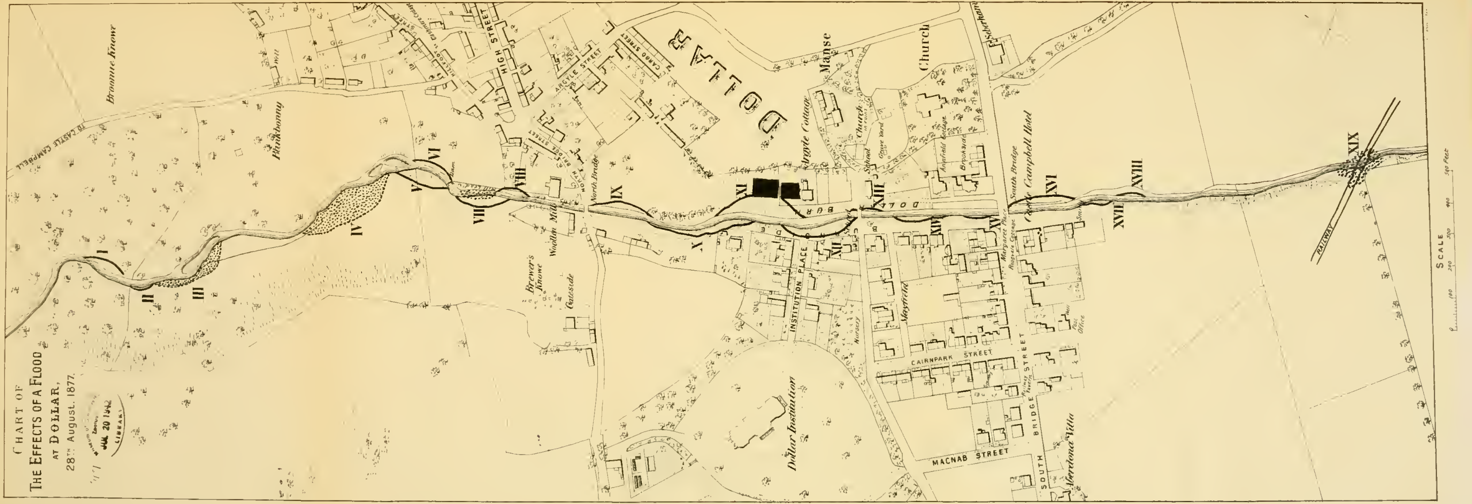


CHART OF
THE EFFECTS OF A FLOOD
AT DOLLAR,
28TH August. 1877.
Brownie Knowe
TO CASTLE CAMPBELL
Blinkbonny
HIGH STREET
ARGYLE STREET
DOLLAR
Manse
Church
Argyle Cottage
School
Grave Yard
North Bridge
Woollen Mill
Brewer's Knowe
DOLL BURN
INSTITUTION PLACE
Nursery
Mayfield
Margaret Place
CAIRNPARK STREET
MACNAB STREET
SOUTH BRIDGE STREET
South Bridge
Campbell Hotel
Post Office
Dollar Institution
RAILWAY
SCALE
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
XIX

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSION 1874–75.

EDINBURGH: M'FARLANE & ERSKINE.
1875.

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSION 1875-76.

EDINBURGH: M'FARLANE & ERSKINE.
1876.

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSIONS 1876-78.

EDINBURGH: M'FARLANE & ERSKINE.
1878.