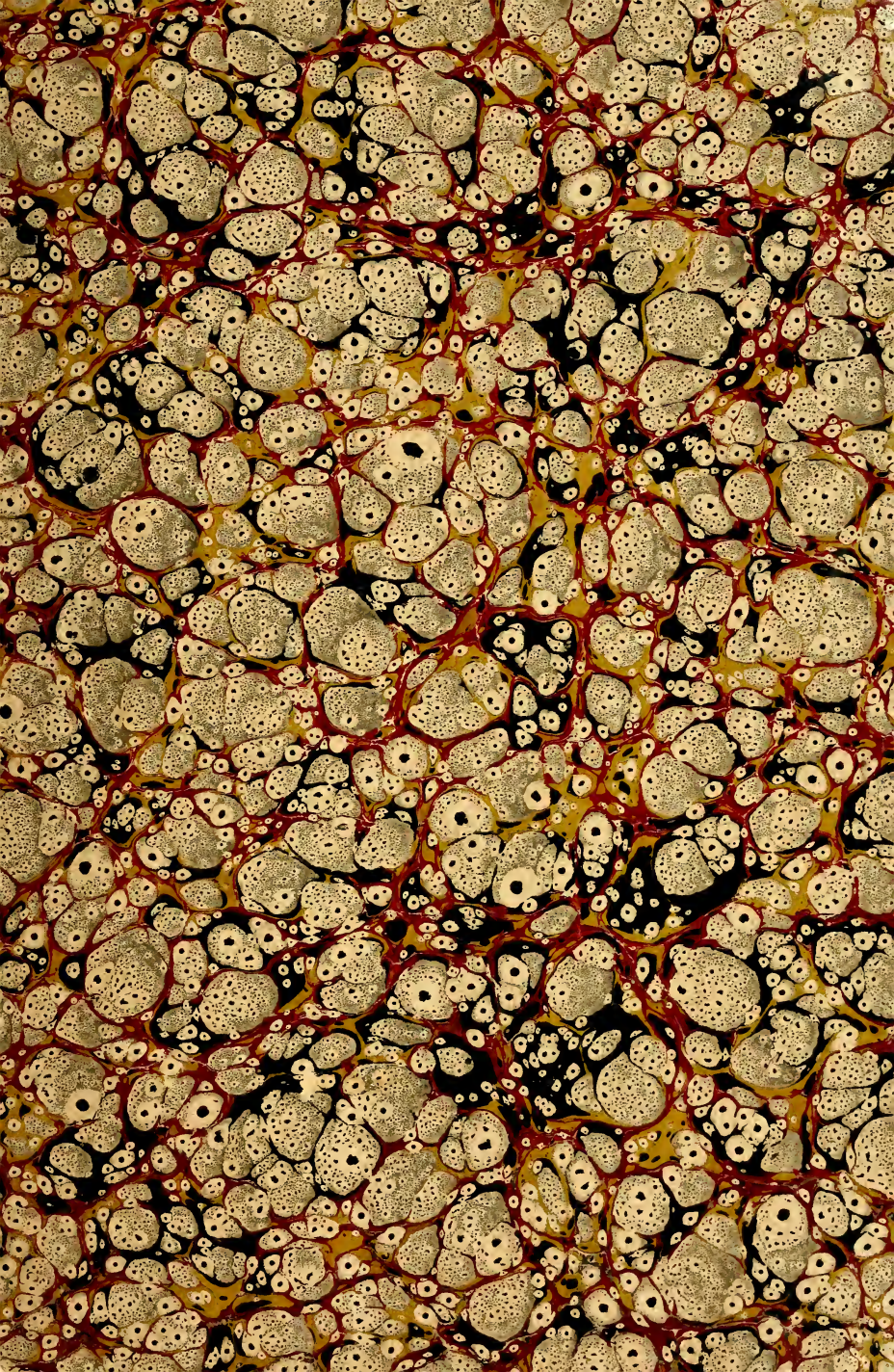


PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY

OF

EDINBURGH.

1880-81.

VOL. VI.

EDINBURGH:
PRINTED FOR THE SOCIETY BY M'FARLANE & ERSKINE.
MDCCCLXXXI.

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSION CX.

Wednesday, 17th November 1880.—Professor DUNS, D.D., President, in the Chair.

The CHAIRMAN delivered the following opening address on "The Beginnings of Scottish Natural Science:"

GENTLEMEN,—The address of your retiring President has, as far back as my recollection goes, with not many exceptions, been devoted either to a *resumé* of the chief points in the literature of a special branch of science, or to a general retrospect of the recent work of the Society, or to biographical notices of members deceased within the year. When it fell to me to open the centenary session of the Royal Physical Society, I sketched somewhat fully the leading facts of our history, using the sketch as a sort of setting for a brief biographical notice of Sir James Y. Simpson, and as the occasion for an attempt to estimate the value of the original contributions made to our *Proceedings* by Dr Thomas Strethill Wright, who at the time was still spared to the Society and to science, and whose discoveries were passing into scientific literature, without being accredited to him.

When my attention was turned to the duty of this evening, I thought the hour might, not unprofitably, be given to some ornithological questions which seem to me to call for re-

view and criticism. Speculative views are beginning to prevail touching the bird's place in nature, the classification of birds, and their migrations, which call for examination. I am afraid we are on the edge of alleged perfect integrations on these questions with insufficient data, and that we are drifting to something like a philosophy of ornithology based on very scant materials indeed. But for several reasons I turned away from this subject. It seemed better fitted for a paper that could be freely discussed than for an address from the chair. I took another topic, and to this I now turn: Books, better than battles, or, indeed, any other feature in the history of a people, indicate the great steps of a nation's progress. Books have their root in, and give expression to, conditions and movements of thought, which, more than mere chronological data, determine the joints of time—historical periods—in a country, or even over a continent. Looking at the wider area from the point of view of our work as Fellows of this Society, I need only name the "Peri Zōōn Historias" of Aristotle, the "Systema Naturæ" of Linnæus, and the "Règne Animal" of Cuvier, around which the whole history of the natural sciences might be grouped under three great epochs. But this history could not be written to any profit, if its materials were isolated from contemporary aspects of thought outside of the domain of these branches of science. Indeed, few things are more suggestive, in tracing the history of any one branch of knowledge, than the complicated inter-dependencies and inter-actions which exist between it and others often wide apart. I might illustrate this very fully from a department with which it is my work to be somewhat familiar. Take one instance, not out of place in the presence of a purely scientific society, when given as illustrative merely. I do not think any one could form a just appreciation of the theological thought of Germany, towards the middle of this century and later, who is ignorant of the speculative views of Lamarck—views which, having given their tone to culture in Germany, passed over to America, where they soon made their mark on theology, ultimately leading to the pantheism of Emerson, and the philosophical deism of Theodore Parker; and on science, giving the biased archæology of Gliddon and Nott,

and the not less biased anatomy of Morton. The same line of remark might be followed in regard to the more limited area of one country—our own, for example. But this is not my intention at present. Besides, it would land me in the heart of discussions wholly alien to our work here. I wish, then, to indicate in outline, rapid, sketchy, rough, and broken, the rise and early progress of the natural sciences in Scotland. These include zoology, botany, and geology, chemistry having a place assigned to it as a most influential factor in each, claiming, at the same time, to rank on its own merits as itself a special branch. In this statement, general review, and occasional criticism, I shall deal mainly with zoology and geology, and with the former more than the latter.

I need hardly remind you, in the outset, that the method of the Scottish school of science has ever been painstaking observation in order to legitimate induction, and induction in order to the discovery of law. In a word, things have been valued by us chiefly for the thoughts that underlie them.

The advantage of linking the present with the past is, that we see the foundations of knowledge—we get a history. Now notwithstanding the great influence wielded by Aristotle's works on mediæval thought, there does not seem to have been any very early practical attempt in Scotland to systematise current forms of the knowledge of nature. Geology, as a definite branch of science, is but of yesterday, though we shall see its beginnings in our country were hinted at more than 500 years ago, but the hints had long to wait for recognition. Zoology more early compacted into systematic form, though its classification long continued of the most rudimentary kind, and its indications of species hesitating and uncertain. The earliest evidences we have of attention being given to the living forms, in the midst of which men of all times walk, are to be found on sculptured stones, on illuminated manuscripts, or in mediæval, or *post-paulo* mediæval chronicles. In these, however, the imagination of the observers is generally more marked than their knowledge of the phenomena observed. Beast and bird, reptile and fish, have rank and a place assigned to them in a system of natural symbolism, whose demands, in the long run, led away from the representation of

existing animals, and took refuge in zoomorphic combinations of mammal and fish, or of bird and reptile; or, not unfrequently, it found expression in the production of impossible forms, whose chief significance is the testimony they bear to the strong credulity or grotesque fancy of those who portrayed them. In so far, however, as these early artists confined themselves to the representation of plant, and bird, and beast with which they were well acquainted, their sketches are often exceedingly true to nature, and of the most spirited kind. From my own knowledge, I can assure you that the chronicles, chartularies, annals, and volumes of correspondence of early times, are rich in information for the working naturalist, and often supply data of an important kind for deductions touching both climatal and industrial conditions in our own country, and also in the western, central, and sub-central European area itself. The "Capitular of Charlemagne," A.D. 812, *De Villis Imperialibus*—an ordinance concerning the management of the royal estates—may be mentioned as literally crowded with illustrative materials.

Besides, some curious information as to the knowledge of nature in our own country might be gathered from other sources. For example, the occurrence of the bones of marine mammals, as seals (*Phocidæ*) and porpoises (*Delphinidæ*), in the refuse heaps of ancient religious houses, is suggestive, when set alongside of recent instances. Thus the kitchen middens of Iona have yielded remains of several cetaceans, in association with the bones of the pig, the horse, the red-deer, and the goat. The marine forms were used by the monks, most likely throughout the year, but were in special repute during Lent, being supposed to be warm-blooded fish! From J. Beete Jukes's "Excursions in and about Newfoundland, 1839, 1840," I quote the following: "The good fathers of the Church, however, either in pure ignorance of natural history, or by a little pious fraud, willing to indulge their flocks during the cold and hardships of a sealing voyage, have come to the unanimous determination that seals *are fish*. . . . I am afraid I rather staggered one man by asking him if he ever heard of any fish that had hot blood and suckled their young?" Jukes adds that he learned afterwards that in the

old rules of the Church seals, otters, whales, porpoises, and all cetacea and amphibia, are classed as fish. We need not wonder at this, when we remember that the flesh of the seal found its way even to royal tables. "So late as the reigns of the Jameses the clerk of the kitchen sometimes notes among the contents of the royal larder, with other strange food, *dimidium phocæ*—a side of seal."

There are some notices in Adamnan's "Life of St Columba" which help us to picture, in very faint outlines, no doubt, the notions of nature current among the leaders of thought in those early days. Adamnan's work seems to have been written in the last decade of the seventh century; yet notices occur in it which shed some light on recent observations. Here is a case in point: In Thompson's "Natural History of Ireland," vol. ii., p. 131, after a quotation from Giraldus as to flocks of cranes (*Grus cinerea*) numbering a hundred, being frequently seen, it is added: "If the bird meant by Giraldus were the true crane, and not the heron, which is commonly called by that name in Ireland at the present day, the stately bird would seem to have been once as common here as it was in early times in Ireland." I think the way in which this bird is referred to shows that it was the crane, and not the heron. In Ireland it is now a very rare visitant. Now, in Adamnan's Life we are introduced to the Saint prophesying the arrival of a crane three days later, on the western side of Hy or Iona, from the north of Ireland (*de aquilonali Hiberniæ regione*), weary and fatigued, having been long driven about by various winds. The winged stranger arrived, and, after a rest of three days, betook itself back to Ireland. We may discard the prophecy, as no more than the setting in which a true observation was placed, and then the incident gives weight to the statement of Giraldus. Again, the Saint visits Skye (*Scia insula*), and enters a dark forest, where he meets a wild boar. Again, when, having to cross the Ness near its mouth, he hears that the place at the time gave shelter to a huge monster, which had slain a man when attempting to swim across. Had a shark found its way to the firth? In the same narrative you get glimpses of salmon-fishing in river and loch—the pre-Waltonians landing occa-

sionally fish of immense size. Then we have Columba so blessing the soil of Hy (Iona) as to free it in all time from reptiles —a condition easily brought about by the increase of the inhabitants, and the growth among the people of industrial pursuits, of which there is clear evidence in the increased attention given to agriculture, and the accompanying success in the form of plentiful harvests. I have referred to the wild boar in connection with Columba's visit to Skye. We have later notices of it on the mainland, which show that it was fast disappearing. In the reign of Alexander III., Edward de Montealto, Sheriff of Forfar, sets down as part of his expenditure for the year four and a-half chalders of corn for the wild boars—*porci sylvestres.* The remnant of the fierce boars of the great Caledonian forest had come to be, as our foxes now are, reared and preserved for purposes of sport. Then we get a glimpse into the natural history of Eskdale so early as A.D. 1200. When the Avenels granted Eskdale to the monks of Melrose, they reserved the game, as hart and hind, boar, roe, falcon and tercel. They were allowed only to trap the wolves, but were strictly forbidden to interfere with the hawks. The very trees on which the hawks usually built were to be held sacred. Cosmo Innes has shown from the "Ayr MS.," written in the reign of Robert the Bruce, that the tod (fox), whitret (ermine), mertrick (martin), wild cat, and beaver must have been very common at that period, because their skins were articles of export. The beaver has long been lost; the wild cat and the cat martin are year by year becoming more rare, and are likely soon to disappear altogether. Once more, the references to the fauna of Scotland in the printed or MS. records, which range from the last decade of the seventh to the second of the 16th century, the period of Boece, might be multiplied; but these may suffice to show that while the higher forms took the attention of the people, no effort was made during that long period to systematise them, and little, if any, attention paid to their structure and habits. The seal, and the dolphin, and the whale were regarded as viviparous fishes (*sunt alii vivipari, ut phocæ, ceti, balenæ*). Bats were observed, but only to be set down as half quadruped, half bird (*medium quid inter*

animalia quadrupedia et volucres vespertilio est). The sponge had been noticed, but it, too, was a transition form (*medium quid inter plantas et aquatica animalia*). We smile at the simplicity of these early observers, in localities far outside of the great lines of thought. But might not these guesses be the steps towards that principle of structural gradation which lies at the root of modern classification? We may say of them what most of us have often had to say of some contemporary workers—We are grateful for your facts, but would rather not have your philosophy. We welcome your data, but would rather dispense with your generalisations. The men of these olden times were, no doubt, quite right when they said that the otter lived equally well either on land or in water; but when they held its place in nature to be alongside of the frog because of this, their inference was absurd (*alii amphibii uti Lutra, Rana, etc.*). Clearly, then, the time at which we have glanced has not much information to give us of any scientific value, though it has much to interest us, as showing how men began to observe. The period was one of comparative haze, under which many good and true things were hidden. What was wanted was warm, strong sunlight to dissipate the haze, and reveal to us that world of beauty, and of order, and of ever active vitality, in all its living forms which lay hid beneath. These men were the heralds of the dawn, but the dawn was not yet, though it was on the threshold; and it began to break in 1527, when Hector Boece, Principal of King's College, Aberdeen, published his "Story and Chronicle of Scotland," a bulky volume, written in Latin, but translated into the Scottish idiom of the upper classes by John Bellenden, Archdeacon of Moray, for behoof of James V., who could not read the original. This work should be interesting to philologists, as an example of the Scottish language of the time, a language which differed so much from the English then current, that it was again translated for behoof of our southern neighbours into the English tongue. But this by the way.

To estimate the references to natural history which abound in Boece's work, we must keep in mind his starting-point. Speaking of himself, he says that "he was singularly addicted

to the study of natural history, and much delighted with such physical curiosities as were most extraordinary and surprising." He expected in natural science a wonderland, and he made it so. Facts were of no value to him, if they linked not themselves on to the weird fancies, in which superstition has its root, and on which it lives and grows. I need not dwell on his record of marvels—his beast which in 1510 emerged from an Argyleshire pool, the size of a greyhound and footed like a gander; his otter which could strike down trees with its tail; his sea-monks, which abounded in the waters around the Bass, but which never appear except as heralds of a great pestilence; his golden mountain in Garioth, with its sheep whose fleeces and teeth were like to burnished gold; or his "claick geese," which seasonally were evolved from barnacles. He even gives instances, quite satisfactory to all who take assertion for proof. Nor need one wonder at this, in view of the imaginary forms which some recent speculatists have thrust in to fill up gaps in the theoretical genesis and genealogy of our higher vertebrates. Nevertheless, "Boece His Story and Chronicle" claims our regard, both because of its references to well-known forms, and because it not unfrequently throws out hints well fitted to make present students stop and consider. I give an example in Bellenden's words: "Of fische is mair plente in Scotland, speciallie of salmond, than is in ony other partis of the warld. And because the procreation and nature of salmond is uncouth and strange, we have inscrit the maner thairof in this buke. . . . And after thair spawning thay grow sa lene and small that na thing appeirs on thaim bot skin and bane, and has sa warsche grist that thay ar unproffitable to eit. Sum men says all other salmond that metis thaym grous lene on the same maner as thay ar. For sundrie of thaym are found lene on the ta syde and fat on the tother." Does this last remark point to the infectious presence of *Saprolegnia ferox* in those early days? Be this as it may, in almost every dozen of infected fish you may find one "lene on ta syde and fat on tother." In addition to information of this kind, the student of his works meets with evidences of the "*mens divinior*"—the poetic spirit, which some affirm to be a characteristic of all true naturalists! Referring to the pearl mussel

(*Unio margaritiferus*, Linn.), he says,—"These early in the morning, in the gentle, clear, and calm air, lift up their upper shells and mouths a little above the water, and there receive of the fine and pleasant breath of heaven" as dew. Pearls were to Boece only dewdrops solidified—a conceit which calls to mind R. Browning's allusion to the sapphire—

> "Stone which dewdrop at first
> (An old conjecture) sucks by dint of gaze
> Blue from the sky, and turns to sapphire so."

Had Boece given us more science, we would not have grudged him these freaks of imagination. The science comes later, though not free from the conceits. Bringing our review down the generations, and noting the joints of time and their characteristic links as we proceed, we come to 1578, the date of the publication of Bishop Leslie's "Description of Scotland," a quarto volume printed at Rome in that year. Leslie keeps, in a great measure, clear of Boece's fables, and gives us a good deal of interesting information relative to our raptorial birds, to grouse, capercailzie, whales, salmon, herrings, etc. But it was not till 1684, the date of Sir Robert Sibbald's "Scotia Illustrata," that zoology as a science—systematic zoology—had a well-defined place in Scottish literature. Yet the efforts, whose records I have thus hastily reviewed, could no more have been dispensed with, than the gathering of loose stones could, if you are to have a compact building of any sort. Much rubbish had been accumulating, but so likewise had much good material. Unskilled hands may have thrown unsuitable stones on the heap, which skilled hands finding there, as if by intention, may have built into the structure; but in good time all this will be put right. The value of the record of these efforts consists in its showing us beginnings, and thereby making clear the indebtedness of the present to the past. Now, I suppose, every true scientific worker owns to the indebtedness; but is there not a tendency to pay off the score in the somewhat shabby fashion of exaggerating the deficiencies of the workers in those olden times, that *our* excellences, if not *our* perfect knowledge of one form and another, might stand out in very bold relief?

Sibbald personally, equally with his voluminous works, is to me full of interest, whether studied from the point of view of his relations to the past, or regarded in the light of his varied surroundings. Yet we have no worthy memoir of a man, who not only bulked largely in the view of his time, but whose works have been as a quarry, and have yielded rich treasures to all who, since his day, have done efficient service in the departments of Scottish zoology, botany, and archæology. It were easy to string together the learned titles of his works, but this would be scant justice to one to whom Scottish science owes so much. We desiderate a biography in which, in fact, the man shall be more than his works, and the works shall be regarded, not from our point of view, but in the light of his time. We want, in short, to know the man himself, not as isolated from other men, but as influenced by the past to which he succeeded, and as influencing the day in which his lot was to live and labour, while he kept in inoculative contact with society, yielding to domestic ties, gladdened in prosperity, or disciplined by the touch of sorrow. In a word, we wish to see him doing the work of earth, and, as we know, doing it well, because himself knowing and cherishing something higher and better. Around this personality we might rally the varied fruits of a life's labour, and bring into organic unity what to many at present seem only the scattered results of random effort. The theme is a tempting one, but neither the present occasion, nor the time at our disposal, admits of it being more than touched here. In a sentence or two the preparation for his lifelong studies may be indicated. Referring to his first session at the Edinburgh University, he says—"It was my fortune to meet Sir Kenelm Digby his Discourse of bodies and the Immortality of the Soule, and with Thomas Anglus his Dialogues *de Mundo*, which I read with great delight, and became a student of the atomestick or crepuscular philosophy." His mother, the heiress of Boyd of Kipps, wished him to study for the Kirk; but, he says, the churchmen "wrote reproachfull discourses against others, and occasioned factions in the State and private families, which gave me ane disgust of them." He took to the study of medicine—"wherein," he says, "I thought I might be of no faction." It is

clear he soon found out his mistake, for he had to record—"There hath been a match of scolding here among some of our young physicians. I wish they did apply themselves more to observation than dispute and inventing of new hypotheses." Again, "There is a hot paper war here betwixt some of the college and the chirurgeon apothecaries." It seems almost true that there is nothing new except what is very old. The characteristics of widely separated generations set themselves side by side. The amiable youth lived to learn that all great ends are reached through toil, and strife, and strong contendings.

Sibbald afterwards studied at Leyden, taking anatomy, among other branches taught by different professors, under Sylvius. "I saw," he says, referring to Sylvius, "twenty-three human bodies dissected by him." He afterwards went to Paris and Angers for some time, and then returned to London, whence, by slow coach stages, he reached York. "I took," he adds, "horses and a guide to Newcastle, and hyred the same guide and his horses, and came over the fells to Jedburgh, and so by Melrose to Edinburgh, the penult day of October 1662." The desire to bring Scotland abreast of lands more favoured by science became to him a strong, overmastering passion, and to this we owe his "Scotia Illustrata," the realisation of the Edinburgh *Hortus Medicus*, which ultimately culminated in our Botanical Gardens, the active and influential part he took in establishing the Royal College of Physicians of Edinburgh, and also his numerous works on natural science, Roman antiquities, and provincial history.

Any estimate of the value and true merits of Sibbald's zoological work would be unsatisfactory, if not unfair, which did not take into account—(1.) That his attention was limited to Scottish natural history; (2.) That it was no part of his plan to deal with the gradational relations of animals,—that is, with systematic classification and their place in it; (3.) That all he had in view was to catalogue Scottish forms, in order that, on the one hand, as a Naturalist, he might make manifest how rich our country is in species, and, on the other hand, as a Physician, that he might indicate the supposed therapeutical value of our plants and animals. Now, when

we smile at the outstanding empiricism in the latter, we should remember not only the absence of a true chemistry in those days, but, even more, the prevalent superstitious views of nature, as in herself the nurse and the healer of all who were willing to wait at her door. And, perhaps, apart from the superstition, it would not be unwise, in our time of numberless specifics, to wait trustingly a little more on nature than we do.

The ideal Sibbald set before him, on his return from the Continent, may not have been a very high one; but, such as it was, he realised it. In any circumstances he would not have succeeded in the statement and illustration of principles. His mind was not of this sort. He had a thirst for particulars, and his records are perfectly trustworthy, so far as they deal with his own observations; but a natural bent at least in the direction of credulity, led him too readily to take statements on trust. But it is not necessary to go back to Sibbald's day for men of this type. They are ever at the door. Looking thus to the time, we need not be astonished to find in Sibbald's work, *Vespertilio* standing, as if a true bird, between *Caprimulgus* and *Corvus*, or cetaceans having a separate group value assigned them under fishes. Yet even here we see juster views appearing, as in all times of transition they do. Thus, having *placed* the "*Ceti*," he proceeds to tell us that in their leading aspects of structure they rank with quadrupeds—the term *mammalia*, it should be remembered, did not come into use till the publication of the tenth edition of the "Systema Naturæ," 1758, up to which date Linnæus himself ranked the *Cetacea* under *Pisces*,—that is, twenty-three years after the first edition of his great work. Yet Sibbald had hinted at their true place sixty-six years previously. In his "Phalainologia," 1692, he says their bones and internal structure are similar to those of terrestrial animals. There is, moreover, a passage in this treatise which shows how far he had broken away from *a priori* methods of study—"Cum antem hæ etiam, non solum apud vulgus, sed nec satis Auctores distinguantur, necesse est ut in varia genera suasque species per proprias differentias et notas characteristicas distribuantur: Quantum scilicet ex naturæ libro (qui unicuique patet et intuenti se ingerit) hoc perspicere licet"—

a passage, it seems to me, not unworthy even of Linnæus or Cuvier! We justly accredit Linnæus with the merit of having first clearly defined and illustrated the zoological terms, class, order, genus, and species. But it is interesting to find words like these in the pages of a Scottish observer who preceded him by so many years. Perhaps, however, the best way to indicate what Sibbald did in this, the systematic department of zoology, is to give a free rendering of his divisions under the class

BIRDS.

A. Large Birds.

I. Terrestrial, or those which frequent dry land.

1. Flesh Eaters; hooked beak and talons.
   Divisions, *Diurnæ*, as Hawks.
   Nocturnæ, as Owls.
2. Grain Eaters; with straight or less hooked beak and talons.

B. Little Birds.

1. Tenuirostres; *a*, Tail of one colour, Hedge Sparrow.
   b, Tail of two colours, Wagtail.

II. Aquatic, or those which seek their food in the water, or near it.

1. Fissipedes; *a*, Waders, as Herons; *b*, Swimmers, as Water Hen.
   c, Slender-billed, as the Stilt; *d*, Short-billed, as the Lapwing.
2. Palmipides; (1.) *Tridactylæ; a*, Wanting the hind toe; *b*, Having the hind toe free.
   (2.) *Latirostres*, as the Swan.

He concludes his chapters on birds with a list of those of whose relations he is ignorant, or of which he may not have any personal knowledge. The first on this list is the "Gare" —"Avis Gare dicto, corvo marino similis, ovo maximo"— the Great Auk (*Alca impennis*), which we know from other sources was rare even in Sibbald's day. In the list of birds a great deal of curious information is given as to localities, habits, and uses, both as food and "physic,' all deserving the attention of young ornithologists.

I need not follow the history of Scottish zoology farther

down. Little, indeed, could be said till we come to 1778, when the minister of Moffat, the Rev. Dr Walker, was appointed as the first professor of Natural History in the Edinburgh University, and almost nothing of true progress after Walker's death, till the publication of "The British Animals," 1828, by Professor Fleming, my predecessor in the New College Chair of Natural Science.

When, after the last meeting of Council, I began the preparation of this Address, it was my intention to sketch the early history of Scottish Geology in the same way of running narrative and surface remark as that of Zoology; but I soon saw that neither my time nor your patience were likely to admit of this. May I recommend the subject to our young geologists? The field is full of interest, and will substantially reward a painstaking, thorough survey. The starting point, at the beginning of the thirteenth century, prepares us for the work of the Scottish alchemists, soon to follow. We get a glimpse not only of the foundation of chemistry, but even of those of mineralogical and stratigraphical geology; because, with all the prevalent empiricism and false method and crude hypothesis of the times, there is associated the record of observations permanently valuable, and, as such, true steps in the history of science—steps connected with great names—as Michael Scott, thirteenth century; James IV., 1488-1513; Sir George Erskine of Invertiel; John Napier of Merchiston, the inventor of Logarithms; Sir David Lindsay, first Earl of Balcarres; Patrick Ruthven, Alexander Seton, and Patrick Scott,—men of the sixteenth and seventeenth centuries. One can almost forget the greedy hunt of these old workers after the "*Lapis Divinus*," and the "*Quinta Essentia*," when we see how near they often were to Baconian method, and with what loving longings they waited at the doors of true knowledge—method and knowledge which we could not have reached, except by being warned by their blunders, and helped even by their small attainments. He is a poor student who despises and kicks away the ladder on whose rungs he has mounted to success. The generation which despises the past will not do much for the future. In such a survey, moreover, one meets with much to let sunshine in on studies,

which have ever a tendency to beget a feeling akin to thoughtful sadness. Indeed, this may be said of all persistent, hard, earnest, intellectual work. So that when Albert Dürer painted his "*Melancholia*" in the midst of the instruments and symbols of science, he gave grand expression to this thought as regards our life-work. It is something, then, to find a field of inquiry in which we not only meet with much knowledge true to nature, but once and again also with incidents which compel a smile, or even a hearty laugh, not generally, however, at but with these men of the olden time. Society is, unhappily, so constituted that science may only expect from it what, with few exceptions, is all it has hitherto got—a crust of bread. Thus our pleasure, when in our pursuits we find that science itself can sometimes (excuse the remark) butter the crust! Take an instance. When James IV. set up furnaces in Edinburgh to search for the Philosopher's Stone, he associated with him a Frenchman, Dr Damian. As we read and inquire, we come on Damian in a new relation, and I had almost said a physical plight. He had made it plain, *a priori* (to himself, at least), that man, had he wings, might fly; and so, having made himself wings, he struck boldly out from the walls of Stirling Castle in the eyes of a crowd. Bishop Leslie gives the result,—"He brak his thee bane." "The weyt thairof he ascryvit to that thair was sum hen fedderis in his wings, quhilk yarnit and covit the mydding and not the skyis." About the best comment, I think, on this, is the fact that his royal master afterwards, as a *solatium*, created him Abbot of Tongland! Again, in such a sketch of geological progress, we would have to pass from the work of the alchemists to the pages of Bishop Leslie, in which, for the first time, we find the description of some surface deposits, coupled with a theory of their origin, and then to the writings of Sibbald, but would meet with little in our survey worth lingering over till 1785, when, in Hutton's great work, the proposition was laid down which served as the foundation for the Scottish School of Geology—"No powers," says Hutton, "are to be employed [*i.e.*, to account for present phenomena] that are not natural to the globe; no actions are to be admitted, except those of which we know the principle."

The appreciation and hearty acceptance of the far-reaching truth in these words will do far more for us, as students of nature, than all the imagination which has recently come to be so much set by as a guide and as an instrument in science. The Damian incident might be a warning! Imagination took the alchemists to the sun and the moon for the origin of gold and silver—

"Sol gold is, and Luna silver we threpe;"

But it signally failed them,—when they sought for these precious metals on the earth!

And now, gentlemen, let me thank you very cordially for having twice done me the honour of electing me to preside over you. I have greatly valued your kindness and indulgence. Without naming the able and accomplished men who are still with us doing yeoman work, and work that will last, in their several departments of science, I feel it a high honour to have had my name associated as President of the Royal Physical Society with those of Captain Thomas Brown, Edward Forbes, Robert Kaye Greville, James Y. Simpson, John Coldstream, George Wilson, John Goodsir, Hugh Miller, Sir John Grahame Dalyell, John Fleming, Thomas Strethill Wright, and others, who in their day rendered signal service to our pursuits. These all have left us a noble example of painstaking, persistent, earnest work—work done in the line of true method. And most of them, as I can affirm from personal knowledge—I speak only of those I knew—held that science is not limited to the discovery of the natural relations of phenomena merely, but that it is no more than her duteous service to set facts in divine relations as well. Their well-known views find fitting expression in the suggestive words of one of the greatest of recent naturalists: "I shall not be prevented," says Agassiz, "by the pretensions of a false philosophy, from expressing my conviction that any manifestation of thoughts is to be considered as evidence of the existence of a thinking being as the author of thought, and an intelligent and intelligible connection between the facts of nature must be looked upon as a direct proof of the existence of a thinking God, as certainly as man exhibits the power of thinking when he recognises their natural relations."

I. *Additional Notes on the Invertebrate Fauna of Lamlash Bay.* By W. A. Herdman, Esq., D.Sc. [Plate I.]

(Read 15th December 1880.)

The present communication deals with the greater portion of the results of about thirty days' dredging during last August and September in Lamlash Bay and its neighbourhood, and is supplemental to the paper on the Fauna of Lamlash Bay which I had the honour of reading before this Society last January.

In referring to publications on the Fauna of Lamlash or the neighbourhood in my previous paper, I omitted to mention two works which I have since met with, viz., a series of papers on the Mollusca of the Firth of Clyde, by the Rev. A. M. Norman, which appeared in the *Zoologist* for 1857-60; and the later edition of Dr Landsborough's "Arran" (1875), by his son Mr David Landsborough, and which contains some natural history lists, including the Nudibranchs found by Alder.

This year I extended the area investigated considerably by dredging down in front of Whiting Bay, and round the outside of Holy Isle. I am still of opinion, however, that the most productive localities are at the north and south ends of Holy Isle and along its western side, especially in the little bay in front of St Molios' Cave. Here, at a distance of from 100 to 300 yards from the shore, and in a depth of 15 to 20 fathoms, the bottom is composed of small stones and dead shells, often profusely covered with Zoophytes and Polyzoa. A dredgeful of these never fails to yield something interesting, such as *Crania anomala, Trichotropis borealis, Lyonsia norvegica, Campanularia gigantea, Aglaophenia myriophyllum, Sarcodictyon catenata,* etc. In this part of the bay were also obtained four species of Holothurians, the only ones I came across.

On the other hand, some of this year's "finds" were dredged on the new ground—for example, *Terebratula caput-serpentis, Eulima polita, Proctonotus mucroniferus,* etc., off the east side of Holy Isle; and *Xylophaga dorsalis, Capulus hungaricus,* and *Goniodoris castanea* off Whiting Bay.

All the old localities in the bay were dredged again, several of them, as "the ground opposite the Farm on Holy Isle," and "along the shore from King's Cross Point towards Lamlash," repeatedly; the latter, at from 10 to 15 fathoms, proving very rich in Nudibranchs and Ascidians.

The muddy and sandy area in the centre of the bay and close to the village was also tried again, but with very little result.

The large *Laminaria* fronds growing on the buoy at the south entrance, and on the wreck off the west side of Holy Isle, were found valuable localities for Zoophytes, Polyzoa, and the smaller Nudibranchs, such as *Eolis despecta*, *Doto coronata*, and others.

Nearly all the species named in my former lists were taken again this year, many of them in greater number and in new localities.

I have not yet been able to examine the Annelides and Crustacea. As I see no immediate prospect of having time to undertake this work, I consider it better to give now the following lists of the additional species found this year, in those groups which I have already gone over, than to delay them till I have time to overhaul the rest. In my former paper there was no list of the Ascidians, as I wished to examine the specimens more carefully, and had not then had time. A considerable number of additional species have been added to the collection this year, including several new to science. As this group is being gone into in more detail than any of the others, the report on it is reserved for a separate paper.

During this summer I gave a good deal of attention to the Nudibranchiate Mollusca, and was rewarded by the discovery of several rare and interesting species, one at least of which is new to science.

For the list of Foraminifera I am indebted to Mr Frederick Pearcey. He has kindly examined for me specimens of the sand and mud from the bottom, the sediment in my bottles, some stones, dead shells, zoophytes, etc., and has picked out and identified the Foraminifera. I only regret I did not bring him home more material.

Mr Pearcey says that the specimens of sand and mud are of different degrees of fineness, but all of much the same composition, viz.: quartz grains, particles of coal, small and broken shells of Mollusca, Annelide tubes (*Serpula*, etc.), fragments of Polyzoa, valves of Entomostraca, fragments of tests and spines of Echinoderms, and calcareous Algæ, the latter being very abundant in some localities.

ADDITIONAL LIST OF SPECIES.

FORAMINIFERA.

I. Imperforata—

Miliolidæ.

Spiroloculina limbata (D'Orb.).
S. depressa (D'Orb.).
Quinqueloculina oblonga, var. (Mont.).
Q. ferussacii (D'Orb.).
Biloculina ringens (Lamk.).
B. compressa (D'Orb.).
Cornuspira foliacea (Phil.).
Miliolina trigonula (Lamk.).

Astrorhizidæ.

Astrorhiza limicola (Sandahl).
Off Whiting Bay, 25 fathoms.

Lituolidæ.

Trochammina sp.

II. Perforata—

Lagenidæ.

Lagena vulgaris, var. *striata* (Williamson).
L. striata (D'Orb.).
Many.
L. marginata (W. & J.).
L. squamosa (Mont.).
Polymorphina lactea (W. & J.).
Many.

Polymorphina lactea, var. *tubulosa* (D'Orb.).
P. compressa (D'Orb.).
P. communis (D'Orb.).

GLOBIGERINIDÆ.

Globigerina bulloides (D'Orb.).
The arctic form.
G. inflata (D'Orb.).

TEXTULARIDÆ.

Textularia sagittula (Defrance).
Abundant and living, often attached to Hydroids.
Bulimina pupoides, var. *marginata* (Defrance).

ROTALIDÆ.

Planorbulina vulgaris (D'Orb.).
In great abundance, usually attached to stones, coal, dead shells, zoophytes, etc., growing to a large size, and often very irregular in shape.
Truncatulina sp.
A few dead shells in 15 fathoms, and attached to Polyzoa and Hydroids from 30 fathoms.
Discorbina globularis (D'Orb.) ?
Living, and often attached to Polyzoa and Hydroids.
Pulvinulina karsteni (Reuss).
Abundant and living.
Rotalia beccarii (Linn.).
Very abundant, living.

NUMMULINIDÆ.

Polystomella crispa (Linn.).
Many.
P. striatopunctata (F. & M.).

HYDROIDA.

Campanulariidæ.

Obelia longissima (Pall.).

Campanularia hincksi (Ald.).

On Sertularians, 10 to 20 fathoms.

C. gigantea (Hincks).

Not uncommon on shells and stones off the south-west side of Holy Isle, 15 to 20 fathoms; also off Whiting Bay, 25 fathoms, on shells.

C. raridentata (Ald.).

On *Diphasia rosacea.*

Gonothyrea hyalina (Hincks) ?

Coppiniidæ.

Coppinia arcta (Daly.).

Opposite St Molios' Cave, Holy Isle, in 15 to 20 fathoms.

Sertulariidæ.

Sertularella tenella (Ald.).

Diphasia fallax (Johnst.).

Sertularia cupressina (Linn.).

Thuiaria articulata (Pall.).

Plumulariidæ.

Aglaophenia myriophyllum (Linn.).

Off the west side of Holy Isle in 15 to 20 fathoms.

Plumularia catharina (Johnst.).

P. frutescens (Ell. and Sol.).

Opposite the farm-house on Holy Isle, 200 yards from the shore, in 10 to 20 fathoms.

ALCYONARIA.

Alcyoniidæ.

Sarcodictyon catenata (Forb.).

On stones and dead shells off the south-

west side of Holy Isle, especially off St Molios' Cave, 15 to 20 fathoms.

ECHINODERMATA.

Every species of Echinoderm mentioned in my former paper, with the exception of *Palmipes placenta*, was taken again this year.

CRINOIDEA.

Comatula rosacea in the Pentacrinoid state occurred frequently during August, chiefly on *Laminaria* fronds, in from 10 to 20 fathoms. I had found no larval forms in 1879, and this year none were seen in September.

ECHINOIDEA.

Spatangus purpureus (Müller) ?

Fragments off the east side of Holy Isle in 30 fathoms, and off the south end of Holy Isle in 20 fathoms.

ASTEROIDEA.

Solaster endeca (Linn.).

South-west of Holy Isle, 15 fathoms, and off Whiting Bay, 20 fathoms.

HOLOTHUROIDEA.

I. Pedata—

Cucumaria hyndmanni (Thomp.).

Off the south-west side of Holy Isle, 20 fathoms; off St Molios' Cave, 15 fathoms.

Ocnus brunneus (Forb.).

Off the west side of Holy Isle in 20 fathoms.

Thyone raphanus (Düb. & Kor.).

Off the west side of Holy Isle, 15 to 20 fathoms.

II. Apoda—

Synapta inhærens (Müll.).

Off the south-west end of Holy Isle in 20 fathoms.

POLYZOA.

Bicellariidæ.

Bugula avicularia (Linn.).

Cellariidæ.

Cellaria fistulosa (Linn.).
Common off the south end of Holy Isle and off Whiting Bay in 20 fathoms; also south-west of Holy Isle in 15 to 20 fathoms.

Membraniporidæ.

Membranipora catenularia (Jameson).
Off the south-west side of Holy Isle in 20 fathoms.

M. lineata (Linn.).

Cribrilinidæ.

Cribrilina radiata (Moll.).
C. punctata (Hassall).

Escharidæ.

Smittia landsborovii (Johnst.).
Mucronella peachii (Johnst.).
M. ventricosa (Hassall).
Palmicellaria skenei (Ell. and Sol.).

Tubuliporidæ.

Stomatopora granulata (M. Edw.).
South-east of Holy Isle in 25 fathoms, and west of Holy Isle in 20 fathoms.

Buskiidæ.

Buskia nitens (Alder).
On Zoophytes.

BRACHIOPODA.

Terebratulidæ.

Terebratula caput-serpentis (Linn.).
A few living specimens off the south-east and east sides of Holy Isle, 30 to 40 fathoms, on a nullipore bottom.

Several dead specimens off the north-east coast of Holy Isle, 25 fathoms, nullipore bottom.

CRANIIDÆ.

Crania anomala (Müller).

Frequent along the south-west side of Holy Isle, especially off "The Dutchman's Rock," in 10 to 20 fathoms; bottom, stones and dead shells. Also off the south end of Holy Isle, 10 to 15 fathoms; nullipore bottom.

Dead valves occasionally on the *Lima's* "nests" off the north-east end of Holy Isle, 20 to 25 fathoms.

LAMELLIBRANCHIATA.

PECTINIDÆ.

Pecten pusio (Penn.).

Off the Lighthouse, Holy Isle, 15 fathoms.

P. septemradiatus (Müller).

Dead valves, east and south-east of Holy Isle, in 25 to 30 fathoms.

P. striatus (Müller).

Dead.

Nests of *Lima hians* are abundant, not only at the north entrance to the bay, but also off the north-east corner of Holy Isle, off the south-east corner, and off the Lighthouse at the south entrance; also in front of Whiting Bay.

MYTILIDÆ.

Modiolaria marmorata (Forb.).

Off King's Cross Point, 5 fathoms.

ARCIDÆ.

Pectunculus glycimeris (Linn.).

Off Lighthouse, Holy Isle, 10 fathoms. Dead valves; bottom nullipore and dead shells.

KELLIIDÆ.

Kellia suborbicularis (Mont.).
Off the north-east end of Holy Isle, 20 fathoms; nullipore bottom.

CARDIIDÆ.

Cardium fasciatum (Mont.).

TELLINIDÆ.

Tellina squalida (Pult.).
Psammobia tellinella (Lamk.).

MACTRIDÆ.

Mactra solida, var. *elliptica*.
Scrobicularia prismatica (Mont.).

SOLENIDÆ.

Solecurtus candidus (Renier).
Dead.
S. antiquatus (Pult.).
Dead. Several specimens.

PANDORIDÆ.

Lyonsia norvegica (Chem.).
Off Whiting Bay, 20 fathoms, and off the west side of Holy Isle, 15 to 20 fathoms.

PHOLADIDÆ.

Xylophaga dorsalis (Turt.).
In wood dredged off the south end of Holy Isle, 10 fathoms, and off King's Cross Point, 5 fathoms.

GASTROPODA.

I. PROSOBRANCHIATA—

CHITONIDÆ.

Chiton hanleyi (Bean).
C. laevis (Mont.).
Off the west side of Holy Isle, 15 fathoms.

FISSURELLIDÆ.

Puncturella noachina (Linn.).
Off the south end and east side of Holy Isle in 15 to 30 fathoms.

TROCHIDÆ.

Trochus montagui (Wood).

LITTORINIDÆ.

Rissoa inconspicua (Alder).
R. violacea (Desmar.).
R. proxima (Alder).

EULIMIDÆ.

Eulima polita (Linn.).
Off the south end of Holy Isle, 20 fathoms.

CANCELLARIIDÆ.

Trichotropis borealis (Brod. and Sower.).
Off the south-east side of Holy Isle, 20 fathoms, and off the west side of Holy Isle, 15 to 20 fathoms.

PLEUROTOMIDÆ.

Defrancia teres (Forb.).
D. gracilis (Mont.).
D. purpurea (Mont.).
Pleurotoma costata (Donov.).

II. PLEUROBRANCHIATA—

BULLIDÆ.

Actæon tornatilis (Linn.).
Off the west side of Holy Isle in 15 to 20 fathoms.
Scaphander lignarius (Linn.).
Philine catena (Mont.).
South-west of Holy Isle in 15 fathoms.

III. NUDIBRANCHIATA—

EOLIDIDÆ.

Eolis drummondi (Thomp.).
Rather common on Zoophytes, old shells,

etc., in 10 to 20 fathoms, especially from Port Lewis to the Cordon, and along the west side of Holy Isle.

Eolis amœna (Ald. and Han.).

Off the south-west end of Holy Isle in 20 fathoms.

E. picta (Ald. and Han.).

Not uncommon in 10 to 20 fathoms, from Port Lewis to the Cordon.

E. viridis (Forb.).

Off the south-west end of Holy Isle, 20 fathoms. Two specimens.

E. glottensis (Ald. and Han.)?

This species was first discovered in Lamlash Bay by Mr Alder. I cannot determine with certainty whether or not my specimens belong to it. They seem nearer to it than to any other known species, but differ slightly from Alder and Hancock's description. The thickened ends of the tentacles, which are so prominent a feature in Alder's figure, are not well marked, but otherwise the shape of the body and processes, and the number of the latter agree with the characters of *E. glottensis*. In the colouring of the branchial processes, however, there is a slight difference; these organs having exactly the tints figured and described for *Eolis cœrulea* (Montagu).

My notes on the specimens when living are as follows:

Body elongated, pale greenish grey, transparent.

Dorsal and *oral tentacles* also pale green, and of much the same length.

Branchial processes stout, set in eight or nine transverse rows, the three anterior rows placed close together; the centre of each process is of a granular dark green

with a dash of blue in it, while the tips are bright cadmium-yellow, separated from the green by a narrow pale yellow band. Two specimens from the west side of Holy Isle, 15 to 20 fathoms.

Eolis pellucida (Ald. and Han.).

In 10 fathoms between Port Lewis and the Cordon.

*E. molios,** n. sp. (Plate I., Figs. 1-3).

Body longish, tapering to a fine point posteriorly, and of a yellowish green colour.

Oral tentacles of the same colour as body, very short.

Dorsal tentacles also yellowish green, short and thick.

Branchial processes stout but not large, dark blue with large cadmium-yellow tips encircled near the top by a narrow brown band; they are set in eight transverse rows having five processes in each, the three anterior rows are placed close together, the rest having greater intervals between them.

Radula formed of overlapping plates, each of which has a central spine and five lateral denticulations, which decrease in size from the centre to the edge (see Fig. 3).

This species I am unable to identify with any previously described *Eolis*.

Two specimens, about 1 cm. in length when expanded, were dredged from about 10 fathoms, off Port Lewis.

In my former paper I marked *Eolis tricolor* (Forb.) as doubtful. The same species occurred again this year several times, and it is certainly *Eolis tricolor*, though the colours are rather more vivid than those of the figures in the British Nudibranchiate Mollusca. Alder and Hancock say, that they have never seen this animal roll itself up like a hedge-hog

* Named after St Molios, the hermit who inhabited the cave on Holy Isle.

as Forbes stated it was in the habit of doing; my specimens performed this feat frequently, especially when I wished to sketch them in the expanded position.

Eolis despecta (Johnst.).

Common on *Laminaria* and Zoophytes attached to buoy at south entrance to bay, and on wreck off the south-west side of Holy Isle.

PROCTONOTIDÆ.

Proctonotus mucroniferus (Ald. and Han.).

South-east of Holy Isle, 15 fathoms.

DOTONIDÆ.

Doto fragilis (Forb.).

Port Lewis to the Cordon, 10 to 20 fathoms; south-east of Holy Isle, 15 fathoms; off Lighthouse, 10 fathoms; off "Dutchman's Rock," 20 fathoms.

D. coronata (Gmelin).

Common in 10 to 20 fathoms from Port Lewis to the Cordon, etc.; also on *Laminaria* attached to buoy and wreck.

DENDRONOTIDÆ.

Hero formosa (Lovén) (Plate I., Figs. 4-6).

This rare Swedish Nudibranch came up in the dredge on two occasions last summer. My specimens differ somewhat in shape, and notably in the number of branchial processes, from those figured by Sars,* and at first I was inclined to describe them as a new species of *Hero;* but I believe it is safer to refer them to Lovén's species, at any rate until more specimens have been obtained.

When the animals were living and ex-

* G. O. Sars — Bidrag til Kundskaben om Norges Arktiske Fauna; I. Mollusca regionis arcticæ Norvegiæ, p. 316, Tab. 28, Fig. 3, *a-d*; Christiania, 1878.

panded (as figured), the branchial processes, of which there are only three pairs posterior to the dorsal tentacles, seemed larger and more branched than those in Sars' figures, which are more like the appearance presented by the processes after immersion in alcohol.

The specimens were about 2 cm. in length when fully expanded. One of them (Plate I., Fig. 4) had the right dorsal tentacle and the branchial process in front of it in a rudimentary condition, while those of the left side were fully developed.

Opposite farm-house on Holy Isle, about 200 yards from shore, 10 to 20 fathoms; and in 10 fathoms, along the shore from Port Lewis towards the Cordon.

TRITONIIDÆ.

Tritonia lineata (Ald. and Han.).

On *Plumularia pinnata* off the south-west side of Holy Isle, 20 fathoms.

POLYCERIDÆ.

Triopa claviger (Müll.).

On *Laminaria*, 20 fathoms, south-east of Holy Isle; and 10 fathoms, off Lighthouse.

Polycera lessoni (D'Orb.).

Off the south-west side of Holy Isle, 20 fathoms.

Goniodoris castanea (Ald. and Han.).

Off Whiting Bay, 25 fathoms.

EXPLANATION OF THE PLATE.

Fig. 1. *Eolis molios*, n. sp.

Fig. 2. One of the branchial processes of *Eolis molios*—*a*, dark blue; *b*, cadmium-yellow; *c*, brown band.

Fig. 3. Dental plates from the radula of *Eolis molios*.

Fig. 4. *Hero formosa* (Lovén), dorsal view of abnormal specimen.

Fig. 5. *Hero formosa* (Lovén).

Fig. 6. Dental plates from the radula of *Hero formosa*, seen from the side.

II. *Early Chapters in the History of the Squirrel in Great Britain.* By J. A. HARVIE-BROWN, Esq., F.Z.S., etc. Part II.—Mythological, Heraldic, and Historical Evidence in Scotland.

(Read 15th December 1880.)

Before proceeding to a new part of this paper, I wish to correct two errors in my last.

For M'Curtius, *read* M'Curtin's.

O'Brien's Dictionary is not the oldest of the three I mentioned, so the absence of the name *iora* in O'Brien's cannot be held as important evidence of the absence of the species in Ireland, when present in the other two.

I may add that Mr R. M. Barrington, in a paper read before the Royal Dublin Academy this year, and which I now hold in my hand, treats very fully of the species in Ireland, and will make it unnecessary for me to trouble you with further details. One point, however, I mention further on, in which I slightly differ with Mr Barrington as to one of his arguments used against the indigenosity of the squirrel, although I certainly am of the same opinion with him on the main issue.

MYTHOLOGICAL EVIDENCE IN SCOTLAND.

Now to continue:—It may be said that evidence of the occurrence of the squirrel in S. Scotland in early times, is to be found in the valuable Runic scroll upon the monumental stone of Ruthwell, where a squirrel is depicted climbing a vine or other fruit-bearing tendril, and feeding upon the clusters of fruit. But I am inclined to think that, like the use of the name *Con*, this knowledge of the animal is an imported knowledge, and does not necessarily prove its presence in these early times. The Rev. Chas. Swainson is quite of opinion that the squirrel might appear upon such ancient monuments. "From its red colour," he writes to me, "it was always associated with the old Northern God Donar or Thor. And in the Edda we read of the great ash-tree Ygdrasil, whose branches embrace the world, on the crown of which sits an

eagle; under its roots lurks the serpent Nidhögr; while between them the squirrel, ever running up and down, seeks to sow dissension."

In the Ruthwell Stone (of which there is an admirable representation in the "N. Stat. Acct. of Dumfriesshire," pp. 221, 227), the inscription round *an Eagle at the top of the cross* is altogether effaced unfortunately; but from other evidence upon the stone, it seems probable that this *Runic* scroll represented in symbolical language, the struggle between good and evil, which idea is further carried out by the later carvings on the other sides of the monument, probably added about A.D. 680 by the early Christian Cædmon, representing the final triumph of Christianity.

It has also been suggested by writers that the widespread custom of hunting the squirrel,* which was sacred to Donar, the Lightning God, may be considered not only as the relic of a sacrificial rite, but also as a mark of Christian hatred to an animal believed to be dear to a heathen deity.

Further evidence is found in the very similar Runic stone at Bewcastle.† There are two squirrels, very cleverly depicted on the east side of the "Bewcastle Stone;" but I doubt if their simple inscription there, or on the Ruthwell Stone, by any means establishes the fact of their former existence in these localities. At one time, no doubt, Cumberland was more wooded than it is now. Remains of a forest are visible a little below high-tide mark, which, as I am informed by Mr Jackson, is composed of "oak, alder, birch, fir, willow, hazel, and I think beech;" but, he adds, "a time impossible to estimate has elapsed since the forest flourished," as there has been a complete change of level.‡ There is, however, the tradition in Cumberland still as regards various districts, that at one time the squirrel could pass from tree to tree for many miles without descending to the ground, as will be found exemplified by the old rhyme—

* Simcock, "German Mythology."

† See "A Memoir on the Roman Station and Runic Cross at Bewcastle," by the Rev. John Maughan, p. 13. 1857.

‡ In this connection read an interesting abstract of a paper read at the annual meeting of the Cumberland and Westmoreland Antiq. Soc., given in *their Transactions*, Part II. (1876-77), p. 68.

> "From Birkenhead to Hilbere
> A squirrel could go from tree to tree;"—

so related of the old Wirral Forest in Cheshire.

The following question naturally arises, at least to me: Is it not possible that the Ruthwell Stone may have been the cause of the introduction of the name *Con* from Scandinavia into Cumberland, and from Cumberland into Scotland? *Cons* are depicted at Bewcastle, in Cumberland, and almost similarly at Ruthwell. The use of the name might become general when understood, though the animal itself was not native to the south of Scotland. The almost precisely similar representations of it in the two stones clearly point to the same origin.

HERALDIC EVIDENCE IN SCOTLAND.

Mr R. S. Ferguson also informs me that "there is a very old painted glass at Bowness, on Windermere, in Westmoreland, where a squirrel and a falcon are depicted one on either side of the Virgin Mary;" but it may be foreign. It is glass of the thirteenth century. Mr Ferguson, in his tract upon "Bowness Church and its Old Glass," p. 22,* is of opinion that "they are probably merely ornamental accessories, without meaning; but they may be heraldic." Hesitatingly I place this representation in close relationship with the Runic records and the myth of the Edda. If heraldic, it is at least a very early use of heraldic arms upon glass. The representation rather appears to me to be an idea borrowed from the Runic scrolls, in combination with the symbolism of the yet early Christianity.

May not the Virgin Mary, supported on either side by a falcon (query—an *eagle*-like bird?) and a squirrel, be held to symbolise the triumph of Good over Evil—a curious mixture of the myth of Ygdrasil and the Christianity of the early portion of the Christian era, first also exhibited in the two-dated Ruthwell Stone, the serpent (or Evil Influence) being now absent or laid aside?

Of the *origin* of the use of the squirrel in heraldry I have

* Separate. Kendal, 1879. (Reprint from *Trans. Cumberland and Westmoreland Ant. and Archæ. Soc.*)

been unable hitherto to glean anything positive; but it is worthy of remark that so many families in the north of England bear it upon their escutcheons, while, as will be seen further on, it is so rarely met with across the Border.

That its use spread rapidly after its first introduction is highly probable. It was in all likelihood first adopted by some *one influential family*, and its first use was probably as SUPPORTERS. The custom of introducing supporters took place somewhere about the middle of the fourteenth century,* *i.e.*, long after the date of the stained glass window at Bowness.

Though many—and, indeed, most—recent writers on heraldry "pooh-pooh" the great antiquity of heraldry, and refuse to go further back than actual proofs take them, I venture to think that there is much well worthy of attention in Mr W. S. Ellis' "Plea for the Antiquity of Heraldry,"† which renders the ancient origin of the use of animals in many cases obvious, and by circumstantial evidence, traces their descent and use to modern heraldry—as well as in his later and more matured work on the same subject.‡

The Earl of Kilmarnock (surname of Boyd) carried two squirrels as supporters§ (Nesbit's "Heraldry," i., 53). Squirrels occur on the seal of Robert Boyd, Lord of Kilpont, in 1575 (Laing's "Scottish Seals," No. 128). This appears to be unique in Scottish heraldry, and, as the Boyds did not intermarry with other families across the border, the first

* Mr Seton, advocate, Edinburgh, informs me, in confirmation of this, that, as far as he is aware, "the earliest Scotch example of regular supporters (two lions) is furnished by the seal of David Lindsay, Lord of Crawford (1345); but towards the end of the thirteenth century there are a few instances of what may be termed *Single Supporters*, as on the seal of Alexander Stewart, Earl of Menteith, where the escutcheon is placed on the breast of a displayed eagle;" but he adds, "the middle of the fourteenth century may be regarded as an approximation to the period when they (*i.e.*, supporters) began to be used."

† "A Plea for the Antiquity of Heraldry," by William Smith Ellis, Esq., of the Middle Temple, 1853. Specially, in this connection, I would recommend a perusal of his concluding remarks at page 20.

‡ "Antiquities of Heraldry."

§ Shield, couche a fess chequé. Crest on a helmet, with mantling issuing from a coronet, a dexter hand with the two last fingers turned down; Supporters, two squirrels (*op. cit.*, p. 28).

use of the squirrel on their coat of arms probably originated in Scotland; but as the use of supporters in heraldry does not probably date back beyond the fourteenth century, this does not point to any very old actual use of the squirrel in Scottish heraldry; but the origin of its use may possibly be traced directly to the Runic scroll at Ruthwell, or to the similar ideas formed of the meaning of these Runic scrolls at that time on either side of the Borders, or to the meanings of similar representations on the stained glass of Bowness and elsewhere.*

At Selby, in Yorkshire, two of the lights in the east window have borders of brown squirrels cracking nuts on sprays of yellow hazel. Also at Dewsbury Church, in Yorkshire; also at Malmesbury Abbey, on encaustic tiles (*Yorksh. Archæ. and Topog. Journal*, Part 19, pp. 333, 346).

With regard to the appearance of squirrels on sign-boards, Mr W. H. Bidwell of Norwich writes me, as follows: "The Three Squirrels" was the sign of an inn at Lambeth, mentioned by Taylor—the water poet—in 1636; and from a

* In the north of England, it also occurs in heraldry, as follows: Wharton (Beverley, Yorkshire), or, on a chev. az., a martlet between two pheons of the field; crest, on the stump of a tree, erased ppr. a squirrel; sejant, of the last collared—or, cracking a nut of the last (*vide* Berry's "Encyc. Heraldica").

The squirrel also occurs on the arms of the following families: Adott, Creswell-Cresswell, Grensted or Greenford, Hartford, Holt, Henfing, Lovell, Nutshall, Orton, Pace, Samuell or Samwell, Scobington, Squire, Stockwood, Stokes, Warren, Wood (*op. cit.*).

In Norfolk, the family of the Cresswells bear squirrels in heraldry, where it occurs both as a charge and crest. But this is originally a Northumberland family.

In Cumberland, the family of Hasell of Dalemain bears three hazel slips; crest, a squirrel feeding on a hazel nut; but that family came to Cumberland from Cambridgeshire about 1660 (?).

The family of Mounsey of Castleton, near Carlisle, bears a squirrel. But they may have assumed it, because the Roll of Caerlaverock says, that "one Mounci" bore a squirrel (*vide* "The Roll").

Lovell—A chevron between three squirrels.

Samwell—Two squirrels sejant, addorsed (sitting back to back).

I repeat:—It is curious to find such a massing together of families who use the squirrel on their arms in the north of England. It would, at least, appear that the earliest use of the squirrel in heraldry was thus made by some leading family in the north of England.

trades token, it appears that in the seventeenth century there was a similar sign in Fleet Street. Probably it was the same house which was occupied by Gosling, the banker, "over against Dunstan Church," where the triad of squirrels may still be seen in the ironwork of the window. Goslings and Sharpe still have three squirrels engraved on their cheques. "Cages with climbing squirrels and bells to them were formerly the indispensable appendages of the outside of a tinman's shop, and were, in fact, the only *live* sign. One, we believe, still (1826) hangs out on Holborn; but they are fast vanishing with the good old modes of our ancestors."

The surname Squirrel, Mr Bidwell—who has paid much attention to place, and surnames in connection with animals —considers, has arisen from having been used as a heraldic badge. "It is so common a name" (*i.e.*, in the south-east of England and the eastern counties,—J. A. H. B.), "that I think it must have arisen from several centres."

Our evidence of their prior existence at localities anywhere in Scotland south of the old Caledonian forest, or, at at all events, south of the Firths of Forth and Clyde, rests upon very scanty materials. The use of the word *Con*, though admitted by Scottish authors, has every appearance of being a word introduced from South Cumberland, otherwise it seems difficult to account for the large extent of intermediate country where the name is not known in the north of Cumberland.

HISTORICAL EVIDENCE IN SCOTLAND.

There is very general silence regarding the species in old family and other records, both in Cumberland and in south of Scotland. It is not mentioned in Lord W. Howard's "Household" Books, just published by the Surtees Society —*tempore* Queen Elizabeth,—nor is there mention made of it by De Vallibus, Baron of Gilsland, amongst tithes given to the "Canons of Lanerwit," as I am informed by Mr Rich^{d}. S. Ferguson (*in lit.* 26, iii. 79). Mr Ferguson also tells me that he knows of no documentary evidence relating to squirrels in mediæval times. Heysham, in Hutchinson's "History

of Cumberland" (1794), says, they "are not common except in the neighbourhood of the lakes;" but they are now (1879) common everywhere in the county.

Returning to Scotland, we find in the "New Stat. Acct." of Berwickshire, the statement, that "the red squirrel is also said to have been at one time a denizen of Dunglass woods in Cockburnspath Parish,* which is the northernmost parish in the county. Again, we are told, that "amongst the animals which have disappeared" from Hounam Parish in Roxburghshire—which parish lies close to the base of the Cheviots—"are *Lutra vulgaris* and *Sciurus vulgaris*;" † but when we come to search for other records upon which these could have been based, we find nothing of sufficient reliability to be forthcoming.

It certainly is curious to find so little of positive evidence of its occurrence recorded. Mr Tate, who has already given us a paper upon the species,‡ considers it doubtful "whether squirrels are indigenous to the Borders, or existed there in former times. There is not," he says, "sufficient evidence that they were exterminated, although the climate is evidently not unsuited to them; and it is possible that the extensive destruction of forests and woods, from the period of the Norman Conquest till the accession of James I. to the English throne, may have caused extirpation of the original breed." Mr Tate believes "that there is not evidence upon the grounds, that, although the skins of squirrels, as well as of cats, foxes, hares, rabbits, kids, lambs, were articles of commerce in the district in 1377, when, according to a charter for pontage, one hundred of them—*i.e.*, squirrels—was charged a toll of one halfpenny on passing over Alnwick Bridge;" still, he says, "such skins may not have been grown in the district;" and I think it can be shown that he has very good ground, indeed, for his expressed doubt, at least as regards the squirrels' skins;§ because, in the accounts

* *Op. cit.*, Berwickshire, p. 299 (1841).

† *Op. cit.*, Roxburghshire, p. 4 (1841).

‡ *Proc. Berw. N. Club.*, 1863-68, vol. i., p. 440.

§ The following is an extract from "Folio Scots Acts," vol. i., p. 667 (new pagination), being export duties levied in the time of King David,

of the Chamberlain, for moneys laid out by him at the marriage of David II. to the King of England's sister in 1328, occur the items: "Et in lxxij supertunicis ('surcoats') de strandlyn, et vij supertunicis de squirrelles," which appear to have been *brought from Flanders to Scotland* by one Peter Machenar, who is paid his expenses, and who is afterwards called "a Flanders merchant." * Later in the accounts of John of Dunfermline, in 1329, similar items appear—*e.g.*, for fourscore "surcoats" of squirrels (*de scorella*), and of *strandlings*, "xxxij et xiiijs," and, "iiij^{xx} supertunicis *scorellorum* et de strandelings, supernis per empcionem. Et de iiij^{xx} supertunicis de *scorellis* et de strandelings per empcionem in compoto precedenti," all of which also appear to be foreign merchandise.†

The Rev. M. G. Watkins sends me the following further interesting note in this connection: "It is curious that a cursory inspection of the 'Ledger of Andrew Halyburton, Conservator of the Privileges of the Scotch Nation in the Netherlands, 1492-1503, together with the Book of Customs and Valuation of Merchandises in Scotland, 1612,' shows no mention of squirrels, though skins of all other Scotch animals (seemingly) are frequently named and priced." [This is part of the same series, published 1867.]

But Professor Newton's opinion—*in lit.*—that "our squirrels could never have had a pelt comparable to that of the animal in cold countries" is sufficient, perhaps, to explain the omission, so that it would be arguing on insufficient evidence if we concluded from these omissions, or from these notices of imported squirrel skins, that squirrels did not then exist in the south of Scotland.

amongst others: "Of peloure of a tymmyr of skynnis of toddis, quhytredys, mertrikis, cattis, beveris, sable, ferrettis, or swylk uthyr of ilk tymmyr at pe, outpassing iiijd; of pe tymmyr of *skurel*, dycht, and letheryt, viii; of ilk otyr skin a halfpenny." The company in which the "skurel" here finds itself, viz.—that of "beveris," points to Scandinavian or Russian origin, and to the *grey squirrel* pelt of commerce.

* *Vide* Chamberlain's "Rolls of Scotland," vol. i., p. 30.

† *Op. cit.* ("Exchequer Rolls of Scotland"), Edw. Stuart and Burnet, published by the Lords Commissioners of Her Majesty's Treasury, 1878. The item "iiij^{xx}"=fourscore. I have been unable to discover what animal the name *strandelings* was applied to.

It is true, that even of late years, our red squirrel skins have been a good deal worn in this country in articles of ladies' dress; but there is no evidence to show that they were ever valuable articles of commerce.

On the other hand, there is no evidence of a satisfactory kind that proves the existence of the squirrel in the south of Scotland, beyond the unsupported statements in the "Statistical Account" above quoted.

Again, in 1642, we find an export duty paid upon squirrel skins of £2, 5s. per 1000 from England.* These, there can be little doubt, were also grey squirrels' skins, which, obtained originally in Scandinavia or Russia, passed through Flanders, became items of merchandise between Flanders and Scotland, paid a toll when passing over Alnwick Bridge—payable to the Scotch king ("Folio Acts," vol. i., p. 667), and were finally exported again from England, and charged an export duty as above.

Regarding the nature of the timber growth which covered the south of Scotland, I believe we do not require to go far out of our way for evidence. We know that it was composed to a large extent of birch and hazel, as shown by the deposits in our bogs and mosses, as well as by recorded historic evidence, and by still existing remains, such as those at Fernihirst in Roxburghshire, and other localities. That conifers also existed there can be no doubt; but we are not aware that there is sufficient evidence of any large tracts of country in the south of Scotland having been clothed densely enough to have afforded shelter to the squirrel at the early period at which we suppose them to have travelled along the coast lines.†

* "A SVBSIDIE, granted to the King, of Tonnage, Poundage, and other sums of money payable upon merchandise exported and imported. According to a Book of Rates, agreed upon by the Honourable House of Commons, and hereto annexed. London. Printed for *L. Blaiklock* and *T. Hewer*, and are to be sold near *Temple Barre* in Fleet Street, MDCLIII."

† Consult in this connection "Timber Growths of Past Times." Geikie, *Trans. Royal Soc. Edinb.* for 1864. Also Cosmo Innes, "Notes on Early Scottish Planting" (*Op. cit.*, vol. iv., p. 446).

Professor Geikie writes me: "I do not think we have satisfactory proof either way"—*i.e.*, for or against the densely wooded nature of the hill-sides in the south of Scotland.

We know that at the present time squirrels migrate from the higher, more exposed, and smaller woods and coppices, to the lower, more sheltered, and larger coverts, on the approach of severe weather.

All our earlier authors on Scottish natural history are silent as regards the species occurring in the south of Scotland. Sibbald wrote in 1684, but only mentions the species as occurring "in meridionalis Plagæ Scotiæ Sylvis."

Sir Robert Gordon also mentions them at a still earlier date—1630—as inhabiting Sutherlandshire;* but we can find no authorities for its occurring in the south of Scotland beyond the two vague records—already alluded to—of the authors of the "New Statistical Account."

The first mention of the species, even by its Gaelic name, dates about the middle of the seventeenth century.†

I cannot find any earlier record of their skins becoming fashionable as articles of dress than those quoted above from the Chamberlain Rolls of 1328.

This is, no doubt, a curious blank in the animal's family records; but, as I will proceed to point out, is not perhaps so very difficult to account for as at first sight may appear. Our only records, vague and uncertain as they are, and, for reasons already shown, not of great value in tracing the earlier movements of the species, still point, by their localisation, to a northward migration along the coast lines, at a period when the interior of the country presented a less genial climate, and when the northern parts of Great Britain were still "struggling into a warmer state of existence," and escaping from a sub-arctic into a more temperate climate.

The only conclusion we can arrive at is, that if ever indigenous to the south of Scotland, the squirrel must have disappeared from it at a very early period, advancing northward to the shelter of the denser forests north of the Firths of Forth and Clyde.

It is, perhaps, not insignificant in this connection to note the local migrations of the species, which, without doubt, took place during the severe winter of 1878-79. They

* "Hist. of Earldom of Sutherland," 1630.

† *Vide* "The Lament for Macgregor of Ruaro."

became scarce in Dumfriesshire at many localities, and elsewhere in the south of Scotland; whereas, in Perthshire, "never had they been so abundant as they were in the winter of 1879-80." They have fled the more exposed places, and sought the shelter of the larger tracts of forest and of larger food supply. I have many correspondents' letters remarking upon these facts; so the severe effects of the winter of 1878-79 produced their mark on the squirrel population of 1879-80.

These considerations certainly lead up to the same results which have been so clearly pointed out by my friend Mr E. R. Alston, in his admirable account of the "Mammalia of Scotland," and from which I quote, as follows:

"A consideration of the relative depths of the channels which respectively divide Ireland and the islands from the mainland of Scotland, would lead us to the conclusion that the severance of the former took place first, and that the Orkneys remained longest un-insulated. An upheaval of about 240 to 270 feet would bring the latter again into communication with Caithness, while it would require a rise of about 300 to 320 feet to reunite the Hebrides with Skye, and of 700 to 900 feet to restore land communication between the various parts of South-Western Scotland and North-Eastern Ireland. Nor does the distribution of mammal life seem to me to contradict such a hypothesis. The absence from the known fossil fauna of Scotland and Ireland of most of the characteristic post-pliocene English animals shows that the northward migration of these forms was slow, gradually advancing as the glacial conditions of the northern parts of our islands decreased in intensity. Thus it is not difficult to suppose that the hedgehog, small shrew, ermine, badger, *squirrel*,* and mountain hare may have found their way through Southern Scotland into Ireland, long before they were able to penetrate into the still sub-arctic regions of the Highlands. Subsequently, when the continued depression of the land had isolated Ireland, and the improvement of the climate had continued, the shrews and voles may well

* But compare remarks under Ireland, R. M. Barrington in *Proc. Ryl. Dub. Soc.*, May 1880.

have found their way northwards along the comparatively genial coasts, before the larger beasts of prey could find a sufficient stock of game. . . . Such a hypothesis of the dispersal of English mammals through Scotland and Ireland appears to me to be the only one which explains the peculiarities of their present distribution, and is likewise in accord with the facts of physical geography."

As far as our present knowledge shows, the squirrel was not indigenous to the central portions of Scotland south of the Firths of Forth and Clyde. If they were indigenous in the south of Scotland at all, they probably passed up along the more "genial coast line" till they reached more thickly and warmly wooded tracts.

As we proceed further north, however, and approach nearer to the southern limits of the old Caledonian forest, circumstances under which we must consider the prior distribution of the squirrel materially alter. It is always easier to prove a positive than a negative; and, I believe, there can be little doubt regarding the fact that the squirrel was indigenous to *nearly* the whole mainland of Scotland north of the Firths of Forth and Clyde.* We have abundant testimony, which will all be brought forward in due course. But before plunging at once into its positive history, there is still a stripe of debatable ground which is worthy of our attention: I mean what may be called the central portion of Scotland, or, in other words, that part of Scotland lying between the Firths of Forth and Clyde, north of the line of the old wall of Antoninus, and between the latter and the Vale of Menteith—in fact, the county of Stirlingshire—a comparatively small area, yet worthy of a short notice in connection with the prior distribution of the squirrel in Scotland.

Mr John Young of the Hunterian Museum, Glasgow, has further informed me, that he "found some years ago a quantity of hazel nuts, all well-grown, and many of them having a neat round hole gnawed on one side, so as to get at the kernels." These nuts, Mr Young tells me, were filling

* Or, in other words, that, in the first instance, a natural dispersal of the species took place, populating these tracts from a much more southern—or, possibly, eastern—centre in Europe before the separation of Great Britain.

the fissures in the limestone strata at Campsie, and "had been brought into that position by water, entering the rock from the higher portions of the hill. The most interesting point about these nuts, however, is, that there are now no hazel bushes on that part of the hill, nor has been in the memory of the oldest inhabitant. In the neighbouring glens where hazel bushes are still found, we find no nuts so large or well grown as those filling the limestone fissures."

Having admitted that other rodents besides squirrels gnaw nuts, of course, we must also admit the possibility here; but it is only right also to consider the circumstances.

First, we may admit, I think, that these large well-grown nuts, larger than those upon bushes growing at the present day in the neighbouring ravines, belonged to a bygone era of hazel growth, and may have been gnawed at a very early date before the juicy kernel had wizened or dried up. But we must also remember the wonderful antiseptic properties of peat, and allow for the possibility that these nuts may have been preserved in the higher peat; and, in comparatively recent times, during floods and rains, have been washed out of their beds and brought into the position in which Mr Young found them; and the further possibility that some other rodents may, in their wanderings in search of food, have found them out, and had a good meal, like Peregrine Pickle, "after the manner of the Ancients." Here is a possibility which only shows, I think, how impossible it is, according to our present lights, to place any real importance upon discovered stores of gnawed hazel nuts as tending to prove a former distribution of the squirrel, or decide as to the species which fed upon them and gnawed the holes. Such a question opens up many other points of interest.

However, it may just be worth passing notice to mention that there is some shade of reason for believing that the species may have populated as far south as this limit. There is good reason to believe, that for a considerable distance south of the southern limit of the old Caledonian pine forests, a country clothed with oak groves extended. We have abundant evidence of this in the peat-mosses of the Vale of Menteith, which, it is believed, were contiguous to the pines,

and we find unmistakable traces of oak stumps over many parts of the central Stirlingshire hills. Topography even is not without its teaching in this connection, for we have, above the present town of Denny, a range of hill called at the present time "The Darrach," signifying "a place full of oaks," and forming a continuation with the Campsie Fells. The probability is—nay, almost the certainty is—that a continuous great oak forest stretched south from the edge of the Caledonian pines to the Campsie Fells. This is no great distance either in a direct line as the crow flies, or, shall we say, as the squirrel travels. If so, what more likely than that our little friend should sometimes find a change of diet desirable; and, as indeed he does at the present day, make annual migrations to feed on the plenteous supply of what he loves so well—the acorn and the hazel nut, or beech-mast? It may be said, "but this is mere hypothesis." Granted at once; but still I hold it is one worth advancing, and not without its points of interest connected with the former distribution of the squirrel in Scotland.

To sum up: My present idea is, that squirrels following the coast districts as they advanced northward, avoided the colder interior of the south of Scotland, but spread more generally over the interior north of Forth and Clyde, where they found better shelter, and pine forests to protect them from the weather. That, in the time of harvest and the ripening of hazel and other food, local migrations took place, but to no great distance south of their winter home; to what exact distance, we cannot now say with certainty. We have evidence of similar local migrations at the present day influenced by change of seasons and food supplies.

We now begin to tread on firmer ground, however, and in bringing forward all the evidence I have been able to collect, I believe the most satisfactory arrangement is to enter the various items chronologically under each county. Beginning, then, with Dumbartonshire—having already disposed of Stirlingshire—we can, I think, dismiss it in a very few words.

Dumbartonshire.

Squirrels must have been extinct in this county long prior

to 1791, if indeed they ever were indigenous, as no mention is made of them in a very full and careful list of the animals of Luss Parish, in the "Old Statistical Account."*

We must not be misled, either, by the passage in the "New Statistical Account" of the parish of Row, which states that "amongst the animals which have become less common in many places, there are occasionally found the roe and the squirrel," etc. These do not indicate the former distribution, but are no doubt fresh arrivals, as squirrels reappeared in Dumbartonshire at Luss in 1831, as I am informed by John Colquhoun, Esq.

Argyleshire.

It is well known that the district about Glenorchy and eastward, as well as much of the country around the north end of Loch Awe, and probably an even more extensive district, was covered with extensive woods of pine and oak,† which were subsequently burned down by order of the Government, in order to rid the country of wolves.‡ There was an extensive forest also in Glen Etive, continuous with that

* This list is one of the fullest given in any of the numerous accounts of the parishes by the clergymen, and, from internal evidence, appears to be singularly correct and reliable. The author was the Rev. John Stuart, minister of Luss, a very eminent Gaelic scholar, who translated the Scriptures into the Gaelic language, and also a learned botanist and naturalist, of whom we find honourable mention made in Lightfoot's "Flora Scotica," and who accompanied Lightfoot in his tour, and who is the authority for the Gaelic names in Pennant's "Caledonian Zoology." A connection informs me that people of kindred tastes came great distances to visit him when at Luss. He was a native of Breadalbane.

† See also Stuart's "Lays of the Deer Forest," vol. ii., pp. 231, 232.

‡ In the district there appears to be a belief current that the reason of the destruction of the woods was not really so much to get rid of wolves and wild beasts as to prevent an over-drug of timber in the market. The company which is understood to have purchased the timber, after cutting and floating away, *via* Loch Awe and the river Awe, all that they required or found it profitable to cut and remove, set fire to the remainder, to prevent other later comers from overcrowding the market. This tradition was related to me by a very intelligent boatman on Loch Awe; and he further told me that his great-grandfather "remembered when all the country around Loch Awe was covered with pine woods. This," he continued, "would be quite two hundred years ago." Some remains of this old pine wood may still be seen upon the slope of Ben Cruachan, above the Pass of Brander, and upon the islets of Loch Awe.

above referred to. Appin and Lismore were always well wooded tracts, so it will be seen that Argyleshire was at an early period suitable for the safe harbourage of the squirrel, as well as of other wild animals. It is not surprising, therefore, to find an unusually perfect chronological chain of evidence regarding the squirrel in Argyleshire.

Sibbald wrote in 1684—"Sciurus . . . in meridionalis Plagæ Scotiæ Sylvis reperitur."*

Alastair MacDonald, the famous Jacobite bard of Argyleshire, thus speaks of the squirrel in his poem of "The Bark of Clanranald," which is justly considered his masterpiece:†

"*xv.* Six [men] were chosen as a reserve, in case any of those named should fail or be carried overboard by a sea, so that one of these might take his place.

"Let six rise now, quick and ready,
Handy, lively,
Who will go, and come, and leap
Up and down her,
Like a hare on mountain top,
Dogs pursuing.
Who can climb the tight, hard shrouds
Of slender hemp,
Nimbly as the May-time squirrel
Up a tree trunk."‡

In 1741 MacDonald also notices the Gaelic name of the squirrel—*Feòrag*—in his "Gaelic Vocabulary," and is the second author who does so.

1760-1780.—"MacIntyre, another Gaelic bard of note," as Rev. A. Stewart informs me, "who lived in Glenorchy,

* "Scotia Illustrata." "Hist. Animalium in Scotiæ."

† A. MacDonald composed his descriptive poems between 1725 and 1745, about which time he was resident "on the farm of Corrie-Vullin, at the base of Ben Hiant, adjacent to Castle Mingary," in Ardnamurchan. He was buried with his kindred on Eilan Feoinain, in Loch Shiel. I am indebted to Rev. Alexander Stewart and Mr James Macpherson for information and references in this connection, and to the latter gentleman for the above translation by Sheriff Nicholson. The title of the poem here quoted is "Boennacha Luinge," *i.e.*, "The Blessing of the Galley or Bark [of Clanranald]."

‡ Literally, "Nimbly as squirrels of the May-time (can climb) up a tree trunk of the dense wood," *e.g.*, "*Cho grad ri feoragan Ceitein: Ri Crann* RO-*choill*," RO as a prefix meaning *very, exceedingly:* ro-choill, a *very* wood, a *true* wood.

speaks of squirrels, as if he were familiar with them, in a satirical poem on a tailor that had offended him. MacIntyre died in 1812. His poem on the tailor was composed long before his death—say 1760 or 1780."

1790.—The "Old Statistical Account" records that, "The squirrel is now become very rare, if not totally extinct, in Lismore and Appin;" * but Dr Fleming, writing in 1819, informs us that "squirrels were rare in Argyleshire, in these woods where they had abounded some years before," referring to about the same date—about thirty years previous, viz., 1790.†

1812.—Their presence is still testified to at this date by Professor Walker, who writes: "Habitat sylvis præsertim coryletis. In sylvæ Lornæ superioris, antehac copiose, nunc rarior." ‡

1809-19.—And the Rev. A. Stewart, Nether Lochaber, informs me, that "an old man, only lately deceased, told me that in his younger days—say sixty or seventy years ago (1809-19), the squirrel was not uncommon in the woods about Appin House." §

1839.—The Rev. A. Stewart also writes to me, that "about twenty-five years ago I saw more than once a rudely-stuffed squirrel in the inn at Shean Ferry, then occupied by one Ewen Cameron, who, I think, is still in life; and this specimen was said to have been shot or captured some ten or twelve years previously—say about forty years ago (1839), in the woods about Appin House."

In 1842, in the "New Statistical Account" of Argyleshire, squirrels are spoken of as formerly existing and abounding, "but now extinct."

We have here excellent reason for believing, from the chronological sequence of the records, that the species lingered till a very late period in Argyleshire. Indeed, so closely related are the records of Dr Walker in 1802—his "nunc rarior" in the district of Lorn—with the "not un-

* *Op. cit.*, vol. i., p. 487.
† *Edinburgh Magazine*, iv., p. 507, June 1819.
‡ "Essays on Nat. Hist.," 1812, p. 498.
§ *In lit.* ‖ *Ibid.*

common" in the *more northern* district of Appin, and *more restricted* area of "the woods around Appin House" of the old man, interviewed by the Rev. A. Stewart, that we may safely, I think, consider that they lingered at least till 1839 or 1840, when Ewen Cameron of Shean Ferry captured or killed his specimen which the Rev. A. Stewart saw at the inn—and this conclusion, perhaps, in the face of the evidence offered by the "Old Statistical Account," with its "now rare, if not totally extinct, in Lismore and Appin" in 1793. We cannot, however, I think, put aside the evidence of the "New Statistical Account" with its "but now extinct" in 1842. It is a positive statement, and we have no other later dates which will confute it. Our next date evidently belongs to the history of the extension from centres of introduction, as will be shown in the second part of this essay (*vide* under Argyleshire, next part, *infra*).

Perthshire.

The squirrel is referred to in our oldest and most popular Gaelic song, viz.—"The Lament for MacGregor of Ruaro," which may safely be dated as before 1650, or the middle of the seventeenth century. Mr James MacPherson, to whom I am indebted for calling my attention to this, states: "That the 'Lament' was composed during the proscription of the hapless Clan Gregor, is proved beyond dispute by the words of the 'Lament' itself; and their proscription dated from 1603; but we know, moreover, from other sources, that the MacGregors of Ruaro, commemorated in the song, have been extinct for at least two centuries, so that the date of its composition may be pretty confidently set down as before 1650, or the middle of the seventeenth century." The bard says:

"Ge ralamh an fheórag,
Gheobhar seól air a faotuinn."

Tho' nimble the squirrel,
It may be captured with patience.

lines composed, be it remembered, a century before there was a thought of the artificial planting of trees on a large scale;

and it follows, as a conclusion from which there is no escape, that the squirrel must have been a denizen of the native woods in the country of the MacGregors, which then comprehended the districts of Menteith, Breadalbane, Strathtay, and Rannoch, all in Perthshire. Ruaro is in Breadalbane; and in Rannoch was, and, I suppose, still is, the famous "Coille dubh Raineach," one of the remnants of the old Caledonian forest, which had often, doubtless, proved a safe hiding-place in times of danger.*

These forests formed an almost continuous stretch of old wood, with those mentioned under Argyleshire.

Aberdeenshire.

There is no mention of the species whatever in the "New Statistical Account" of Aberdeenshire (1843); and even the "Old Statistical Account" is perfectly silent on the subject. *If present at that date at all*, it must have been surely next to unknown—one would have thought—or some mention of it would have been made by some one of the Old Statistical writers. On the other hand, it is quite possible, though, I think, hardly probable, that it might have lingered on without any notice of it being taken by the writers of either of these accounts. In the same year that the "New Statistical Account" was published, Macgillivray wrote in the "Naturalists' Library," after indicating its general distribution in Scotland at the time, as follows: "In many districts is of rare occurrence. . . . In the northern districts it appears

* Other references to its mention are as follows:

"Dh'fhas mo chridhe cho eibhinn
Sgŭn leŭman mar an *fheorag.*"

So joyful grew my heart,
That like the squirrel I could leap.

(Second general collection of old Gaelic "Poems and Songs," published at Perth in 1786.)

"Struagh nach robh un mar an fhaolinn,
'Na cho caol ris an *fheorag.*"

Would I were like the sea-gull,
Or the squirrel so slender.

(Old and unpublished song—"Mairi Nigh'n Doumhuil," Mary, the daughter of Donald—taken down by Mr MacPherson from recitation of a native of Badenoch.)

to be unknown," which statement was published without comment by Sir William Jardine.*

In 1853 Macgillivray visited Braemar, and there he could find no trace of it, though he "not only looked for it, but made inquiries respecting it of various persons qualified to give correct information. Mr Cuming had never seen or heard of it; nor had any other individual of whom I asked;" but he adds: "Sir William Jardine says it also occurs on the Don."† This statement of Sir W. Jardine's may very likely have been called forth, owing to the statement in the "Naturalists' Library" above quoted, and have been the result of further inquiry since that time; but I have failed to find it recorded anywhere amongst Sir William's writings, so probably it was orally supplied.‡

Mr George Sim of Aberdeen, who has supplied me with much useful and interesting material for this county, writes to me as follows: "I, of course, cannot say when the squirrel first made its appearance on Deeside, yet I am satisfied it must have been prior to 1853, and I think Macgillivray not having heard of it may be accounted for in this way: Until lately it was scarcely known by the name of squirrel, being usually called ferret, foumart, or futteret, by the country people. Even now, when it is much more common, it is often so called. And since Macgillivray did not see it himself, any inquiry respecting it under its proper name would not have been understood." In reply to further inquiry, Mr Sim assures me that these erroneous names are often (indeed commonly) applied to the squirrel by country people who bring him specimens for stuffing at the present day.

This argument, however, I can hardly bring myself to accept, because Macgillivray distinctly says he "made inquiries respecting it of various persons *qualified to give correct information.* Mr Cuming had never seen or heard of it, nor

* "Nat. Library," vol. vii., p. 233.

† "Deeside and Braemar," p. 390.

‡ Very probably had Macgillivray had the opportunity of revising his own proofs, which he had not, as the work was a posthumous publication, he would have supplied further information as to this record.

had any other individual of whom I asked." And, even though the most correct are liable to err, I can hardly conceive that had the species been present in those portions of Braemar and Deeside which Macgillivray traversed, that such a prominent, easily described and identified species would have escaped the notice of all; nor do I think would such a careful naturalist as Macgillivray be likely to be led from his inquiries, merely by these erroneous local names.

As will be seen further on, however, there is some reason to believe that the squirrel may have lingered in the higher parts of Don, as the records of its lingering in Strathspey, though not actually continuous, very nearly approach to being so; but the evidence otherwise is decidedly against its continuous presence in Upper Don. A correspondent on Don-side informs me that "the oldest inhabitants have no traditions regarding it. I am sure it was extinct in this district until about twenty years ago; they came up Don-side. There is no place in the neighbourhood of the name of Feòrag."

That the country must have been eminently suited to its requirements in past times there can be scarcely any doubt, for even at the present day we find very abundant indications of the native pine forest reaching far up the hill sides, almost, in one place, to the immediate base of Ben Muic-dhu; and, perhaps, nowhere in Scotland will we find such extensive traces of the old Caledonian forest as we do among the hills which cluster round the valleys of the Dee and Don. The Gaelic topography of the district, which has retained its purity of pronunciation almost intact in the Upper parts of Dee, also teaches us something of the limits of the old forest in past ages, for we find the "Glen of the fir-trees"—Glen Guithsach—far away on the shoulder of Cairn Toul, and stretching away beyond, over the ridge, the great forest of Rothiemurchus extends into Strathspey.

The occurrence of a locality called *Carn Feòrag* cannot, perhaps, alone be accepted as evidence of its early presence with any degree of certainty. The name Feòrag, however, was well enough understood by the Highlanders of Braemar, where topography is believed to have descended in its Gaelic purity.

Macgillivray informs us that in the interval between 1811 and 1853, "the greater, and by far the finest, parts of the Braemar pines were sold and cut down." * It is, therefore, perhaps all the less probable that the species would linger here unnoticed. A large portion of the forest in Glen Tanar appears to have still existed about 1813. At that time it contained "almost innumerable trees of such magnitude as would be fit for masts of the largest size," etc.†

Inverness, Nairn, Elgin.

The Rev. Lachlan Shaw,‡ in his "History of the Province of Moray" (1775),§ was the last to chronicle the squirrel as lingering in that district. He says—"There are still in this province foxes, badgers, and *squirrels*, weasels, etc.;" and he tells us further,—"The squirrel is a pretty, sportive, harmless creature; it is a kind of wood wesel—haunts the fir-trees. If you toss chips or sticks at it, it will toss pieces of the bark back again, and thus sports with you. If it is driven out of a tree, and skipping into another, finds the distance too great, it turns back to its former lodge, its bushy tail serving as a sail or wing to it."

Pennant also mentions it as occurring on the Spey,‖ more than a hundred years ago. He says it is "scarce in Scotland; a few in the woods of Strathspey."¶

On Speyside, or the *lower* reaches of the river, there certainly is every reason to believe it became extinct. The Rev. Geo. Gordon says—"Squirrels were undoubtedly known at an early period in Strathspey, where it is said their num-

* "Deeside and Braemar," p. 136. See also under "Extension in Aberdeenshire," next part, *infra*.

† Daniel's "Rural Sports," Supplement, p. 312.

‡ The Rev. Lachlan Shaw was minister of Kingussie, and resided near the primeval forests of Glenmore and Abernethy, in Strathspey.

§ Second edition (1827), pp. 205, 206.

‖ Lightfoot's "Flora Scotica"—Sketch of Caledonian Zoology (1777).

¶ Mr Gordon informs me of the following recognised divisions of the valley of the Spey. "From the mouth to Lower Craigellachie it is called *Speyside*, between *lower* and Upper Craigellachie it is called *Strathspey* (Abernethy lies in this portion), and what lies above Upper Craigellachie goes by the general name of Badenoch."

bers were much diminished by a series of severe winters.* I am certain," he continues, "that squirrels were not known in the lower or northern part of Elginshire, or on Speyside, at least, from 1810, until the recent immigration from the west;† and I do not find any record of them being here after Shaw's day. They were not met with on the lower reaches of the river until after they had spread eastward from Cawdor (in Nairn), and Altyre (Moray) to the neighbourhood of Elgin."‡ He further remarks—"It is certainly remarkable that these animals should have disappeared for so long from a district" (referring to Moray and Inverness) "where there must always have been sufficient wood to shelter them,§ and where of late years they have spread so vigorously and extensively."

* After passing through a winter of unusual severity, 1878-79, our thoughts are not unnaturally turned to consider some of those severe winters which have occurred before. It is not long since a writer in one of our Scottish daily papers gave a *resumé* of these; and it is not, perhaps, without some significance in this connection, that two of the most terrible occurred just about the times between which it may be supposed the squirrel became scarcer or extinct. One was in 1740, and it continued for *five months*, and "destroyed vegetation of all kinds over wide districts of country." The next occurred in January 1795, when thousands of sheep were lost, and a number of shepherds perished. In 1788-89, 1794-95, 1797-98, the mean temperature was equally low with that of 1878-79. It is this succession of hard winters which one of my correspondents alludes to. Various reports have also reached me of the decrease of late of squirrels at many localities in Scotland, which decrease is usually ascribed to the severe winter of 1878-79. Some of these will be found recorded in this essay under Dumfriesshire, and also in a paper by me, "Ornithological Journal of the Winter of 1878-79, etc.," in the *Proc. Nat. Hist. Soc.*, Glasgow, 1879, p. 142. The decrease here, however, is often counterbalanced by as rapid an increase in other districts, pointing to migration as the result and not deaths, outlets for migration being now more numerous than they were before planting became general in Scotland.

† Referring to the extension of range eastward from Beaufort Castle centre subsequent to 1844—see under "Extension from Beaufort centre," next part, *infra.*

‡ *In lit.*

§ On the banks of the Spey "so late as the year 1728, masts of fifty and seventy feet in length were procured for the navy," as we are informed in Campbell's "A Journey from Edinburgh through North Britain," 1811 (the first edition was issued in 1802), vol. i., p. 42. At a later date, according to Dick Lauder ("Account of the Great Floods of 1829," p. 203), viz., 1730-37,—the York Building Company purchased a portion of the forest of Abernethy for £7000, and worked it till as late as 1737. The ancient forest

Mr Knox, speaking of their disappearance and the causes of it, suggests that "martens (which, it is well known, was an abundant species 'during the first half of the present century') may have assisted in their extinction; and the rapid increase of the squirrel during the past thirty years," Mr Knox, writing in 1872, considers, "supports this supposition, martens being now more kept under, and gamekeeping being more general." *

But while it appears evident enough that the squirrel became extinct on Speyside, it is not quite so clear that it did so in Badenoch and Strathspey. Macgillivray seems to have had some suspicion of their lingering there, and in the valley of the Don in Aberdeenshire; but it does not appear that he was aware of the introduction at Beaufort in 1844. Writing in 1853, he says, "it occurs even on the Spey;" † the fact of his not alluding to the introduction almost conclusively shows that he did not know of it.

Mr James MacPherson gives me satisfactory evidence of the very early appearance in Strathspey and Badenoch. He has taken much interest in the subject, and been at great pains to obtain for me the most accurate information. He writes as follows: "Malcolm MacDonald, master mason, aged about seventy, born in the parish of Alvie, and now residing on the Belleville estate, says, that he first saw the squirrel at Belleville in 1828 or 1829. Remembers the occasion very well, and is quite sure of the date. An animal, at first supposed to be a polecat, was observed by some of the workpeople in a tree at the mill-dam between Belleville

reached into Badenoch as far as Kingussie, as may be gathered from the Gaelic origin of the word—Kingussie, *i.e.*, *Ceann-quithsach*, or "The head or extremity of the Fir-wood" (*vide* Robertson's "Gaelic Topography," etc., p. 405); and much information regarding the old Caledonian forest will be found in the notes to "The Lays of the Deer Forest," vol. ii., p. 219, *et seq.*, which it would be well to consult in this connection.

* *Vide* "Autumns on the Spey." Gisborne appears to have been impressed by a similar conviction as regards the wild cat:

> "The tawny wild cat, fiercest of the beasts
> That roam in Britain's forests, wont on high
> To seize the rapid squirrel."
>
> —"*Walks in a Forest*," p. 48.

† *Op cit.*, p. 390.

House and the Mains. A gun was fetched, and the animal shot. This, he believes, was the first squirrel seen in the Belleville woods, although, after that date, they became familiar, and increased very rapidly." The same person "believes the patch of wood at Dalwhinnie to be about sixty or seventy years old. He stayed at Dalwhinnie for some time in 1824, but never saw or heard of a squirrel in the plantation."

Mr James MacPherson himself states his opinion, that squirrels did not become extinct in Inverness-shire, and he remembers them as numerous about Belleville "thirty-five years ago," say 1844—*i.e.*, the same year that they were re-introduced at Beaufort; and, he adds—"and I do not recollect having ever heard of them spoken of by old people as *strangers*, although I am certain it cannot always have been so in that precise locality. The Craigbhuie was planted with fir, I should suppose, about 1790 or 1795, and twenty years later would afford an eligible settlement for prospecting colonists from Rothiemurchus. . . . About the same time, immediately beneath the Craigbhuie, the more ornamental spruce and larch were also introduced;" and other strips and plantations of different kinds of woods formed "an almost unbroken woodland communication with the forest of Rothiemurchus and Glenmore, and so on down Strathspey."

The fact of their being present so early as 1829, and numerous so early as 1844 at Belleville, certainly points either to one of two alternatives—either, as he suggests, they did never become actually extinct, and were resuscitated by the new planting which took place under the directions of, and on the extensive property of, Sir J. Grant of Strathspey—which, we are told, along with those of the Duke of Athole and Lord Breadalbane, "would far overbalance in extent those of any other private proprietor perhaps in Britain," all of which plantations were performed betwixt the years 1777 and 1817;—*or*, the squirrels had reached north from the Dunkeld Restoration, *via* Kingussie and Glen Truim, and by Dalwhinnie, in an incredibly short space of time, taking the bare and elevated nature of the country into consideration, and the great extent of unsheltered moor over which they would require to travel.

But it would appear to be quite against this line of approach, that the earliest squirrels we can hear of in Aberdeenshire came into Braemar from Forfarshire at Glen Tanar and Invercauld in 1857, and very soon after appeared at Old Marr Lodge, near the Linn of Dee, and about the same time in Glen Muick.* Having been long before this at Blair-Athole, it seems scarcely credible that they would not have passed through Glen Tilt, over only ten miles of open moor, *sooner* than they would have reached Aviemore, a distance, *via* Struan, Dalwhinnie, and Glen Truim, more than four times that distance, over equally barren ground. We have quite failed to obtain any data whatever which can in any way be said to favour this line of advance.

The Rev. Lachlan Shaw's record in 1775, and Pennant's, 1777,† dating close to that of the commencement of the planting in Strathspey, certainly seem strongly to support the opinion that they were continuous in the district, and did not become extinct; and further in evidence of this, we find the general impression of others,—amongst whom Mr George Sim of Aberdeen,—that the squirrel occurred around the head waters of the Don in Aberdeenshire at an even earlier date than it did at Braemar, following the published statements given on the authority of Sir William Jardine.‡

On the other hand, Macgillivray, writing in 1843, says—"In many districts is of rare occurrence; . . . in the northern districts it appears to be unknown."§ At that time Sir W. Jardine, at all events, did not appear to be in a position to testify to its presence, although afterwards, when Macgillivray wrote his "Deeside and Braemar," in 1853, he (Macgillivray) said, as before quoted: "Sir William Jardine says it also occurs on the Don."‖

Under Extension of the Species in this district will be found a passage quoted at length, which appears to argue for

* See under "Extension in Aberdeen," next part, *infra.*

† Lightfoot collected his materials in 1772. Pennant probably collected his in 1769, the date of his first tour, and there is every reason to believe that his informant was the Rev. Lachlan Shaw.

‡ *V. antea,* p. 50, foot-note.

§ *V. antea,* p. 50, foot-note.

‖ "Nat. Library," vol. xiii.

the extension from Perthshire, *via* Glen Truim, but it does not prove that the squirrels which first appeared about Aviemore were not indigenous, or were not *resuscitated* by the fresh planting. [The passage is quoted from the *Elgin Courant* in the "Scottish Naturalist," vol. i., p. 49, and will be found in full in the next part.* I believe it expresses the opinion of Captain Dunbar Brander of Pitgaveny.]

Old people still alive in Strathspey speak of the squirrels as old acquaintances, and never heard of them as strangers, and there seems to be abundant evidence in favour of the supposition of their continuance and subsequent resuscitation in Badenoch and Strathspey.†

Malcolm Clark, the fox-hunter in Glenfeshie, on being interrogated by his son on behalf of Mr James Macpherson, depones that he is eighty-five years of age. He saw the first squirrel he ever remembers to have seen in the natural pine-woods of Rothiemurchus. His son writes: "My father is now eighty-five years of age, and has been acquainted with the *Feòrag* since his boyhood. He has never heard them spoken of as strangers in this country."

The Rev. W. Gordon of Braemar supplies the following: "An elderly man (sixty-nine), Mr Robert Grant, a native of Rothiemurchus, but who has been resident here for about forty years, informs me that some of his earliest recollections are associated with squirrels, which were abundant in his native woods of Rothiemurchus."

Mr D. MacDonald, writing to a friend from Glenfeshie under date of 3d March 1879, has the following very interesting note: "I have also observed that the few to be seen on my own side of the Feshie are larger and lighter in colour than those I have seen in the woods skirting Loch Insh. The former woods, you know, are natural forest, whereas round

* *Infra.*

† Captain Dunbar Brander's opinion that all of Nairn, Elgin, and Banff owe their population of squirrels *to an extension from the south* would thus appear to gain additional support, while the extension eastward from Beaufort Castle, being of a somewhat later date, very possibly may have been overtaken and merged in the southern advance. There are, however, sufficiently extensive areas of country having no connecting records of appearance along Speyside to cause one still to favour the extension from Beaufort.

Loch Insh they are all planted. My inference is that squirrels feed chiefly upon cones in natural woods, and on bark in plantations; that the cone-fed squirrel is better off than his bark-fed brother." *

We may, I think, then, safely conclude that the squirrel did not become extinct in Strathspey, and that, although the young planting was too late to save the indigenous capercaillies, it was in time to save the indigenous squirrels, and that they rapidly revived, and had already become very numerous by the year 1844 or earlier. The woods on Spey at Belleville would be in a fit state to receive and support them probably as early as 1815 or 1820.

I cannot learn that they lingered in Strathglass or the north of the county, any persons whom I have interrogated, or who have given evidence, saying that "they do not remember them as ever inhabiting Strathglass before the restoration at Beaufort."

Ross-shire and Cromarty.

In Ross-shire we find trace of the squirrel in Glen Ainaig, a wooded glen running down from the wild mountains of the Balnagown and Frevater deer forests to Oykel Bridge, in the parish of Kincardine, which is partly in Ross and partly in West Cromarty, and marches with Assynt in West Sutherland. The Rev. Andrew Gallie thus records the fact: "Squirrels are also found in Glen Ainaig."†

* A similar statement is made regarding the squirrels of Roxburghshire, their unusually large size being specially taken notice of; and the very small size of squirrels north of Loch Ness is also noted.

† "Old Stat. Acct.," vol. iii., p. 514 (1792).

This record is quoted again in the "New Statistical Account," *word for word* (*op. cit.*, Ross and Cromarty, p. 404), in a somewhat pretentious list of the animals of the parish; but though we must accord credit to the earlier account, I hardly think it credible that they would survive till 1842. The Rev. Hector Allan, however, in the "New Stat. Account," gives us the following particulars of his predecessor's life, which will prove useful in this connection: "Mr Andrew Gallie, who succeeded, was ordained at Nigg by Mr John Sutherland of Tain, 27th July 1756, to the mission of ———. On the 6th September 1758, he was admitted to the parish of Laggan, in the Presbytery of Abertarff, and transported to Kincardine 11th October 1774. Mr Gallie died on the 15th May 1803, in the twenty-ninth year of his ministry here." It is, therefore, probable that the squirrel survived in this part of Scotland until a comparatively late date. Possibly the last remnant may have had their dissolution hastened by the severe winter of 1795.

Sutherlandshire.

Concerning the squirrel in Sutherland we find mention of it in the quaint, useful, oft-quoted passage in Sir Robert Gordon's "Earldom of Sutherland," * where he enumerates the wild animals of the north-west of the county, and includes "Skuyrells." It is not necessary here to quote the full passage again, but it may not prove uninteresting to add an extract from his description of the county as it appeared in those days. "There are thrie principall forests in Southerland besides Scottarie, which lyeth in Strathbroray; Tivarie, which is in Strathvely; Gleanshin, which lyeth upon the river Shin; Leag-Lamd, which lyeth in Strathbroray; Shletadell, which is in the parish of Loth, and divers other particular schases and hunting-places full of wood and deir. To witt, the forest of Diri-Chat, which is of the parish of Kildonan, wherein are conteyned the tuo hills, called Bin Ormin; the forest of Diri-Mramigh, which is within the parish of Lairg, wherein is conteyned Bin-hie and the great hill Tain Bamd. All these forrests and schases are very profitable, etc." [Here read former quotation, *loc. cit.*, p. 19]. . . . "Ther is not one strype in all these forrests that wants trout and other sorts of fishes. . . . In Durines, west and north-west from the Diri-more, there is ane excellent and delectable place for hunting, called Parwe, where they hunt the reid-deir in abundance; and sometymes they dryve them into the ocean sea at the Pharo-head, wher they doe tak them in boats as they list. There is another pairt in Southerland, in the parish of Loth, called Shletadell wher ther are reid deir, a pleasant place for hunting with grew hounds. Heir also sometymes they dryve the deir into the South Sea, and soe doe kill them" (Sir Robert Gordon's "Earldom of Sutherland," 1813, p. 314).

Mr J. Crawford of Tongue also informs me that during the progress of the recent reclamation of land in the Tongue dis-

* "History of the Earldom of Sutherland," 1630, by Sir Robert Gordon, not printed from his MS. until 1813. Quoted fully in my last essay on "The Capercaillie in Scotland," and in the "New Statistical Account" of the County.

trict, by the Duke of Sutherland, large trees were dug out from a depth of 3 feet in the mosses, which were charred with fire from 10 to 15 feet of their length—some of these even now measuring 3 feet in diameter and very fresh. "Some of them are cored out with fire for several feet in length as if they had been burned down" (*In lit.*, 13th Jan. 1879).*

We have been assured by Mr Thomas Mackenzie that there is not a tree standing in Sutherland that is one hundred years old.

Ireland.

I intended to have treated of the past and present distribution in Ireland, as mentioned in my former portion of this essay, but I now find it quite unnecessary to do so, my friend Mr R. M. Barrington having fully exhausted the subject in an able paper read before the Royal Irish Academy, which paper I now hand round for examination; and I would particularly direct attention to the map.

The only point in which I differ from Mr Barrington is in respect to what he says on page 4 of the said tract, viz., that "its present remarkable distribution, and its rapid increase of late years," is an "argument against its being indigenous." My reasons for disagreeing in this respect will, I trust, be made plain to you later, when I come to treat of its restoration and increase in Scotland. Meanwhile, it is, perhaps, sufficient to say that the squirrel lingered longest in Scotland where the largest tracts of wood remained, and probably did not become extinct in the forest of Rothiemurchus, and that it only increased and spread in directions where fresh young plantations were formed, affording natural outlets: that we have proof also of the keen winters affecting them severely, and causing migrations, and their abandoning small and non-continuous coverts of hard wood, overcrowding the denser wooded districts, both in past and in later seasons.

* At the present day, in Transsylvania, it is a custom of the gypsies, and travellers, and huntsmen, and even the woodmen, to kindle fires for cooking and warming themselves inside of the hollow boles of the old oak trees (*vide Ibis*, 1875, p. 190, and *Journal of Forestry*, 1879, p. 477). None of these, however, which we saw standing were charred outside, and nearly all were vigorous and green.

Shortly summarising the foregoing evidence, we have seen that the squirrel occurred at an early date, and had a wide distribution in the pine woods and country—perhaps, all the country—north of the Firths of Forth and Clyde (as shown by the records of Sir Robert Gordon and the "Old Statistical Account" of Kincardine Parish, Ross-shire, not to speak of the other evidence I have given). We have seen also that there is every reason to believe that it did not become absolutely extinct in Scotland, but lingered in the great old forest of Rothiemurchus until resuscitated by the new growth of suitable woods; and that it remained in Argyleshire up to an unusually late date, probably surviving up to about the year 1839 or 1840, when Ewen Cameron, as related above, probably killed the last, and had it stuffed. Further, that our record from Ross-shire, in the "Old Statistical Account," makes it probable that it survived to a comparatively late date—towards the close of the last century—in the wooded glens of Ainaig. Like native races of men at the present day, which are fast approaching towards extinction, the squirrel lingered longest in the more inaccessible and wilder wooded parts of the country—in the "Meridionalis Plagæ Scotiæ" of Sibbald, and the "Sylvæ Lornæ Superioris" of Dr Walker, and the forest of Rothiemurchus. In Ireland our data are not sufficiently full *to place beyond doubt* its former occurrence there. Upon a correct reading, perhaps, of the poem above mentioned, and a right interpretation of many of the animals' names mentioned therein, will depend the decision on this part of its former distribution, as well as upon the comparison of the minutiæ of early distribution of various other species, with geological changes as pointed out by Mr Alston (*vide antea*, p. 41).

I believe that a minute study of any single species, or group of species, which has become extinct or nearly so, will develop new facts regarding variations in population, depending upon changes of condition. In the case of the squirrel, several factors seem to have been at work in bringing about its decrease or extinction. In some parts of Scotland, the extinction may have been due to one only of these factors, viz.—

the destruction of forests;* in others—and this, I believe, to be the most general—to a combination of these factors. Two of these may be best expressed by quoting the following passage in Murray's "Distribution of Mammals:" "If man or carnivorous animals were amongst them, their extinction would only be the more rapid. If none but herbivorous animals took refuge there, the food would be insufficient for numbers, and they would drop off by inanition." The scarcity of food might be occasioned by the great age of the forests, or by destruction of forests either by fire or by cutting down; and another factor, working in unison with these, may have been the severity of the winters as hinted at by one of my correspondents. The super-abundance also of carnivorous animals would hasten their extinction.

Nor can we account for the curious migratory habits of many species,—more especially noticeable in virgin forests, but also distinctly and constantly brought before our notice even in this country at the present day,—otherwise than by applying the well-known natural law, which enforces a natural extension of species. I do not speak of the seasonal migrations of birds which pass along our shores, halting only to rest for a brief period ere they resume their long flights to and from the far north; but of the local migrations, which, if we may use the phrase, sway backwards and forwards from one part of a limited area to another, and are occasioned by, and regulated by, the food supply or the capabilities of a district. If these safety valves were closed, the consequence would be poverty of blood, starvation, disease, helplessness before a natural foe, death, annihilation; and much goes to prove the unfavourable general character of the comparatively limited area of North Britain at the time of the decline of the squirrel, and the extinction of the Capercaillie and other animals. We have seen that, at least in Strathspey, the

* It was the custom to fell trees in ancient times for several reasons: when the farm-houses were built on the hill slopes the valleys were great forests, and the people burned great portions to rid them of wolves, and lest enemies should also find shelter. Later, when the country became more peaceful, the inhabitants descended to the valleys and destroyed the forests, in order to make clearings for agricultural purposes, and on which to build their houses.

probability is that this safety-valve was re-opened by the planting there, just in time to save the remnant. No more forcible illustration, perhaps, of the natural law that a given area will only support a limited number of individuals can be found, than in the abnormal increase of the Pallas sand-grouse, and consequent "irruption" of the species into Europe in 1863 (*vide Ibis*, 1864).

In this connection Sir Dudley Marjoribanks, Bart. of Guisachan, Inverness-shire, writes (*in lit.*) as follows: "In 1862, I saw a dead squirrel on the bridle path at Ardnamulloch, fourteen miles west of Guisachan, and at the end of the district of natural pine and birch. It was at the end of the stalking season, and the squirrel appeared to me to have died from stress of weather and not from violence. I heard of another the same year being found dead at Ault-beith, ten miles further west, and where there is not a tree within miles." Thus it will be seen that they had distributed themselves almost to the very far upper end of Glen Grivie, almost to the base of the backbone of mountains which form the natural boundary between the faunal districts of MORAY and WEST ROSS (*vide* Map). Significant is the further statement by Sir Dudley Marjoribanks, that "The squirrel here is a shabby little animal in comparison with his southern brother. I doubt whether he would weigh half as much in the scales—and he is not nearly so rich in colour." Therefore, feeding principally upon natural growth, being of an inferior and smaller type, wandering far in search of better food, they would in all probability succumb all the more easily to severe weather such as was experienced in the winter of 1860-61 and 1861-62.*

* I have elsewhere in this essay more fully pointed out also that the severity of the winter of 1878-79 banished the species from many localities, whilst the sudden increase again of the species, later in the year 1879, pointed to an *emigration* caused, in the first instance, by the intense cold. At the time when they became extinct, or nearly so in Scotland, the forest ground was much curtailed, and the loopholes of escape were not so numerous. Failing a natural migration, as already explained, they would die (*vide Proc. Glasg. N. H. Soc.*, 1879).

III. *On* Saxicola deserti (*Rüpp.*), *the Desert Chat, and its Appearance for the first time in Great Britain.* By John J. Dalgleish, Esq.

(Read 19th January 1881.)

The desert chat or wheatear is a native, as its name signifies, of dry, arid, and sandy regions. Mr Gould admits three species, all founded upon this one, viz., *S. deserti*, *S. albogularis* (Blyth), and *S. montana* (Gould); but Mr A. O. Hume has, in *Stray Feathers*,* the Indian ornithological journal, I think, clearly shown that in this he has been in error, and that the two latter represent the species in mid-winter, and breeding plumage respectively, and the former the autumn or spring plumage. It has not previously been recorded as having visited these islands, nor, so far as I can ascertain, has it ever occurred on the continent of Europe. On the island of Heligoland, however, which is yearly becoming more interesting to the ornithologist, from the number of rare visitants to its shores during the periodical migrations, it has been obtained on two occasions by Herr H. Gätke, the well-known resident ornithologist, as recorded by Mr Seebohm in the *Ibis* for 1877, p. 162. The first of these, a female in autumn plumage, was captured on 4th October 1855, and the other, a male, also in autumn garb, on 26th October of the following year.

Although thus almost unknown north of the Mediterranean, or, I may say, of the Atlas Mountains, the desert chat has nevertheless a most extensive range, stretching in an almost unbroken line, where the country is suitable to its habits, from the Algerian Sahara to the warm plains of Central India. Canon Tristram, and other recent travellers in Algeria, have found it all across the Sahara, and in the southern portions of the Atlas Mountains, where it seems chiefly to inhabit sandy salt plains, destitute of bushes. It is common in Egypt and Abyssinia. In the latter country Mr Blanford found it on the coast, near Annesley Bay, in the winter, from which district it seems to migrate in February. Von Heuglin mentions

* Vol. i., p. 188. 1873.

its occurrence on the coasts and islands of the Red Sea, as far south even as the Gulf of Aden. It has been obtained in the peninsula of Sinai, and Canon Tristram secured specimens in the month of January on the shores of the Dead Sea. In Persia it has been observed by several naturalists, including St John and Blanford, the latter of whom states that it is common in winter on the shores of the Persian Gulf and the coasts of Baluchistan, and in summer is found breeding in considerable numbers on the upper grounds in Southern Persia. The naturalists who accompanied the expedition to Yarkand found it near Kashgar early in April, where it appeared to have newly arrived from the warmer deserts to the south-east. Dr J. Scully has also recorded it as common in the plains of Kashgaria, at elevations of 4500 feet, and in some portions of the hills, even up to that of 12,300 feet, where he considers it probably breeds in June and July. Severtzoff found it breeding in Turkestan, and it occurs on the eastern shores of the Caspian.

In India it occurs during the cold season over all the north-west portion of the country, in the upper provinces, the Punjab, Rajpootana (where Captain Butler records it as a common winter visitant, arriving about 7th October, and leaving about 1st April), and in the north-west provinces. The most easterly point to which it extends, as hitherto recorded, is Nagpoor, where Mr Blanford obtained three specimens. In habits it seems much to resemble the common wheatear. Mr J. H. Gurney, jun., describes its flight as "moderately swift, but not direct. Its tail is never still a moment, and, as in the other wheatears, the jerking action is always accompanied by a slight vibrating motion of the wings." Speaking of it in his "Rambles of a Naturalist," as observed by him in Egypt, he says, "a little bush, high enough to raise them a few feet above the plain, is always a favourite perch, or the banks of a field, or mud walls of a garden, or, in default, a stone. They occasionally fly high, but seldom go far without alighting." Mr A. O. Hume, writing in "Stray Feathers" of its habits and appearance in North-West India, says, "the bleaker and more inhospitable the wastes that

stretched away, the more at home true to his name, seemed the desert wheatear."

It seems to have been found breeding only in Algeria, and in Persia, and other parts of Central Asia, visiting the plains of India, as above stated, only in the winter season, to which the same migratory instinct possessed by the common wheatear, seems to lead it. It is said to have a pleasant song, which is uttered even during winter. Its food is stated to be small insects. Its nest is placed in similar situations to that of the common wheatear, but sometimes under a bush: its egg is of a light greenish-blue, with pale liver-coloured spots at the large end.

It has been remarked by naturalists that few females of this and other species of *Saxicolæ* are obtained in proportion to the number of males, Mr J. H. Gurney, jun., estimating the proportion in Algeria as one of the former to eight of the latter. Referring to this fact, Mr Dresser, in his description of the present species, thinks it not improbable that the female may after a time assume a plumage resembling that of the young male.

The specimen which has been the occasion of the foregoing remarks, and which is now on the table, was killed on 26th November last, by Mr Watt, gamekeeper to Lord Balfour of Burleigh. It was sitting on a stone in moorish ground, at the side of Gartmorn Dam, on the property of the Earl of Zetland, near Alloa, in Clackmannanshire. It fell into the hands of Mr John Taylor of Alloa, who wrote to me, mentioning that he had a wheatear in his possession, the late date of whose appearance he thought worthy of notice, stating at the same time that the markings appeared to him different from those of the common wheatear. Having asked him to send it to me for examination, it has proved, on a careful comparison by Mr J. A. Harvie-Brown and myself, with skins from Egypt and India,* to be a specimen of *Saxicola deserti* (Rüpp.), the desert chat or wheatear. It is a male in autumn plumage, at which period the feathers of the throat, which in summer are of a jet black colour, begin to be edged by a creamy colour, and the margins of the wing feathers are

* I am indebted to Mr H. E. Dresser for the loan of these skins.

also more distinct; the back is also of a greyer tinge at that season. Unfortunately ten days elapsed, after it was shot, before Mr Taylor obtained it for preservation, but although it has suffered a good deal in appearance in consequence, he has been very successful in setting it up. The contents of the stomach consisted of small flies.

I may add that this is the second addition to the *Saxicolæ* on the British list within a recent period, a specimen of *S. rufa*, the russet chat, having been obtained for the first time in England, at Bury, Lancashire, on 8th May 1875, as recorded in *P. Z. S.*, 1878, pp. 881, 977.

In connection with the occurrence of this specimen, it may be interesting to mention that some days later, namely, upon 9th December, a male waxwing (*Ampelis garrulus*, L.), in fine plumage, was killed in the same neighbourhood, at Howtown, on the banks of the Devon, two miles west from Alloa, on the estate of Shawpark. It had been observed for some time previously. When obtained, it had been feeding upon the hips or seed-vessels of the wild rose. Writing on the occurrence of these specimens, Mr Harvie-Brown informs me that, from the returns which he and Mr Cordeaux have received from the lightships in the English Channel, of the migration period of the autumn of 1880, it appears that, contrary to precedent and to the experience of 1879, the lines of migration were, during the whole autumn of 1880, *from* the French coast *to* the English coast; and that Great Grey Shrikes were unusually numerous in Great Britain, and crossing Heligoland from east to west about the end of November, and Great Snipe not uncommon; while somewhat earlier, or on 21st September, an Esquimaux Curlew (*Numenius borealis*, Forst.) was obtained in Kincardineshire, and a Glossy Ibis (*Falcinellus igneus*, Gm.), on October 4, in Aberdeenshire —these all pointing, in his opinion, to an unusually large wave of migration westwards during the late autumn.

IV. *The Invertebrate Fauna of the Firth of Forth.* By George Leslie, Esq., Demonstrator of Zoology in the University of Edinburgh; and W. A. Herdman, Esq., D.Sc., F.L.S. Part I., Comprising the Hydroida, Alcyonaria, and Echinodermata.

(Read 19th January 1881.)

Introduction.

The following is intended to be the first of a series of papers, in which a list of the Invertebrata found in the Firth of Forth shall be given. We have been led to undertake this work on the suggestion of Sir Wyville Thomson and others, who think it is desirable that a fairly complete record of the marine fauna of the estuary should be easily attainable by those studying the zoology of the eastern coast. The special necessity for a list of the fauna of the Forth will be admitted, when it is considered that the estuary has always been the favourite and most accessible collecting ground with the numerous students of natural history attending the University of Edinburgh, and special facilities for its completion exist, as many able zoologists have during the last two centuries published the results of their work on the same subject. In recent years, however, since zoological classification has assumed its present form, nothing aiming to be a complete revision of the Invertebrata of the Forth has been produced, and the varying nomenclature of species renders the older partial lists of comparatively little use to the student of the present day. We are fully conscious that we will not be able to catalogue the entire invertebrate fauna in these papers, and that even some forms which have been found and chronicled may have escaped our notice; but this is the less to be regretted, as we hope in subsequent papers to add to our lists, or otherwise amend them.

A good description of the physical geography of the estuary may be found in the introduction to Parnell's "Fishes of the Firth of Forth"* and elsewhere, so that we shall here note only some of its more salient features.

* Trans. Wern. Soc., vol. vii., p. 162.

The length of the estuary, measured from its junction with the sea to the vale of Stirling, where it terminates in the river, is about 56 miles. The tide, however, flows to Craigforth, 25 miles above the proper estuary. Where it joins the sea, its breadth, from St Abb's Head on the south side to Fifeness on the north, is nearly 40 miles. As we ascend it rapidly contracts, so that at Elie, 10 miles above Fifeness, it is only 7 miles broad. Above this it again expands into an extensive basin, which at Musselburgh has a breadth of about 20 miles, and then gradually narrows, until at Queensferry it is only 2 miles across. Above Queensferry it again expands, for a distance of about 14 miles, into a basin having an average breadth of 4 miles, and terminates in the river.

The most important islands of the Firth are the May, situated a little above its junction with the sea; the Bass, nearly opposite North Berwick; Inchkeith, in the centre of the greater basin; and nearer its upper contraction the islands of Inchcolm, Inch Mickery, and Cramond Island. Inch Garvie lies opposite Queensferry.

The maximum depth of the estuary at its mouth is about 35 fathoms; at the mouth of the greater basin 28 fathoms. From the May to Inchkeith, the greatest depth in the middle of the channel is from 16 to 18 fathoms. Above Inchkeith the Middle Bank stretches, separating the north channel, with a depth of 16 to 25 fathoms, from the south channel or Leith Roads, varying from 3 to 16 fathoms. At the upper contraction of the greater basin, between Inch Garvie and North Queensferry, the depth increases to 37 fathoms, and above this it gradually becomes shallower. The greater part of our dredging has been done in the south channel, and between Inchkeith and the May.

In 1710, Sir Robert Sibbald, a learned Edinburgh physician, published a list of the exsanguous (invertebrate) animals which he supposed were common to the Firths of Forth and Tay.* He divides them into four classes: (1.) the *Molles*, among which are to be found Cephalopods, Asterids, and Medusæ; (2.) the *Crustrate*, comprehending Crustacea and

* "History of Fife and Kinross," p. 53. Edin., 1710.

Echinids; (3.) the *Testacea*, being Gastropods, Lamellibranchs, and Cirripedes; and (4.) the *Sea-insects*, among which we recognise *Aphrodite aculeata*. Sir Robert enumerates sixty-eight species of invertebrates. Of these many can be identified with our commonest species; others are more difficult of recognition under their somewhat lengthy but vague pre-Linnean designations.

In 1809, Professor Jameson read to the Wernerian Society of Edinburgh a paper, entitled, "A Catalogue of Animals of the Class Vermes, found in the Firth of Forth, and other parts of Scotland." Under the title Vermes he includes, as was usual at this date, representatives of the various invertebrate sub-kingdoms. Jameson enumerates seventy-seven species from the Firth, among which the only Molluscs are two species of *Tritonia*, one of *Doris* and one of *Chiton*. He divides the Vermes into—(1.) Mollusca, including Nudibranchs, Ascidians, Annelids, Holothurids, and Coelenterates; (2.) Testacea, of which *Chiton* is the only example given; (3.) Crustacea, including Echinids, Asterids, and Ophiurids; (4.) Coralla, being the Alcyonaria, Sponges, Polyzoa, and Sertularids; and (5.) Zoophyta, including *Pennatula*, *Hydra*, and *Coryne*.

In the same volume of the "Memoirs of the Wernerian Society," p. 370, is a paper by Captain Laskey, "An Account of North British Testacea," in which he enumerates between sixty and seventy species of Gastropods, Lamellibranchs, and Cirripedes, obtained in the Firth of Forth. Much doubt, however, has been expressed by distinguished conchologists as to the genuineness of many of the localities given in this paper.

Among those who have largely contributed to our knowledge of the fauna of the Forth, Mr H. D. S. Goodsir, who promised to attain to an equal scientific eminence with his brother, the illustrious anatomist, must be mentioned with special praise and regret. He discovered many new genera and species in the Forth, to which reference will be made in the text of this paper. He joined the Franklin Expedition in the capacity of naturalist, and shared in its disaster.

Many professors of the University of Edinburgh have from time to time investigated the fauna of the Forth, and of these Professor Jameson has already been mentioned; in more

recent years Professors Goodsir, Edward Forbes, and Allman, held the most distinguished places.

Professor Goodsir was an anatomist in the widest and most philosophical signification of the word, and on this his great reputation is mainly based; but it may sometimes be forgotten that he was also an accomplished marine zoologist. Many of the species in our lists are given on his authority. In 1838, Professor Goodsir communicated to the Cupar Literary and Antiquarian Society a list of the marine animals collected at Anstruther by his brother, Harry Goodsir. We have not been able to ascertain whether this was ever published.

Professor Edward Forbes, although a pioneer in the investigation of marine faunas, does not seem to have personally done much dredging in the Forth. The period during which he occupied and adorned the Chair of Natural History in the University was too brief and too fully occupied with other work to admit of this.

The work of Professor Allman on the Hydroids and Polyzoa is well known, and his writings are indispensable to the student of marine zoology. They will be very frequently quoted in these lists.

The researches of Dr Thomas Strethill Wright are among the most valuable of those which we have to notice. Dr Wright gave much attention to the Protozoa and Coelenterata, and contributed to the Proceedings of the Royal Physical Society a series of papers, entitled, "Observations on British Zoophytes," in which the histology, physiology, and development of many of the Hydroids are treated in the most admirable manner.

About twenty years ago a committee of marine zoology was formed in the Royal Physical Society, for the purpose of dredging the Forth and neighbouring waters. The preparation of a list does not seem to have been an object with this committee, but some of their rarer finds are recorded in the Proceedings of the Society.

The most complete list hitherto published is that by Dr M'Bain, R.N., in the Rev. Walter Wood's book, "The East Neuk of Fife." The specimens mentioned in that work were

mostly collected by Dr M'Bain himself and by Dr Howden, but some attention was also paid to the literature of the subject. The authority of this list will frequently be used in our paper.

We are especially indebted, and would now tender our best thanks, to Mr F. M. Balfour, F.R.S., Fellow and Lecturer of Trinity College, Cambridge, who has very liberally given us lists of the rarer forms which he has dredged in the Forth. Mr Balfour's assistance is the more valuable, as his work has principally been done in a part of the estuary which we have had comparatively little opportunity of investigating.

Dr M'Intosh's excellent "Marine Invertebrates and Fishes of St Andrews" should be consulted by students of the local fauna. From the proximity of the locality investigated, this work is very interesting in connection with the fauna of the Forth.

In addition to a study of the somewhat voluminous but scattered literature of the subject, our opportunities of acquiring a knowledge of the fauna of the Forth have consisted in—(1.) shore-collecting, extending over several years, at many points on both sides of the Firth; (2.) collecting from the refuse of the fishing boats at Newhaven and other piers; (3.) occasional night excursions with the oyster dredgers and long-line fishermen from Newhaven; and (4.) dredging excursions, in both sailing boats and steamers, organised in connection with the University Class of Practical Zoology.

ABBREVIATIONS USED IN THE LISTS.

G. J. A., . . .	Professor Allman, F.R.S.
F. M. B., . . .	F. M. Balfour, M.A., F.R.S.
Colds., ...	Dr Coldstream.
Com. Mar. Zool., . .	Committee of Marine Zoology of the Royal Physical Society.
J. G. D., . . .	Sir J. G. Dalyell.
Flem., ...	Dr John Fleming.
E. F., ...	Professor Edward Forbes.
H. D. S. G., . . .	Harry D. S. Goodsir.
J. G., ...	Professor Goodsir.
Howd., ...	Dr Howden.
R. J., ...	Professor Jameson.
G. J., ...	Dr George Johnston.

M'B., ...	Dr M'Bain.
M. & B., . . .	Möbius and Butschli.
Br. Mus., . . .	Specimen from the Forth in the British Museum.
Ed. Mus., . . .	Specimen from the Forth in the Edinburgh Museum of Science and Art.
C. W. P., . . .	Charles W. Peach.
F. E. S., . . .	Professor Franz Eilhart Schulze.
Sim., ...	Mr Simmons.
Th., ...	Lieutenant Thomas, R.N.
T. S. W., . . .	Dr Thomas Strethill Wright.

COELENTERATA.

In the present part we can only give lists of the *Hydroida* and *Alcyonaria*, as the other sections of the Coelenterata, viz., the *Zoantharia*, the *Acalepha*, and the *Ctenophora* have not yet been sufficiently worked, and the material at our disposal is not extensive enough to enable us to compile anything like complete lists of these groups.

So far as the Hydroid Zoophytes are concerned, however, we have had plenty of material. They have always been a favourite group with marine zoologists, and have been studied in the Firth of Forth by successive generations of naturalists, who have frequently been rewarded by the discovery of species new to science.

Professor Allman and Dr Strethill Wright, whose researches we have already referred to in the Introduction, have contributed largely to our knowledge of the Hydroids. The section of Dr Wright's work most interesting to us, in connection with these lists, is his careful investigation of the more minute Zoophytes, among which he discovered so many new species—especially in the Athecata. Further work of the same description among the smaller Campanularians would almost certainly yield interesting and valuable results.

The nomenclature and arrangement in the following list are those given in Hinck's "History of the British Hydroid Zoophytes," from which we have in various ways derived the greatest assistance. For many of our names and localities we are indebted, in addition to the last-mentioned work and Dr Wright's papers, to Allman's "Gymnoblastic Hydroids,"

and various lists and notices by Professors Allman, Forbes, Jameson, Drs Fleming, M'Bain, George Johnston, F. E. Schulze, and others.

In our own investigations, comprising shore-collecting and dredging from fishing boats and steamers, extending over several years, we have taken the great majority of the species of Hydroids recorded as having been found in the Firth of Forth, and have been fortunate enough to discover several which have not hitherto been met with in this area. Our most notable deficiencies are among the minute Athecata discovered by Wright.

HYDROIDA.

I. Athecata—

Clavidæ.

Clava multicornis (Försk.).

Firth of Forth (*T. S. W.*); Kincardine to Fifeness (*M'B.*); Kincardine, 2 fathoms (*Th.*); Firth of Forth (*G. J. A.*).

This species is common between tide marks on various parts of the shore. We have taken it at Joppa, at Wardie, and at South Queensferry.

It is the *Clava repens* of Wright (*Proc. Roy. Phys. Soc., Edin.*, 1857; *Ed. New Phil. Jour.*, July 1857).

C. squamata (Müll.).

Queensferry on *Fucus vesiculosus* (*T.S. W.*); Craigflower (*G. J. A.*).

In Dr Wright's paper on *Clava* this species figures as *C. membranacea* (*Ed. New Phil. Jour.*, July 1857).

C. nodosa (T. S. Wright).

Queensferry and Largo, on *Delesseria sanguinea* (*T. S. W.*).

This species was first described in *Proc. Roy. Phys. Soc., Edin.*, for 1862.

Turris neglecta (Lesson).

Queensferry (*T. S. W.*).

We found a few specimens some years ago near Joppa.

The gonozooid of this species was known for about twenty years before Wright traced the development of the fixed polypites, which he described under the name of *Clavula gossii* (*Ed. New Phil. Jour.*, July 1859).

HYDRACTINIIDÆ.

Hydractinia echinata (Fleming).

Firth of Forth (*T. S. W.*); common on univalves (*M'B.*); off the Bass Rock (*F. E. S.*).

This is a common species, and we have often dredged shells encrusted with it off Inchkeith, on the oyster bank, and in other parts of the Firth. Specimens may frequently be found on the shore after storms. F. E. Schulze* mentions having found this species on the beach between Portobello and Fisherrow.

PODOCORYNIDÆ.

Podocoryne carnea (Sars).

Inch Garvie (*G. J. A.*).

Clionistes reticulata (T. S. Wright).

Granton (*T. S. W.*).

CORYNIDÆ.

Coryne pusilla (Gaertn.).

Firth of Forth (*M'B.*).

Syncoryne eximia (Allman).

Firth of Forth (*G. J. A.*).

S. sarsii (Lovén.).

Firth of Forth (*T. S. W.*).

* II. Jahresb. d. Komm. z. Untersuch. d. deutsch. Meere in Kiel, p. 123. Berlin, 1875.

We took this species once in a pool near Wardie.

Mr F. M. Balfour informs us that he has dredged it in shallow water near the Bass Rock.

Syncoryne gravata (T. S. Wright).

North Berwick (*T. S. W.*).

S. decipiens (Dujard.).

Firth of Forth (*T. S. W.*).

S. ferox (T. S. Wright).

Firth of Forth (*T. S. W.*).

Gemmaria implexa (Alder).

Zanclea implexa, in "British Hydroid Zoophytes."

Inch Garvie (*T. S. W.*); Firth of Forth (*G. J. A.*).

Stauridium productum (T. S. Wright).

Caroline Park, on *Hydrallmania falcata* (*T. S. W.*).

EUDENDRIIDÆ.

Eudendrium rameum (Pall.).

Leith shore (*Colds.*); Firth of Forth (*Th.*); Firth of Forth (*J. G. D.*); Firth of Forth (*G. J. A.*).

We have obtained this species from the fishing boats at Newhaven.

E. ramosum (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*Th.*); Leith shore (*R. J.*); near the Bass Rock (*F. E. S.*); Firth of Forth (*Ed. Mus.*).

We have dredged this species frequently in from 3 to 8 fathoms in the Firth.

E. arbuscula (T. S. Wright).

Queensferry (*T. S. W.*).

E. capillare (Alder).

Firth of Forth, on *Delesseria sanguinea*, from 5 fathoms, and at low water on Ascidian's tests (*G. J. A.*).

ATRACTYLIDÆ.

Wrightia arenosa (Alder).
Atractylis arenosa, in "British Hydroid Zoophytes."
Largo (*T. S. W.*).

Perigonimus repens (T. S. Wright).
Firth of Forth, on Sertularians, etc. (*T. S. W.*); Firth of Forth (*F. E. S.*).
We dredged this species last summer near Inchkeith.

P. sessilis (T. S. Wright).
On rocks at Granton, and on shells from deep water (*T. S. W.*).

P. palliatus (T. S. Wright).
On a shell, Granton (*T. S. W.*).

P. vestitus (Allman).
On a *Buccinum*, Firth of Forth (*G. J. A.*).

P. linearis (Alder).
We dredged this species near Inchkeith last summer.

P. miniatus (T. S. Wright).
On stones at Largo and at Granton (*T. S. W.*).

P. coccineus (T. S. Wright).
Inch Garvie (*T. S. W.*).

P. bitentaculatus (T. S. Wright).
Off Inchkeith (*T. S. W.*).

P. quadritentaculatus (T. S. Wright).
Firth of Forth (*T. S. W.*).
Mr Hincks and Professor Allman suspect that this and the preceding species may both prove immature forms.

Garveia nutans (T. S. Wright).
Inch Garvie (*T. S. W.*); Firth of Forth on Algæ, etc. (*G. J. A.*).
Described by Professor Allman as *Eudendrium bacciferum* (*Ann. N. H.*, July 1859).

Bimeria vestita (T. S. Wright).
Bimer Rock, North Queensferry, and Inch Garvie (*T. S. W.*); Firth of Forth on Algæ, etc. (*G. J. A.*).

Dicoryne conferta (Alder).
Firth of Forth (*G. J. A.*).
We dredged this species on *Apporhais pes-pelicani* off Kirkcaldy last summer.

Bougainvillea ramosa (v. Ben.).
Queensferry (*T. S. W.*).
We have taken it in 7 fathoms.

B. fruticosa (Allman).
Firth of Forth (*G. J. A.*).

Bougainvillea sp.
Some specimens of *Bougainvillea* dredged last summer off Inchkeith we are unable to identify with any of the known species. In some respects they resemble the variety of *B. muscus* mentioned by Hincks on page 112 of the "British Hydroid Zoophytes."

TUBULARIIDÆ.

Tubularia indivisa (Linn.).
Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*).
We have dredged this common species from 7 fathoms in the Firth.

T. larynx (Ell. and Sol.).
Firth of Forth (*M'B.*); Kincardine (*Th.*); Firth of Forth (*Ed. Mus.*); Firth of Forth (*F. E. S.*).

T. coronata (Abildg.).
Firth of Forth (*M'B.*).
We have dredged this species from 10 fathoms.

T. attenuata (Allman).
Firth of Forth, 15 fathoms (*G. J. A.*).

Corymorpha nutans (Sars).
Firth of Forth, 14 fathoms (*G. J. A.*).

PENNARIIDÆ.

Vorticlava proteus (T. S. Wright).
Fluke Hole (*T. S. W.*).

II. THECAPHORA—

CAMPANULARIIDÆ.

Clytia johnstoni (Alder).
Firth of Forth (*F. E. S.*).
This species, the *Campanularia volubilis* of Johnston, is common in the Firth of Forth, chiefly on other zoophytes; we have taken it frequently.

Obelia geniculata (Linn.).
Firth of Forth (*M'B.*); Newhaven (*Ed. Mus.*).
In profusion on *Laminaria* all along the coast; we have taken it at Wardie, Aberdour, Elie, etc.

O. longissima (Pall.).
We found this species on the shore at Longniddry, cast up after a storm, some years ago. We also dredged it in the Firth of Forth last summer.

O. dichotoma (Linn.).
On the beach between Portobello and Fisherrow (*F. E. S.*); Firth of Forth (*Ed. Mus.*); Firth of Forth (*G. J.*); Firth of Forth (*Th.*); off the Bass Rock (*F. E. S.*).
We dredged this species last summer between Inchkeith and Kirkcaldy.

Campanularia volubilis (Linn.).
Firth of Forth (*Th.*); Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*).
We have obtained this species from 5 fathoms.
It is not improbable that the species referred to under this name by M'Bain was *Clytia johnstoni* (Alder).

Campanularia verticillata (Linn.).
Firth of Forth (*Th.*); Firth of Forth (*M'B.*).
Not common. We have dredged it from about 10 fathoms.

C. flexuosa (Hincks).
Firth of Forth (*M'B.*).
Dredged last summer near Kirkcaldy.

C. decipiens (T. S. Wright).
Firth of Forth (*T. S. W.*).

C. integra (Macgill.) ?
Dredged last summer near Inchkeith.

Thaumantias inconspicua (Forb.).
Firth of Forth (*T. S. W.*).
This species was only known by the gonozooid until Dr Strethill Wright reared the polypites from the ova.

Gonothyræa lovéni (Allman).
Cramond Island (*G. J. A.*).
We have taken this species in considerable quantity about low water mark at Wardie.

Campanulinidæ.

Campanulina acuminata (Alder).
Firth of Forth (*T. S. W.*).

C. repens (Allman).
On Sertularians from 5 fathoms (*G. J. A.*).

Opercularella lacerata (Johnst.).
Morrison's Haven (*T. S. W.*).
We found this species a few years ago at Newhaven.

Lafoeidæ.

Lafoëa dumosa (Fleming).
Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*); Firth of Forth (*F. E. S.*).
Common in the Firth, on the oyster bank, in 3 to 10 fathoms; usually parasitic on

other zoophytes, such as *Hydrallmania falcata.*

Lafoëa fruticosa (Sars).

Firth of Forth (*F. E. S.*).

We have dredged this species once or twice along with the preceding.

Calycella syringa (Linn.).

Off the Bass, Firth of Forth (*F. E. S.*).

Not uncommon, on other zoophytes.

Filellum serpens (Hassall).

The *Reticularia immersa* of Sir Wyville Thomson (*Ann. Mag. N. H.*, 2d ser., vol. xi., p. 443).

We have obtained this species from the refuse in the Newhaven fishing boats; it was also dredged last summer near Inchkeith.

Trichydridæ.

Trichydra pudica (T. S. Wright).

Fluke Hole (*T. S. W.*).

Coppinia arcta (Dalyell).

We have found this species frequently in the fishing boats at Newhaven.

Halecidæ.

Halecium halecinum (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*Th.*); Firth of Forth (*F. E. S.*); Firth of Forth (*Ed. Mus.*).

One of the commonest species in the Firth; very common on the oyster bank; dredged frequently from 5 fathoms.

H. muricatum (Ell. and Sol.).

Firth of Forth (*C. W. P.*); Firth of Forth (*R. J.*); Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*).

We obtained a fine specimen a few years

ago from the Newhaven fishing boats. We have also collected it at North Berwick, cast up after a storm.

Halecium plumosum (Hincks) ?

Dredged last summer.

H. beanii (Johnst.).

Queensferry (*T. S. W.*); Firth of Forth (*Ed. Mus.*).

We have dredged this species in 8 fathoms between Inchkeith and Kirkcaldy.

SERTULARIIDÆ.

Sertularella polyzonias (Linn.).

Firth of Forth (*M'B.*).

A very common species in about 5 fathoms on the oyster bank westwards from Inchkeith, where it attains a large size.

S. rugosa (Linn.).

Firth of Forth (*M'B.*).

We obtained this species frequently at low water mark at Elie some years ago.

Diphasia rosacea (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*F. E. S.*).

Not rare on shells and stones from a few fathoms in depth. We dredged it frequently last summer near Inchkeith.

D. fallax (Johnst.).

Firth of Forth, plentiful (*Colds.*); Firth of Forth (*M'B.*).

D. attenuata (Hincks).

Firth of Forth, in 22 fathoms on a sandy and shelly bottom (*F. E. S.*).

D. tamarisca (Linn.).

Firth of Forth (*Colds.*); Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*).

We dredged this species last summer near the Isle of May.

Sertularia pumila (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*).

Common between tide marks on stones, *Fucus*, etc.; in profusion at Wardie.

S. operculata (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*Colds.*).

We have found large masses of this species cast up on the shore between Longniddry and North Berwick.

S. filicula (Ell. and Sol.).

Firth of Forth (*M'B.*).

We have dredged this species frequently. We got it last summer in 7 fathoms near Inchkeith.

S. abietina (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*).

Not uncommon on stones and shells from the oyster bank.

S. argentea (Ell. and Sol.).

Firth of Forth (*M'B.*); Firth of Forth, 8 fathoms (*F. E. S.*).

This species is not uncommon. We took it frequently last summer on old shells, etc., from between Inchkeith and Kirkcaldy.

S. cupressina (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*R. J.*); Firth of Forth (*Th.*); Firth of Forth (*Ed. Mus.*).

We have dredged this species several times in the Firth.

Hydrallmania falcata (Linn.).

Firth of Forth (*M'B.*); off the Bass Rock (*F. E. S.*).

Probably the commonest species in a few fathoms of water off Newhaven. It occurs

in profusion in some places, and attains a large size.

Thuiaria thuja (Linn.).

Firth of Forth (*M'B.*); near Inchkeith (*Th.*); Leith shore (*R. J.*); Firth of Forth (*Ed. Mus.*); Firth of Forth (*F. E. S.*).

Common in 5 fathoms and upwards.

T. articulata (Pallas).

We dredged this species near Inchkeith last summer.

PLUMULARIIDÆ.

Antennularia antennina (Linn.).

Firth of Forth (*M'B.*).

We have dredged this species several times. It is sometimes found cast up on the beach.

A. ramosa (Lamk.).

Firth of Forth (*M'B.*); Firth of Forth, in 25 fathoms (*F. E. S.*).

We dredged this species last summer in 10 fathoms. It is not nearly so common in the Firth of Forth as *A. antennina*, but at Lamlash, on the west coast, it occurs in profusion, and is much the commoner of the two species.

Plumularia pinnata (Linn.).

Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*); Firth of Forth, 25 fathoms (*F. E. S.*).

Not uncommon; dredged last summer between Inchkeith and Kirkcaldy.

P. setacea (Ellis).

Firth of Forth (*M'B.*).

We obtained this species plentifully at low water mark near Elie some years ago.

P. catharina (Johnst.).

Firth of Forth (*M'B.*); Firth of Forth (*Colds.*); Firth of Forth, on a sandy and

shelly bottom in 30 and in 22 fathoms (*F. E. S.*).

We dredged this species on several occasions last summer from about 10 fathoms.

ALCYONARIA.

Alcyonidæ.

Alcyonium digitatum (Linn.).

Firth of Forth (*F. E. S.*).

Very common on the oyster bank. We have obtained it between tide marks attached to the rocks, near Elie.

Gorgoniadæ.

Gorgonia flabellum (Linn.).

Professor Jameson ('Wernerian Memoirs,' vol. i., p. 561) recorded this species as having been found by Mr Mackay on Leith shore.

Professor Goodsir dredged a large specimen in the Forth.

A young friend, Mr Malcolm Laurie, lately picked up a worn specimen on Portobello beach.

All the specimens seem to have been dead; and there can be little doubt that the species never occurs in a fresh condition in these seas.

Pennatulidæ.

Pennatula phosphorea (Linn.).

Firth of Forth (*F. E. S.*); Firth of Forth (*Ed. Mus.*).

We have obtained this species cast ashore, and in the fishing boats at Newhaven.

Virgularia mirabilis (Linn.).

Dredged near Inchkeith (*Sim.*); Prestonpans Bay (*R. J.*); Firth of Forth (*Ed. Mus.*).

ECHINODERMATA.

In this list the Crinoidea are omitted, as no specimen of this group has hitherto been found in the Firth. *Antedon rosaceus*, which is extremely common on the west coast of Scotland, may yet be found within our limits, as its area of distribution seems to extend round the northern coast; and Mr C. W. Peach has recorded it off Peterhead. *Antedon sarsii*, a northern species, may be looked for in the seaward limit of the Forth. In the list of Ophiuroidea the arrangement and nomenclature of Professor Lyman, as given in his "Ophiuridæ and Astrophytidæ,"* has been followed; and in the Asteroidea, Professor Ed. Perrier's arrangement, used in his "Révision de la Collection de Stellérides du Muséum d'Histoire Naturelle de Paris."† For the Echinoidea, we have followed Professor Alexander Agassiz' nomenclature, as given in his "Revision of the Echini."‡

Much work must still be done in the investigation of the Holothuroidea of the British Seas before they are properly understood, and the list of the Forth species of this group, which we give, is that which we now regard with least satisfaction. Although from time to time a considerable number of species of Holothurids have been obtained in the Forth, the group is very poor in individuals, so that specimens for comparison are rarely obtained.

We have obtained the greatest assistance in the preparation of this list of Echinodermata from the works above mentioned. Also from Professor Edward Forbes' "History of British Starfishes," and from the Rev. A. M. Norman's valuable paper on the "Crinoidea, Ophiuroidea, and Asteroidea of the British Seas."§ Although not always adopting the nomenclature of Professor Forbes, we have in every case given the names used by him in his description of Echinoderms, as his work is in the hands of every student of the group.

* Mem. Mus. Comp. Zool., Cambridge, Mass., 1864.
† Archives de Zoologie Experimentale, 1875.
‡ Mem. Mus. Comp. Zool., Cambridge, Mass., 1874.
§ Ann. and Mag. Nat. Hist., 1865, p. 98.

OPHIUROIDEA.

Ophiuridæ.

Ophioglypha lacertosa (Linck).

Firth of Forth (*E. F.*); Firth of Forth (*M'B.*).

This species is the *Ophiura texturata* of Forbes. It is common near the mouth of the Firth, and becomes scarcer higher up. We have dredged it on several occasions at depths of 4 to 7 fathoms.

O. albida (Forbes).

Firth of Forth (*E. F.*); Firth of Forth (*M'B.*).

The *Ophiura albida* of Forbes. It is a very abundant species in the Firth, and we always obtained it in great numbers on the oyster banks near Inchkeith, and further down the estuary. It prefers sandy bottoms.

O. affinis (Lütken).

Bass Rock, 24 fathoms (*M. & B.*).*

Ophiocoma nigra (O. F. Müll.).

Firth of Forth (*M'B.*); Firth of Forth (*F. M. B.*). On the deep-sea lines.

Ophiocoma granulata of Forbes. This species is not common in the Firth. We have obtained it at Newhaven, the specimens having probably been brought in on the fishermen's lines from the vicinity of the May Island. On some parts of the west of Scotland this is the most abundant species in a few fathoms of water.

Ophiopholis bellis (Johns.).

Firth of Forth (*Howd.*); Prestonpans (*Ed. Mus.*); Firth of Forth (*F. M. B.*).

* II. Jahresb. d. Komm. z. Untersuch. d. deutsch. Meere in Kiel, IV., Echinodermata.

The *Ophiocoma bellis* of Forbes. This beautiful species is somewhat sparsely distributed in the Forth. We have taken it on the oyster banks at 5 fathoms, and in deeper water in Aberlady Bay, and have obtained it while shore-collecting near the piers.

Amphiura filiformis (Müll. sp.).

Firth of Forth (*Howd.*); Bass Rock, 24 fathoms (*M. & B.*).

The *Ophiocoma filiformis* of Forbes. This species is found on the west coast of Scotland and in the Irish seas. Mr F. M. Balfour found it plentiful on mud and gravel near Dunbar.

A. chiagii (Forbes).

Off Anstruther (*H. D. S. G.*); Firth of Forth (*F. M. B.*); Bass Rock, 24 fathoms (*M. & B.*).

The first record of the occurrence of this species in the Forth is that of a specimen obtained from the stomach of a cod off Anstruther, by Mr H. Goodsir, and which was described as *Ophiocoma punctata* by Forbes in his "History of British Starfishes." In 1845, Forbes described an ophiurid * (*Amphiura chiagii*), which is supposed by the Rev. A. M. Norman to be the adult form of Forbes' earlier *O. punctata*. *Amphiura chiagii* is not uncommon near the mouth of the Forth, and is found on both the western and eastern coasts.

A. squamata (Dell. Ch. sp.).

Newhaven (*J. G.*); Firth of Forth (*Howd.*); Dunbar (*Ed. Mus.*).

The *Ophiocoma neglecta* of Forbes. We

* Trans. Linn. Soc., vol. xix., p. 151.

have often found it under stones and in rock pools while shore-collecting. It is with us nearly confined to the littoral and upper laminarian zones.

Ophiocnida ballii (Thompson).

Off Anstruther (*J. G.*).

In his "History of British Starfishes," Forbes mentions two species of Ophiocoma, viz., *Ophiocoma Ballii* of Thompson, from the coast of Dublin, and a new species, *O. Goodsiri*, from the Forth. From a comparison of type specimens of these, Mr Norman has determined that *O. Ballii* and *O. Goodsiri* belong to the same species, and of the two specific names, that of *Ballii* has the priority.

Amphiura ballii is found on our northern and eastern coasts, and in the Irish Seas.

O. brachiata (Mont.).

Firth of Forth (*Howd.*).

The *Ophiocoma brachiata* of Forbes. We have never found it in the Forth, and include it in our list on the authority of Dr Howden. *O. brachiata* has elsewhere been recorded from our western and Irish coasts.

Ophiothrix rosula (Linck).

Leith (*Ed. Mus.*); Firth of Forth (*M'B.*); Firth of Forth, 22 fathoms (*M. & B.*).

The *Ophiocoma rosula* of Forbes. This is the most abundant of the Forth species of Ophiuridæ, occurring in great numbers on the oyster and shell banks, and extending into deep water. The pigmentation of different individuals is very varied, but it is always easily recognised by the generic character of the two large triangular plates on the dorsal surface opposite the origin of each ray.

ASTROPHYTIDÆ.

Astrophyton linckii (M. and T.).

We include this species in our list with the most complete reservation, our only authority being a manuscript of Captain Laskey's quoted by Forbes, in which he mentions having obtained "a great Medusa's-head Starfish in a herring net at Dunbar." *A. linckii* is a northern species, and was frequently dredged during the "Porcupine" Exploring Expedition. The probability of its occurrence in the Forth is very slight. Mr Norman, for whose opinion we have the highest respect, considers that its area of distribution is confined to the seas of Scandinavia and Shetland.

ASTEROIDEA.

ASTERIADÆ.

Asterias rubens (Linn.).

Firth of Forth (*Ed. Mus.*).

The *Uraster rubens* of Forbes. This is the most abundant species of Asterid in the Forth, being brought up in numbers at almost every dredging. It is especially common on the shell banks at about 5 fathoms, but we also found it at all the localities which we have dredged. Forbes describes a variety *A. coriacea* from the Forth, which is characterised by the prominent spines of the dorsal ridge. We have frequently obtained this variety.

A. violacea (O. F. Müll.).

Firth of Forth (*E. F.*); Firth of Forth (*Howd.*).

The *Uraster violacea* of Forbes. We have often obtained this species or variety in

the Firth, and have always been inclined to regard it as a mere variety of the widely-distributed and polymorphic *Asterias rubens*. At present, however, we have followed Mr Norman and Professor Perrier in giving it the rank of a separate species. Forbes states that it is by far commoner than *A. rubens* at the mouth of the Firth.

ECHINASTERIDÆ.

Solaster papposus (Linn.).

Firth of Forth (*Ed. Mus.*).

Solaster papposa of Forbes. It is a common species in the Firth. We often got it at low tide, and have dredged it from shallow water to 14 fathoms. It attains a very large size, and in this respect offers a marked contrast to its dwarfed northern congeners, *S. borealis* and *S. furcifer*.

S. endeca (Linn.).

Anstruther (*J. G.*); Firth of Forth (*M'B.*). This species is less common than *S. papposus*. We never obtained it at low water on the rocks, but dredged it frequently at depths of 5 to 16 fathoms.

Cribrella oculata (Linck).

Firth of Forth (*M'B.*); Firth of Forth (*F. M. B.*).

The *Cribella oculata* of Forbes. It is a not uncommon species. We have found it among rocks at low water at Aberdour and near Newhaven, and have dredged it on the oyster banks and elsewhere at greater depths.

GONIASTERIDÆ.

Hippasteria plana (Linck sp.).

Firth of Forth (*Dr Neill*);* Firth of Forth (*F. M. B.*).

* Fleming, "Hist. Brit. Animals," p. 486. Edin., 1828.

This species is the *Goniaster equestris* and *G. abbensis* of Forbes. It must be regarded as an inhabitant of only the seaward limits of the Firth. Mr F. M. Balfour has obtained one specimen from the Forth, which he thinks was from the deep-sea lines, or possibly from the creels. In Mr Norman's account of its general distribution, it is said to occur on the western, evidently a misprint for the eastern, coast of North America. It is abundant on the cod banks off Halifax.

ASTROPECTINIDÆ.

Luidia savignyi (Aud.).

Firth of Forth (*Howd.*).

Professor Perrier includes under this specific name the *Luidia fragilissima* of Forbes = *Asterias savignyi* of Audouin and *Luidia sarsii* of Düben and Koren; and in this we follow him. Although it has been obtained on several occasions near the mouth of the estuary, we have not been so fortunate as to find it. Our friend Dr Traquair informs us that he has dredged it off North Berwick.

Astropecten irregularis (Linck).

Firth of Forth (*E. F.*); Firth of Forth (*M'B.*).

The *Asterias aurantiaca* of Forbes, according to whom it is common in the Forth. We have found it on several occasions among the refuse of the fishing lines, and while dredging in rather deep water; but it can scarcely be reckoned one of our commoner species, at least in the upper reaches of the estuary. Mr F. M. Balfour has found it rather commonly in the creels, and while dredging near the mouth of the Firth.

ECHINOIDEA.

Echinidæ.

Echinus esculentus (Penn. sp.).

Firth of Forth (*E. F.*); Firth of Forth (*M'B.*).

We have followed Professor Alex. Agassiz' nomenclature of this species, which is the *E. sphaera* of Forbes. It is our most common sea-urchin, and occurs from between tide marks to the greatest depths in the Firth. We often dredged it on the banks around Inchkeith, and at various other places.

E. miliaris (Linn.).

Firth of Forth (*Ed. Mus.*).

We have never found this species in the littoral zone, but have obtained it at 5 fathoms off Inchkeith, and in the north channel in 18 fathoms.

Strongylocentrotus dröbachiensis (O. F. Müll.).

The *Echinus neglecta* of Forbes. Mr F. M. Balfour has found this species on a muddy bottom, at 30 fathoms, near the mouth of the estuary.

Clypeastridæ.

Echinocyamus pusillus (Müll.).

We found some dead specimens on the shore at Largo, and have dredged it. Mr F. M. Balfour found it common near Dunbar.

Spatangidæ.

Spatangus purpureus (Leske).

Leith shore (*R. J.*); Firth of Forth (*Flem.*); Firth of Forth (*M'B.*).

Not uncommon. We have frequently dredged it in 5 to 12 fathoms.

Echinocardium cordatum (Penn.).

Firth of Forth (*M'B.*).

The *Amphidotus cordatus* of Forbes. We have obtained it at Elie, and in other sandy bays on the shores of the Firth. It is often cast on shore in great numbers after storms.

E. flavescens (Müll.).

Leith sands (*Colds.*); Bass Rock, 24 fathoms (*M. & B.*).

The *Amphidotus roseus* of Forbes. The records of its occurrence in the Forth, in the "History of British Starfishes," and that by Möbius and Butschli, are the only ones we possess.

HOLOTHUROIDEA.

Psolidæ.

Psolus phantapus (Linn.).

Coast of Fife (*J. G.*); on a baited line near Inchkeith (W. S. Young, *Proc. Roy. Phys. Soc.*, vol. ii.).

Pentactæ.

Cucumaria frondosa (Gunner).

Off coast of Fife (*J. G.*).

This is a northern species, and was obtained in great numbers in Lerwick Bay during the "Porcupine" Expedition. We have not obtained it in the Forth, but it occurs as an inhabitant of the seaward limits. Professor R. O. Cunningham informs us that he has got it on two occasions from the Prestonpans fishermen, who obtained it near the mouth of the Firth.

C. elongata (Düben and Koren).

Bass Rock, 24 fathoms (*M. & B.*).

Occurs at the mouth of the Firth, and is occasionally obtained by the trawlers and

on the deep-sea lines. The *Holothuria montaguii*, founded by Dr Fleming on a specimen obtained in the Forth by Dr Neill, was probably this species.

Cucumaria lactea (Forb. and Goods.).

Off Fife coast (*J. G.*); Firth of Forth (*M'B.*); Firth of Forth, 22 fathoms (*M. & B.*).

This is one of the commoner species near the mouth of the Firth. Mr d'Arcy Thompson informs us that he has obtained several specimens.

Thyonidium commune (Forb. and Goods.).

East coast of Fife (*J. G.*).

The *Cucumaria communis* of Forbes. We obtained one specimen from the stomach of a cod.

Thyone fusus (Müll.).

Anstruther (*J. G.*); Firth of Forth (*Com. Mar. Zool.*).

The *Thyone papillosa* of Forbes. Mr F. M. Balfour informs us that he has taken this species at 12 to 16 fathoms on mud and shells off North Berwick.

Synaptidæ.

Synapta inhærens (Müll.).

Bass Rock, 24 fathoms (*M. & B.*).

Mr F. M. Balfour has found this species under stones, between tide marks, at the mouth of the Tyne, near Dunbar.

In addition to these, two species are described by Dr Fleming in his "History of British Animals," under the names of *Holothuria dissimilis* = *Cucumaria dissimilis*, Forbes (Leith shore, *Colds.*), and *Holothuria neillii* = *Cucumaria neillii*, Forbes (Firth of Forth, *Dr Neill*).

V. *Additional Notes on the Algæ of the Firth of Forth.*

By George William Traill, Esq.

(Read 19th January 1881.)

List of species new to the Firth of Forth, discovered during the year 1880.

1. *Ulothrix flacca.*—Joppa, and Caroline Park, on rocks and fuci.
2. *Rhizoclonium rochianum.*—Earlsferry, on iron-work.
3. *Calothrix semiplena,* Harvey (*Symploca harveyi,* Le Jolis).—Kincraig, in pools at high water, and on exposed rocks in the district, not uncommon.
4. *Chætomorpha arenosa.*—Earlsferry, in pools at high water.
5. *Lyngbya æstuarii.*— Do., do., rare.
6. *Lyngbya luteo-fusca.*— Do., do.

6². *Oscillatoria subuliformis.* — Accompanying *Leptothrix radians* in the Devil's Cave, near Earlsferry.

7. *Enteromorpha percursa.*—Earlsferry, in pools at high water.
8. *Bangia ciliaris.*—Joppa, on small algæ at very low tides.
9. *Prasiola marina.*—Joppa, Granton, Caroline Park, etc., on rocks, boulders, and wood-work, near high water mark.
10. *Myrionema strangulans.*—Earlsferry, on *E. compressa.*

*11. *Dictyosiphon fœniculaceus,* sub-species *hispidus* of Kjellman.—Joppa, parasitical on small algæ in pools at about half tide.

*12. *Dictyosiphon hippuroides,* Areschoug.—Very fine at Dunbar; also at Earlsferry, in pools, from half tide to low water.

*13. *Dictyosiphon mesogloia,* Ag.—Earlsferry, in pools at half tide.

14. *Ectocarpus crinitus.*—At Joppa and Caroline Park, on muddy rocks.
15. *Ectocarpus fasciculatus.*—Earlsferry, on *Lam. saccharina.*
16. *Ectocarpus secundus.*—Joppa, on *Lam. fascia,* rare; also on limpet shells, in pools, at Chapelness, Earlsferry.

* Those with an asterisk are new to Britain.

17. *Ectocarpus brachiatus.*—On *R. palmata,* Earlsferry, rare.
18. *Ectocarpus tessellatus.*—Joppa, in pools, on *Lam. digitata,* rare.
19. *Myriotrichia clavæformis.*—Earlsferry, in shallow pools.
20. *Fucus platycarpus.*—Joppa, on rocks near high water.
21. *Laminaria debilis.*—Joppa.
22. *Laminaria cæspitosa.*—In pools, Earlsferry, rare.
23. *Callithamnion borreri.*—Joppa, on *Chondrus crispus.*
24. *Callithamnion sparsum.*—On *Lam. digitata* stems, Earlsferry.
25. *Callithamnion floridulum.*—Joppa, on rocks at low tides.
26. *Ceramium rubrum,* var. *proliferum.*—Joppa, at low water, rare.
27. *Ceramium rubrum,* var. *decurrens.*—Caroline Park, on *Hal. siliquosa.*
28. *Ceramium rubrum,* var. *fasciculatum.*—Joppa, at low tides, rare.
29. *Ceramium strictum.* — Earlsferry, on rocks, in the shade, etc.
30. *Polysiphonia formosa.*—Joppa, in pools at low water.
31. *Polysiphonia fibrillosa.* — Earlsferry, in pools at half tide; Firth of Forth (*Grev.*).
32. *Hildenbrandtia rubra.*—On pebbles, in shallow pools.
33. *Petrocelis cruenta.*—On rocks near low water.

Note.—All of the above species were found by G. W. Traill, excepting Nos. 2, 4, 5, 7, 13, and 22, which were found by E. M. Holmes, F.L.S.

VI. *On the Structure of* Lepidodendron selaginoides (*Sternberg*), *from the Coal Measures, Halifax, Yorkshire.* By Robert Kidston, Esq. [Plates II. and II.*a*.]

(Read 19th January 1881.)

There is no genus of fossil plants which has received so much attention from geologists and botanists, in regard to their microscopical anatomy, as Lepidodendron.

Since the first specimen, showing internal structure, was

described by Witham in 1832,* numerous articles have appeared from time to time, chiefly in the publications of scientific societies, elucidating more fully its structure.

Among the authors who have contributed to our knowledge of the structure of Lepidodendron since Witham's time are Brongniart, Binney, Dr Dawson,† Professor Williamson,‡ Carruthers, and Lindley and Hutton.§

The study of the organisation of fossil plants is a most difficult one, owing to the imperfect manner in which, in most cases, it has been preserved.

The greater number of specimens of Lepidodendron that have been described are merely the central portions of the stem, which have become denuded of whole or portion of the bark, by destruction of one or both of two zones of delicate tissue.

I mention these difficulties, which beset this branch of botany, as some explanation for the unsatisfactory state of our knowledge of the subject.

The species, *Lepidodendron selaginoides*, to which the following notes refer, has already been described by Professor Williamson in the *Philosophical Transactions*, in his paper "On the Organisation of the Fossil Plants of the Coal Measures,"‖ and by Mr Binney in the *Quart. Jour. of the Geol. Soc.*,¶ under the name of *Lepidodendron vasculare*. Mr Carruthers has also described a plant under the former designation, "belonging to the type described by Mr Binney under the name of *Sigillaria vascularis*;"** but as I agree with Mr Binney in regarding these as different species, there being certain points in their structure which show important differences, the following remarks do not apply in all points to Mr Carruthers' plant.

A re-description of this Lepidodendron requires an apology, which must be found in the belief that there are some important points which these authors have failed to observe.

* Witham, "Fossil Vegetables."

† "Acadian Geology." Dr Dawson. 2d ed., 1868.

‡ Various contributions to the *Phil. Trans.*, entitled, "On the Organisation of the Fossil Plants of the Coal Measures," commencing 1871.

§ "Fossil Flora of Great Britain," vol. ii. ‖ *Phil. Trans.*, June 1871.

¶ May 1862. ** *Trans. of Roy. Mic. Soc.*, Oct. 1869, p. 179.

It will be necessary, before re-describing this plant, to give an outline of its structure as generally stated, and as the specimen to which these remarks specially refer seems similar to that described by Professor Williamson, it will suit our purpose best to quote his own words: "The medullary axis consists of a very peculiar admixture of barred cells, and vessels also barred. I abstain, as I have done in my previous memoir on calamites, from designating these vessels as *scalariform*, because I have not yet found them to be thickened at their angles with continuous deposits of lignine, as is the case with the true scalariform vessels of ferns. . . . The cells of this structure, in the specimen figured, exhibit a tendency to diverge into two forms. We have one thick walled series, arranged in vertical rows, the transverse septæ of which are sometimes rectangular in relation to their sides, but much more frequently oblique, the obliquity tending sometimes in one direction and sometimes in another, even in the same pile. The sides and ends of these cells are alike richly barred. Sometimes the bars are regularly parallel with each other, and arranged transversely, as in the vessels; but very frequently they describe a series of curves, as if one, two, or even three of the angles of the cells had been centres, from which corresponding series of concentric segments of circles had been drawn. . . . The cells of the other class are much smaller, have very thin walls, and appear to be small masses of ordinary parenchyma intermingled with the other medullary tissues. It is possible, but not probable, that this difference is due to mineralisation. . . . The vessels are often almost undistinguishable from sections of the barred cells; indeed, we appear to have here strong evidence of their primarily cellular character. In the specimen figured, those of the centre of the medulla are somewhat widely separated by the two kinds of cellular tissue; but this separation only extends over a small area. In the peripheral portions of the medullary axis they are closely conjoined, the cellular element becoming less abundant, especially the delicate parenchymatous tissue, which is so much more copious in the centre of the structure.

"Immediately investing the medullary axis is a thin cylin-

der of small barred vessels, arranged in parallel series, radiating from the medulla outwards. These represent the ligneous zone. The innermost ones are exceedingly minute, and though they increase in size as we proceed outwards, they rarely exceed ·016 in diameter, the great majority of them being much smaller. It is from the innermost surface of this cylinder that the vascular bundles are given off to the leaves, a point of importance in determining the homologous relationships of the various portions of the Lepidodendroid plants. The radiating arrangement of these vessels suggests, as the quotation already made from the writings of M. Brongniart points out, an exogenous mode of growth, a conclusion fully borne out by the facts yet to be mentioned; small cells, arranged in single or double vertical rows, pass outwards, like medullary rays, between these vessels.

"The tissue immediately surrounding the ligneous zone has almost always disappeared from the specimens of this plant, its place being represented by an almost vacant space; but there are indications, as Mr Carruthers has correctly pointed out, that it has been a delicate form of parenchyma.

"In the present example almost every trace has disappeared, save a narrow ring of disorganised carbonaceous matter at some little distance from the ligneous zone. The space within this tissue represents the innermost portion of what I regard as the cortical layer. . . .

"We now come to the middle bark, a dense, well-preserved layer of thick walled parenchyma, gradually passing into prosenchyma at its outer margin. . . . As the parenchyma of this middle bark becomes converted into prosenchyma at its outer portion, its cells become elongated vertically, and at last pass rapidly into the almost vascular form of prosenchyma, constituting the bast layer of the outer bark. . . . Towards the outermost portion of this tubular prosenchyma we find, in these fossils, a tendency to split vertically, and to the consequent detachment of the epidermal layer. The innermost portion of this detached layer consists of tubes precisely similar in every respect to those of the outer bark, but which again change rapidly as we proceed outwards, first into the prosenchymatous form seen in the middle bark,

and then into a thick walled parenchyma, which constitutes both the superficial portion of the epidermis and the entire surface of the petioles, or bases of the leaves.

"I have here referred the tubular bast layer partly to the outer bark and partly to the epiderm, because when the latter becomes detached, the line of separation usually passes through the middle of the layer; but it may perhaps be more correct to regard the whole of these bast tissues as one sub-epidermal layer."

Further on, in the same memoir, is appended a note, in which he says: "I may premise that my more recent investigations have compelled me to alter some of the terms applied in this memoir to the several parts of the bark, in order to bring them into harmony with what I find in recent *Lycopodiaceæ;* consequently in a third memoir, recently laid before the Royal Society, I have designated the middle bark of this paper the parenchymatous layer. The outer bark I have termed the prosenchymatous layer; and what I have called the epidermal, I now designate the sub-epidermal layer." *

In the specimen which we are considering this evening, the central axis (Pls. II. and II.*a*, Figs. 1 and 2, *a*) consists of parenchyma, some of its component cells being much larger than others. About half of the cells which enter into this part of the structure are reticulated, a character, independent of their general outline, sufficient to distinguish them from the scalariform vessels, when examined in longitudinal section (Pl. II., Fig. 4).

It is impossible, in this case, to say whether originally all the cells of this parenchyma were reticulated or not; but I would be inclined to believe they were, for when examined in longitudinal section it is found in the same pile of cells, one may be reticulated and the one immediately above or below it may not be so marked. The changes which have taken place during mineralisation seem to me sufficient to account for the difference.

Surrounding this central portion we have a circle of scalariform vessels (Pl. II., Figs. 1, 2, and 4, *a″*, *a′*, and Pl. II.*a*,

* "On the Organisation of the Fossil Plants of the Coal Measures." Professor W. C. Williamson. *Phil. Trans.*, June 1871.

Fig. 1, *a''*, *a'*), the larger ones being next to the parenchyma, some of which, in fact, are scattered through it. These vessels become somewhat smaller as they recede from the axis, and on their outer margin are encompassed by a narrow band of very small scalariform vessels, and it is from these last that the foliar bundles are given off (Pl. II., Figs. 1, 2, and 4, *a'*). They are of similar structure to the larger scalariform tubes, but very much smaller.

At various points in the circumference of this narrow band aggregations of scalariform vessels occur. These belong to the leaf system, and similar bundles are found in all parts of the stem, from this region out to the periphery (Pl. II., Fig. 2, *i*).

The vascular system in this plant I look upon as represented by the central cylinder of intermingled vessels and parenchyma, what may be viewed as a single central vascular bundle, from which small twigs pass outwards and upwards to the leaf bases (Pl. II., Figs. 1 and 2, *a*, and Pl. II.*a*, Fig. 2, *a*).

I cannot trace any indication of ligneous zone or medullary rays, either in this species or in any other Lepidodendron I have examined.

It would appear that the system of small scalariform vessels, which surrounds the circumference of the central bundle, has been taken for a ligneous zone by Professor Williamson—a view which seems untenable, if I am correct in connecting this part with what he terms the ligneous zone.

This vascular system is invested by a delicate cellular envelope, which seems to have very seldom resisted decay, before mineralisation took place. A few traces of it are left in this specimen, sufficient to indicate its nature (Pl. II., Figs. 1 and 2, *b*).

Each of the foliar bundles was encased in a sheath of this tissue, which filled up the large openings in the bark, through which they passed to the leaves.*

I have seen this parenchyma well preserved in *Lepidodendron Harcourtii*, where it was sharply defined by its more delicate structure (Pl. II., Fig. 5, *c*) from the adjoining outer layer.

This delicate parenchyma has been designated the inner

* It is not preserved in the specimen now described, but was well shown in *Lep. Harcourtii*, from which Fig. 5 was drawn.

bark, but I believe it has no relation whatever to the cortical system, and it probably corresponds to the sheath of the vascular bundle (Gefässbündelscheide of German authors) (Pl. II., Figs. 1, 2, and 5, *c*, and Pl. II.*a*, Fig. 2, *c*).*

Immediately outside of the last-mentioned structure is a zone of large, firm-celled parenchyma, the cells of which become much smaller towards its outer portion. When this portion of the plant is examined in longitudinal section, the cells towards its inner portion are of an oval form, those towards its periphery are somewhat elongated but cannot be described as prosenchymatous (Pl. II., Figs. 1, 2, and 3, *d*, and Pl. II.*a*, Fig. 2, *d*). These pass gradually into the more delicate and narrower cells of a layer which presents the characters of a meristem (Pl. II., Figs. 1, 2, and 3, *f*, and Pl. II.*a*, Fig. 2, *f*).

The cortex in this plant consists, in my opinion, of an internal portion—the aforesaid zone, and of an external part in connection with the leaf bases, with a meristem between them (Pl. II., Figs. 1 and 2, *d*, *g*). The cells towards the periphery of the internal zone pass into (or more correctly seem to pass out of) a layer of cells, presenting all the characters of a meristem, or formative zone, out of which additions were no doubt made from time to time, to the outer portion of the inner bark (Pl. II., Figs. 1, 2, and 3, *f*, and Pl. II.*a*, Fig. 2, *f*).

The inner, larger celled portion of the bark, as I have defined it, has been called the middle or parenchymatous part of the bark, and its outer portion, the outer or prosenchymatous part of the bark, distinctions which are certainly not shown in the specimen exhibited to-night.

The meristem layer varies from five to ten cells in breadth. In transverse section its cells appear quadrangular, flattened from without inwards, and much smaller than the outer cells of

* The term "vascular bundle sheath" is here used in a somewhat wider sense than that usually employed. As employed in the present paper, it embraces, in addition to the "sheath" proper, all the tissue lying between it and the vascular bundle, so it will probably include the soft bast, which there is every reason to believe would be situated in this region.

In some recent Lycopodiums, and even among individuals of the same species, the prominence of the "bundle sheath" varies considerably—so much so, that, in some cases, it seems hardly distinguishable from the soft bast within it.

the bark, which are more hexagonal in outline (Pl. II., Figs. 2 and 3, *f*). In longitudinal section they are elongated, and have a similar appearance to the true *cambium* in dicotyledons (Pl. II., Fig. 1, *f*). This has been called the tubular portion of the outer bark, by Professor Williamson. The meristem layer is usually ruptured, a character noticed by several writers on these stems. This rupturing is what might be expected from the delicate nature of the meristem cells.

The meristem layer is surrounded by the external layer of the bark in connection with the leaf bases, and is composed of parenchyma, similar to the ground mass of the leaves (Pl. II., Figs. 1 and 2, *g*).

A true epidermis is wanting in these plants, the whole exterior surface being covered by the persistent leaf bases (Pl. II., Figs. 1 and 2, *h*).

The leaves of Lepidodendron seem to have had an articulation a short distance above the base, at which point the upper portion of the leaf separated, the base being persistent for a longer or shorter time. These persistent leaf bases are well shown in the longitudinal sections of this specimen. This is a matter of great importance to systematists, the persistence of the leaf bases being one of the chief characters on which Sternberg founded his genus Lepidophloios, a genus which most authors are now inclined to unite with Lepidodendron.*

From the foregoing remarks, the structure of *Lepidodendron selaginoides* may be said to consist of a central vascular bundle (Pl. II., Figs. 1 and 2, *a*, and Pl. II.*a*, Fig. 2, *a*), surrounded by a delicate parenchymatous sheath of considerable thickness (Pl. II., Figs. 1, 2, and 5, *c*, and Pl. II.*a*, Fig. 2, *c*), outside of which we have the bark (Pl. II., Figs. 1 and 2, *d*), which receives constant additions from a layer of meristem (Pl. II., Figs. 1 and 2, *f*); and immediately outside of this we have an external layer (Pl. II., Figs. 1 and 2, *g*), in direct relation with the leaf bases (Pl. II., Figs. 1 and 2, *h*).

Professor Dickson, to whom I have shown my preparations, has expressed his concurrence with my determination of the

* Carruthers—*Monthly Mic. Journal*, January 1872. Williamson, "On the Organisation," etc., *Phil. Trans.*, June 1871.

existence of a meristem layer between the outer and inner portions of the bark, as also with the comparison I have instituted between the central mass of the stem and a central vascular bundle, with its investing sheath. As to any relation between the increase of the bark from a meristem and the acquisition of arborescent dimensions by Lepidodendroid stems, Professor Dickson reserves his opinion.

Explanation of Plates.

(*The same letter indicates the same part in the various figures.*)

a. Central vascular bundle. *a'*. Small scalariform vessels of foliar system; *a''*. Large scalariform vessels of vascular bundle. *a'''*. Parenchymatous axis of reticulated and non-reticulated (?) cells.

b. Foliar vascular bundles, embedded in traces of the bundle sheath.

c. Space originally occupied by the bundle sheath.

d. Inner portion of bark.

e. Channel through which foliar vascular bundle passed to leaf.

f. Meristem or formative zone.

g. Outer portion of bark.

h. Leaf base.

i. Foliar vascular bundles.

Plate II.

Lepidodendron selaginoides.

Fig. 1. Longitudinal section of portion of stem—$\frac{1}{1}^{2}$.

Fig. 2. Transverse section of portion of stem—$\frac{1}{1}^{2}$.

Fig. 3. Transverse section of portion of inner and outer parts of bark, showing meristem layer situated between them—$\frac{5}{1}^{0}$.

Fig. 4. Longitudinal section of portion of central vascular bundle, showing foliar vessels, large scalariform tubes, and reticulated and non-reticulated parenchyma of axis—$\frac{1}{1}^{2}{}_{5}$.

Lepidodendron Harcourtii.

Fig. 5. Transverse section, showing junction of inner portion of bark and bundle sheath—$\frac{5}{1}^{0}$.

Plate II.*a*.

Lepidodendron selaginoides.

Fig. 1. Central vascular bundle—$\frac{2}{1}^{5}$.

Fig. 2. Transverse section of stem—$\frac{5}{1}$.

VII. *Notes on the Post-Tertiary Deposits of Elie and Largo Bay, Fife.* By R. Etheridge, Jun., Esq., President.

(Read 16th January 1881.)

The post-tertiary deposits in the neighbourhood of Elie and Errol have formed the subject of a valuable paper by the

Rev. T. Brown, M.A., "On the Arctic Shell-clay of Elie and Errol, viewed in connection with our other Glacial and more Recent Deposits." * Having, three or four years since, spent a short time at one of the above localities, Elie, I beg to lay before the Society a few remarks on certain of the beds described by Mr Brown. In doing so I wish to add my mite of testimony to the very accurate manner in which Mr Brown has made his observations. The object of the present paper is twofold; first, to notice more in detail the organic contents of one or two of the beds described in the above paper, and to add a few more facts bearing on certain of the strata in particular.

At the time the Rev. Mr Brown's survey of the Elie neighbourhood was made, three exposures of the post-tertiary deposits were visible. The "Elie Shore Section," extending along high water mark, east from the harbour wall; the "Elie Inland Section," in the railway cutting immediately west of the station; and the Cocklemill Burn, or "Elie Transverse Section," at the east side of Largo Bay. The first and last of these are only now visible, as the railway cutting section has become obliterated. My remarks will chiefly refer to the Cocklemill Burn section. In the details of the section to the east of Elie Harbour, which has now become so well known from the arctic character of the organic remains found in the lower part of the bed, I quite coincide with Mr Brown. His divisions are from above downwards—

1. Blown sand in layers, 4 to 6 feet, hardening in the lower portion into a kind of concrete.
2. A thin raised beach bed of shingle and marine shells.
3. A layer of peat, 5 to 10 inches in thickness.

UNCONFORMITY.

4. Arctic shell-clay—in the upper part consists of layers of deep brown sand with thin partings of coal shale, passing downwards into a stiff, unstratified, tenacious, sandy clay, with intensely arctic shells.

The beds 1 to 3 are still to be seen as described, although a good deal defaced by the scrambling up and down of the numerous visitors to the place. It would be quite impossible

* *Trans. Roy. Soc., Edinb.*, 1867, xxiv., pt. 3, p. 617.

to make any collection from these with a satisfactory result, unless an entirely new face to the section could be cut. There appears to be a second, although ill-defined, peat-bed, much less marked, and very impure, underlying the former bed of peat. The fourth stratum was, at the time I saw it, only partially visible, the heaping-up of the beach material preventing an examination of its lowest portions being made.

I now pass on to a consideration of the Cocklemill Burn, or, as Mr Brown terms it, the "Elie Transverse Section." In the bank of the burn, about 200 yards above the foot-bridge, the following section was observed:

1. Sand, perhaps blown, 2 to 3 feet, containing marine and land shells. Away from the banks of the burn this passes into "dunes," when the marine shells increase in number.

2. Drab sandy clay, 6 inches to 3 feet, containing a few small stones and vertical ferruginous pipings. A quantity of this clay on being washed did not yield any organic remains.

3. Sand bed, 7 to 8 feet.

4. Sandy clay, becoming more argillaceous downwards, and having at its base a thin irregular band of finely comminuted shelly matter and black shale, of variable thickness, containing *Scrobicularia piperata, Littorina litorea, Tellina balthica, Littorina rudis,* var., *Cardium edule,* etc.

5. Fine, stiff, blue clay, 2 to 3 feet, having distributed pretty generally throughout it, *Scrobicularia piperata, Cardium edule, Mytilus edulis, Hydrobia ulvæ, Tellina balthica.*

6. Yellow sand, becoming blue, and in places almost black, downwards to below the water level.

Several visits were made to this section; one, in company with the late Dr M'Bain, R.N., and Mr Howie, of Largo, was particularly interesting, for although no good geological section was then seen, we were very successful in obtaining, under the guidance of the latter gentleman, numerous specimens of *Scrobicularia piperata* living in pools on the muddy flats of the burn. This fact, taken in conjunction with the occurrence of *S. piperata* in the above beds, in the natural position, with its posterior or siphonal end uppermost, is one of particular interest and importance. The position in which this species occurs in Nos. 4 and 5 of the preceding section

would appear to indicate a quiet estuary, or creek bottom, where fossilisation took place, as the Mollusca lived accompanied by little or no disturbance. At another visit to the *Scrobicularia* beds, in company with Mr James Bennie (of the Geological Survey), the foregoing facts and a large suit of specimens were obtained. Some slight difference exists between the details of this section as here given, and as stated by Mr Brown; but this can be easily accounted for without difficulty.

On proceeding a short distance down the burn we come to the point of its embouchment into an open, alluvial flat partially submerged at high tide, and having on each side, east and west, the fine raised beach-beds forming escarpments of 20 feet or more. This section is shown to the greatest advantage on the east side, almost directly west of Kincraig farm house, visible on the rise in the distance. I quite agree with Mr Brown in placing these raised beach-beds above the foregoing *Scrobicularia* beds, for, although, as he justly says, no direct junction can be seen,* still from the fact that the latter have a seaward dip, and so pass out of sight going down the burn, I do not think there can be much doubt of the accuracy of his conclusions. This is the section visible—

1. Blown sand, with land and marine shells, 2 to 3 feet.

2. Laminated sand and shelly *débris*, with several distinct alternating layers of shells, usually whole, and pebbles, and partially rounded stones, about 3 to 4 feet, each layer mixed with a certain proportion of sandy matter. The Mollusca are in a beautiful state of preservation, and many of the bivalves have the valves in apposition.

3. Laminated sand, with here and there a little cross bedding; the laminæ consist of both coarse and fine sand, with occasional partings of comminuted coal shale, and a few small pebbles.

When viewed in cross section, Nos. 1 and 2 present a vertical scarp, but the sand bed invariably stands at an angle of about 30° to 35°. In connection with No. 2 the following facts are worthy of notice, viz.—The great regularity of the several rows of partially rolled stones mixed with the organic

* *Trans. Roy. Soc., Edinb., loc. cit.*, p. 621.

remains, and separated by finer deposits of sand, shelly *débris*, and shells. The fine state of preservation of all the shells, even the smallest and most fragile, for instance, *Tellina fabula* with the valves in apposition; the similar occurrence of *Solen siliqua*, *Mytilus edulis*, *Ostrea*, *Tapes pullastra*, and *Cardium edule*, the two latter even with the ligament preserved. What is more particularly interesting in the case of *T. pullastra* is the occurrence of individuals (fine large specimens), as in the case of *Scrobicularia* in the previous section, in their natural position, with the siphonal end of the shell uppermost, wedged amongst the stones and surrounded with shelly *débris*. Lastly, many of the stones have still attached to them specimens of *Ostrea* and *Balanus*.

The following is a list of the Mollusca obtained by Mr Bennie and myself from the raised beach-beds proper.

BIVALVES.

Anomia.
Cardium edule.
Cyprina Islandica.
Lucina borealis.
Lutraria elliptica.
Mactra truncata.
Mya, sp.
Mytilis edulis.
Pecten pusio.
,, sp.
Pholas candida.
,, crispata.
Ostrea edule.
Scrobicularia piperata.
Solen siliqua.
Tapes pullastra.
Tellina balthica.
Tellina fabula.
,, tenuis.
Venus casina.
,, gallina.
Thracia, sp.

UNIVALVES.

Aporrhais pespelicani.
Buccinum undatum.
Littorina litorea.
,, obtusata.
Helcion pellucidum.
Natica, sp.
Patella vulgata.
Purpura lapillus.
Trochus cinerarius.
Turritella terebra.

This portion of the Cocklemill Burn section is continually spoken of by Mr Brown as the "so-called raised beach;" * and again, "the materials, consisting of shingle, sand, and shells, have been thrown up by the sea, and apparently at different times, and in a confused way." † He appears to be in doubt whether to regard this as a raised beach, or to account for it

* *Trans. R. Soc., Edinb., loc. cit.*, p. 621.
† *Loc. cit.*

as having been thrown up by the sea. For my own part, I think the great regularity of the strata, good state of preservation of the shells, the adhesion of certain species to stones, and the position in which the *Tapes* occurs, all tend to indicate an aqueous rather than an aerial deposition, and that the organic contents of the deposit were not subjected to much friction and rolling before assuming their present position. There certainly is no confusion. Had the deposit owed its origin simply to the heaping-up action of the sea, we should not expect to find such a delicate shell as *Tellina fabula*, with the valves in apposition, and *Solen siliqua* not only in the same condition, but quite perfect and entire, to say nothing of the preservation of the ligament in *Cardium edule* and *Tapes pullastra*.

The Rev. W. Wood, M.A., has suggested a similar formation of these beds, but considers them to be more particularly the result of wind acting on beach material.* I think, however, that the same objections may also be applied in this case.

The well-preserved state of the majority of the shells, and the occurrence of *Tapes pullastra, in situ*, almost lead me to regard at least a part of this section as an old sea bed.

"*Buried Forest*" *of Largo Bay.*—Immediately west of the mouth of the Cocklemill Burn at Shooter's Point, and extending round Largo Bay, is the well-known "buried forest," consisting of peaty material, erect trunks of trees (Fleming), wood of the willow and hazel, hazel-nuts, numerous mosses, and abundant remains of *Arundo phragmites*. The exact sequence of this deposit in the series is obscure; but Mr Brown is probably right in regarding it as the equivalent of the peat bed in the Elie Harbour Section, and Bed No. 2 of the Railway Cutting or Elie Inland Section. The section obtained when the deposit was excavated by Mr Brown showed—submerged forest 4 feet, laminated sand 3 feet, gravel. During a visit to the locality in company with Dr M'Bain and Mr Howie, the "buried forest" was found to be, in places, only a few inches thick, although the latter has, like Mr Brown, found the bed to run as much as 4 feet in thickness. This would probably indicate that it was depo-

* *Proc. Roy. Phys. Soc., Edinb.*

sited on a very uneven surface. Mr J. Bennie accompanied me on my second visit, and we excavated the laminated sandy clay for a depth of two feet or more, and brought away good samples. The sandy clay contains a few stones, to all appearances unscratched, and small rounded patches of a bluish-green colour, not unlike masses of decomposed trap-tuff. It is quite unfossiliferous, so far as indicated by the samples brought away by us.

Mr Howie has succeeded in separating the following species of mosses from the material composing the submerged forest :

Bryum pseudo-triquetrum.	Brachythecium rutabulum.
,, pallescens.	,, albicans.
Mnium hornum.	Amblystegium serpens.
Nockera complanata.	Hypnum filicinum.
Thuidium tamariscinum.	,, scorpioides.
Rhynchostegium rusciforme.	,, crispidatum.
,, prælongum.	,, giganteum.

Hypnum nitens.

Many of the species, which grow under widely different conditions, were found drifted together in broken fragments.*

At the southern end of Mr Brown's "Elie Transverse," or Cocklemill Burn section, is marked a small patch of boulder clay, appearing just above high water mark, immediately on the trap-tuff at Shooter's Point. Although shown in the section, the deposit is not described, and, so far as I am aware, has received little notice at the hands of other observers. It consists of a dark-brown, stiff, stony clay, overlaid by the raised beach-bed, and resting on the tuff of Shooter's Point, against which it abruptly terminates seaward. At this point the bed is about 3 feet thick, and extends in a westerly direction for 50 or 60 yards, or perhaps a little more, towards the mouth of the Cocklemill Burn, and gradually passing below high water mark. The contained stones vary in size from that of a marble up to that of small boulders, and consist of sandstone, tuff, greenstone, and quartz. They are all well rounded, and beautifully striated. Mr Brown's section led me to investigate this clay, and on obtaining samples I at once forwarded them to Mr Bennie for examination, who

* Balingall's "Shores of Fife." "The Flora of Fife and Kinross," p. 147.

shortly after reported " several very white and starved-looking *Foraminifera.*" At once comprehending the importance of this discovery, if a *bona fide* one, we made a further joint-investigation of the deposit, and dug into the bed for a depth of nearly 3 feet, and from the bottom of the excavation thus made we removed several pounds' weight of clay for examination. Although careful search was made throughout this material by Mr Bennie, no further discovery took place. We must not, therefore, lay any stress on the occurrence of these Foraminifera in the meantime.

We endeavoured to clear a surface of the tuff on which the clay rests, to ascertain if it was glaciated. It was, however, in too weathered or decomposed a state to show this, at anyrate to the depth to which we were able to penetrate.

VIII. *On some Spiders from Newfoundland.* By Rev. O. P. Cambridge, M.A. [Plate III.]

(Read 16th February 1881.)

A small collection of spiders made at Brigus, Newfoundland, by Mr Archibald Gray, student of medicine in the University of Edinburgh, and kindly placed in my hands by Mr R. Etheridge, jun. (British Museum), contained three species of *Epeira*, a *Chiracanthium*, and a *Lycosa*. One of the Epeirids appears to me to be new to science; but the *Chiracanthium* and *Lycosa* were in too damaged a condition for their species to be identified. The following is a list of this small collection:

Family Epeirides.

Genus **Epeira.**

Epeira diademata (Clk.).—In the *Proceedings of the Boston Society of Natural History*, 1877, vol. xix., p. 68, Mr J. H. Emerton says that this species " has not been found in America, nor is its place filled by any similar species." Its occurrence, therefore, in Newfoundland, is interesting. Both sexes are among the examples received from Mr Gray. I have carefully compared them with both British and Continental-European examples, and can find no difference whatever.

Epeira obesa (Hentz).—I have never before seen an example of this species, but have no doubt of the identity of those now recorded with the spider described under the above name by Hentz. It is closely allied to *Epeira quadrata* (Clk.), but differs in the femora of the *fourth* as well as of the other pairs, being constantly free from dark maculæ or annuli, while in *E. quadrata* there is always a largish macula or more or less perfect annulus, near the middle of all the femora. There is also a difference in the form of the epigyne from that of *E. quadrata*.

The size of the present spider is perhaps smaller than that of *Epeira quadrata*, though the latter species varies so considerably according to the more or less genial nature of the season, that nothing positive can be stated on this point, inasmuch as *E. obesa* may also vary in an equal degree. The length of the larger of the two examples here recorded is $5\frac{1}{2}$ lines, the other being rather smaller. The pattern on these spiders was very faintly indicated, but it appears to be exceedingly like that of *E. quadrata;* probably a series of examples would enable me to point out some constant though perhaps small differences. The male of *E. obesa* is not yet known. Examples of it would therefore be of great value and interest to me.

Two adult females were contained in the collection received from Newfoundland.

Epeira hilaris, sp.n. Adult female, length, $3\frac{1}{2}$ lines.

Cephalothorax rather short, broad, strongly constricted laterally on the margins at the caput; the occipital region is convex, and, indeed, rather gibbous, its colour is dark red-brown, and its surface is thinly clothed with short greyish hairs.

The *eyes* are in the ordinary position, placed on tubercular prominences, and disposed in three groups, occupying the whole width of the fore extremity of the caput, which is of a greater breadth than usual. The rectangle formed by the four central eyes is much narrower behind than in front, the width behind being about equal to the length of the rectangle. The fore-central eyes are much larger than the hind-centrals, and the intervals separating them are respectively

greater than an eye's diameter. The height of the clypeus is no more than equal to the diameter of one of the fore-central eyes.

The *legs* are tolerably long, 1, 4, 2, 3, and armed with spines of no great strength, the strongest being those underneath the tibiæ of the first and second pairs; they are of a brownish yellow colour, the tibiæ tarsi and metatarsi of the third and fourth pairs distinctly, those of the first and second pairs indistinctly, annulated with deep reddish brown. The femora and genual joints are strongly suffused with a similar hue towards their fore extremities.

The *palpi* are tolerably long, and similar in colour and markings to the legs.

The *falces* are long, powerful, rather directed backwards, and convexly prominent towards their base in front. They are of a deep, rich, red-brown hue, and furnished with bristly hairs.

The *maxillæ* and *labium* are of normal form, of a dark red-brown colour tipped with yellow.

The *sternum* is heart shaped, similar to the falces in colour, and has strongish prominences on its surface round the margin, opposite to the insertions of the legs.

Abdomen large, broad-oval, projecting considerably over the cephalothorax, and extending forwards beyond the thoracic indentation. It is thinly clothed with hairs; the general hue is yellowish, mottled with red brown; two longitudinal strongly angulated black bars, one on each side near the outer margin, strongly edged on their outer sides, and in some parts also on their inner sides, with cream colour, enclose the greater part of the upper surface. The posterior half of the enclosed area is more or less covered with black patches and mottlings, and at its anterior extremity is an oblong, deep, blackish-brown patch, with two small prominent points on each side, and margined exteriorly with cream colour; the sides and under side are marked and suffused with brownish black. From the anterior side of the genital aperture a short, deep, red-brown epigyne is directed backwards close to the inferior surface of the abdomen.

An example of this handsome and distinctly marked

spider was contained among the other spiders received from Newfoundland. It is allied to *Epeira cornuta* (Clk.) and *E. patagiata* (Clk.) of Europe, but is, I think, quite distinct from them, and appears to have been hitherto undescribed.

IX. *Late Chapters in the History of the Squirrel in Great Britain.* By J. A. Harvie-Brown, F.R.S.E., etc. Part III.—Restoration, Resuscitation, and Dispersal of the Species through Scotland: with a Map. [Plate IV.]

(Read 16th February 1881.)

THE MAP.

The accompanying map is not intended to show *with minute accuracy* the present distribution of the squirrel in Scotland, nor the exact extent of the areas populated from each centre. It is merely intended to give a *general* idea of the Faunal divisions of Scotland, and show the *approximate* areas populated from the different centres. The small scale of the map forbade any attempt at precise and exact colouring, nor indeed can our data, as given in the text, admit of any hard and fast line being drawn, showing the limit of the influence of the outward waves of distribution from the different centres, nor the points at which waves from different centres coalesce. The map, it is hoped, however, will assist in a general way, to explain what amount of influence each centre has had in repopulating Scotland.

CENTRES OF RESTORATION IN THE SOUTH OF SCOTLAND, AND ACCOUNT OF EXTENSION OF RANGE IN COUNTIES SOUTH OF THE FORTH AND CLYDE.*

In the latter half of the eighteenth century, the squirrel was introduced from England to the menagerie at Dalkeith, by Elizabeth, Duchess of Buccleuch. This introduction must have taken place, as will be seen in the foot-note, not prior to

* Excluding Dumbartonshire, Stirlingshire, and northward, which districts come to be treated of later.

1767, and probably between that date and 1772, or 1778.* Mr Dunn writes to me as follows:

"I have consulted everybody about here [*i.e.*, at Dalkeith], from His Grace downwards, who are likely to know anything about the matter, and the general opinion of those who know best is, that the squirrel must have been introduced to the menagerie here early in the 17-'seventies.' . . . I think

* A writer in the *Farmer's Magazine* (1802), vol. iii., p. 447, informs us that it was not known *in the Lothians* of Scotland till within the last thirty years (say 1772), when it was said to have been introduced by the "benevolent Duchess of Buccleuch." The general belief at the present day, in the neighbourhood of Dalkeith, is that "Elizabeth, Duchess of Buccleuch, the present Duke's grandmother," introduced the squirrel to the menagerie then kept in the park, "about 100 years ago" (say 1778); and Mr Malcolm Dunn, of Dalkeith Gardens, informs me that this is probably correct, as the menagerie was established by "Duke Henry" (her husband) soon after his marriage (in 1767), and after he had settled at Dalkeith. A correspondent—J. Mitchell, Esq. of Morepark, a native of Dalkeith—tells me (*in lit.*, Jan. 8, 1879) that—"When a boy, eighty-five years ago, and then seven years of age, and when going through the woods around Dalkeith, the squirrel was quite a common sight;" and adds—"it did not excite my surprise, as if it had been newly introduced." This date would therefore be fixed at 1794. The "Old Statistical Account of Scotland" bears evidence of its comparative abundance, and of its subsequent increase and extension of range in the county, and elsewhere, at that date (1791 to 1795), as will be seen further on in the text.

We must put aside as confessedly imperfect—and consequently inaccurate—the evidence of the Earl of Home, who, writing in 1868 to Mr Tate, says: "I cannot tell the year, but to the best of my recollection, it was more than sixty-six years ago" (*vide* Tate on the Squirrel, *Proc. Berw. Nat. Club*, 1868, p. 441), which, taking sixty-six years previous, would put the date of introduction as late as 1802 (*vide* text under 1802, p. 117). Nor can we accept his repetition of the same statement as recorded by Mr Knox when writing in 1872 ("Autumns on the Spey," 1872), that "squirrels were unknown there seventy years ago," again assigning 1802 as the date of introduction. I think we have abundant testimony—published and otherwise—to show that it must have taken place at a very much earlier date. That the memory of—or rather the importance of the fact of—its introduction must have passed away by the year 1845, is perhaps partially shown by all absence of record of it in the "New Statistical Account" of Edinburgh or Mid-Lothian (vol. i.). Fleming, writing in 1819, tells us: "The squirrel is common in the wooded districts of the middle and south of Scotland;" but curiously, he makes no mention of the introduction at Dalkeith, although several contemporary writers do so, as we have shown above (*vide* Constable's *Edinburgh Magazine*, iv., p. 507, June 1819). *Note.*—There appear to be three articles on Scottish zoology by Professor Fleming in the *Edinburgh Magazine*, viz., in numbers for May 1818 and June 1819.

you will be *very near* the date of introduction by saying *about* 1772, but it is possible that this may yet be definitely fixed."

Its progress thence can be traced with some amount of exactness, until in 1802, it had spread through most of the forests of Mid-Lothian and East Lothian.* Professor J. Walker, of Edinburgh, writing in 1795, tells us that—"The red squirrel has become extremely common of late years. In this neighbourhood—Glencorse parish—the woods abound with them, and they are pretty numerous at Woodhouselee."† Dating a little further back (1791) we find that it "has lately arrived at Penicuik, from the menagerie of the Duke of Buccleuch,"‡ and in the "Beauties of Scotland" § (1805) it is further mentioned that "the red squirrel has become extremely common of late years on the banks of the Esk." ||

Tate also puts on record that it spread "to Arniston, about twelve miles from Dalkeith, and thence to Selkirkshire."¶

The next notice of it in the county which I can find is not till 1845, when it is stated that "squirrels gambol in all the trees of the larger woods" of Borthwick parish.**

The "New Stat. Account" is meagre in the extreme in its records of the animal in this county, the short-lived wonder having ceased.

Of the counties marching with Mid-Lothian, or influenced in the population of squirrels, we may here mention, *first:*—East Lothian, which, as we have already seen, was well populated by the species by the date of 1802.††

Then proceeding to counties southward (in which direction the waves of advance of this species appear always, and from whatever centre in the south of Scotland, to be *weakest*, as we hope to prove as we proceed), westward, eastward, north-westward, and north-eastward (being those

* *Farmer's Magazine*, 1802, vol. iii., p. 447.

† "Old Stat. Acct.," vol. xv. (1795), p. 439.

‡ *Op. cit.*, vol. i. (1791), p. 132.

§ "The Beauties of Scotland," Edinburgh, 1805, vol. i., p. 284.

|| "Old Stat. Acct.," vol. i., p. 204.

¶ *Proc. Berw. Nat. Club*, vol. 1863-68, p. 440, *et seq.*, but read on.

** "New Stat. Acct.," Mid-Lothian, vol. i., p. 161.

†† *Farmer's Magazine*, 1802, *l. c.*

directions in which the strongest waves press forward), we find that in Peeblesshire they were "rather rare" in the county in 1841,* though apparently believed to have come from Dalkeith, at which place the introduction is noticed; and again of the parish of Newlands, which is one of the parishes nearest to Mid-Lothian, we are told that—"within thirty or forty years the brown squirrel has found its way hither from Dalkeith."† The date of this volume of the "New Stat. Account" being 1841, and putting the *earliest* date at which the squirrel is by this account recorded as reaching the north of Peeblesshire, we find it fixed at about 1801, by which time, as we have seen, it had populated most of Mid and East Lothian,‡ showing the tardy advance in a southerly direction, as compared with that in westerly and easterly directions.

Continuing our examination of districts southward of Dalkeith, I do not consider that Dalkeith introduction exercised much influence on the extension of range anywhere in a south-easterly direction beyond the confines of the county; indeed, I am not at all clear that *even within the county* some of the localities do not owe their population to the more southerly introductions at Minto, and at The Haining, near Selkirk. We find the statement, significant in its appropriateness to our argument, that "squirrels have appeared (in Galashiels parish), but do not seem to have gained a residence; which, for the sake of game and singing birds, is little desirable."§ Now, at that time (1841), there was no lack of timber-clad ground in the parish of Galashiels itself, and later, when the young plantations got up about Abbotsford, squirrels began to be more abundant, as I am informed by Dr J. A. Smith, on the authority of John Swanston—Sir Walter Scott's forester and gamekeeper. There can be little doubt that these came from the south, either direct from the Minto Centre, or resulted from a few which were sent to The Haining, near Selkirk. ‖

* "New Stat. Acct.," Peebles, vol. i., p. 112.

† *Op. cit.*, "Peebles," vol. iii., p. 136.

‡ *Op. cit.*, "Mid-Lothian," p. 161.

§ *Op. cit.*, "Selkirk," p. 15.

‖ See under Minto Centre, further on, p. 120.

Further, we find that Berwickshire owes nothing to Dalkeith for its squirrels,* and nothing was known of them in Roxburghshire, until their restoration—in 1827—at Minto.

In a south-westerly direction, I believe the waves of advance *may* have been more considerable than in a south and south-easterly direction, but I am inclined to believe that the source of the population of the Lanark districts is only traceable, *in part*, to the Dalkeith influence. We cannot admit that the latter reached so far south into Lanark as the parishes of Crawfordjohn,† nor even so far as Lamington,‡ and I even consider it doubtful if Walston parish § owes its stock to Dalkeith, *because* we have already seen that squirrels had failed to establish themselves at much nearer localities—such as Peebles and Galashiels. The Vale of Lower Clydesdale—*i.e.*, from about Lanark and northwards and north-westwards,—I believe to have been populated from Dalkeith;‖ but any locality south of Lanark and Walston I consider to hold squirrels of Minto origin, and we have already seen that they were comparatively long in reaching Newlands parish—a much nearer locality to Dalkeith, and upon the same general line from that centre.¶

About this point, at all events,—Walston in Lanark,—we may fairly expect to find that the two stream-waves of Dalkeith and Minto *met*, the vanguard of the Minto overtaking the rearguard of the Dalkeith, and *together*, assisting in populating the country north of the Firths of Forth and Clyde.

Westward and north-westward from Dalkeith, we find the record that they abounded in the parish of Abercorn, in Linlithgow,** and Mr J. Colquhoun, in 1831, found them

* See under Minto Centre, further on.

† "New Stat. Acct.," Lanark, p. 500.

‡ *Op. cit.*, p. 811.

§ *Op. cit.*, p. 851.

‖ See further on, p. 125.

¶ See under Minto Centre, further on, p. 125.

** "New Stat. Acct.," Linlithgow, p. 20. In one district of Linlithgow, however, they have become all but extinct. Ten years ago they were very numerous and constantly bred; now they are not to be seen. Captain N. H. Leckie is unable to say if they decreased gradually or suddenly, having been much abroad of late years. The keeper who has been there for two years has

everywhere in large numbers both here and beyond the Firths in Stirlingshire * (q.v.).

In North Lanarkshire, we find that, "though formerly a stranger in these parts, it has become of late common throughout all the wooded districts of Clydesdale. † It had reached into Cadder, ‡ Cambuslang, § and Cambusnethan, ‖ where it had established itself throughout the whole of the district."

Of its occurrence in Lanarkshire, we find no mention in the wonderfully exact work of David Ure—"The History of Rutherglen and East Kilbride," published in 1793.

Before tracing their advance further northwards, we must cry back and pick up a dropped loop in our chain of evidence, and recount the interesting particulars of the Minto restoration in Roxburghshire, which, as I will show, must be considered as the centre for another tract of country. Thereafter, an examination of the Map (Plate IV.) will assist in making the areas populated from each centre more easily understood.

Minto Centre—Roxburgh.

Regarding the former occurrence of the squirrel on the Borders, see remarks on "Historical Evidence in Scotland" (Part II., *antea*, p. 37).

Squirrels were unknown in the county when the present century began, and it was a rare sight fifty years ago,—say 1830.¶ Tate ** states that it was "not resident so much as half a century in Wolflee woods, near Hawick." Tate, writing in 1868, would place this date within 1830. There were "none in 1820, when Sir Walter Elliott left his home:

only seen one or at most two in that time. Captain Leckie is quite sure there has been no organised destruction of them on the adjoining properties nor there, and he suggests the possibility that the smoke from neighbouring paraffin works may have driven them away. This is quite possible, I believe, if the trees are affected by the smoke (Letter from Captain N. H. Leckie, The Thorns, Uphall, Linlithgow).

* J. C., *in lit.*

† "New Stat. Acct.," Lanarkshire, p. 424.

‡ *Op. cit.*, p. 404. § *Op. cit.*, p. 424.

‖ *Op. cit.*, p. 611.

¶ Mr R. Smail, *in lit.*, 12th December 1878.

** *Loc. cit.*

but, in 1835, his father offered rewards for every squirrel killed."* Clearly, then, the Dalkeith introduction had no natural and direct influence here.

I am glad to be able to record, with considerable exactness, the date of the introduction at Minto, through the kindness of my valued correspondent, Mr Malcolm Dunn, of The Gardens, Dalkeith. He writes to me under date of 23d December 1878, and I give here his communication in full:

"I believe," writes Mr Dunn, "I have been fortunate in getting exact data in reference to its introduction to Minto, and that part of the South of Scotland. . . . A Mr Thomas Inglis, who has been on this estate since 1826, and whose father was a gamekeeper in Roxburghshire in the beginning of the century, where Thomas was born in 1805, remembers distinctly that there were no squirrels in that part of Scotland until about two years previous to his coming to Dalkeith (say 1824). Before leaving the south, he was acquainted with the gardener at Minto—a Mr Goodall, an old Dalkeith man;—and when Inglis came to Dalkeith, Goodall asked him as a personal favour to send him 'some squirrels,' which he knew were plentiful here some years before, when he was serving as a journeyman in the Gardens. This Inglis was enabled to do easily, as he was then employed as underkeeper; and, he tells me, he climbed the trees and took the young squirrels out of the nests, and after rearing them for a short time, he sent some of them to Mr Goodall at Minto, and the rest to his own father, who let them loose at The Haining, near Selkirk.† This he confidently assures me he did in the end of the summer (probably July or August of 1827), and that, previous to this, the squirrel was unknown in the south-east counties of Scotland. At Minto they were kept for a year or two by Mr Goodall confined in a large cage or small house, situated in the old orchard attached to the gardens there, but 'somebody' left the door of the cage open,

* *Loc. cit.*

† Making it still more unlikely that the Galashiels record (*antea*, p. 118) was applicable to pioneers from Dalkeith. Two pairs, *i.e.* two males and two females, were sent to each place—Minto and The Haining.

or opened it on purpose,* and the squirrels quickly escaped to the woods, to the no small vexation of Mr Goodall. That," continues Mr Dunn, "is the history of the introduction of the squirrel to the south, as given to me last Saturday by Mr Inglis, and I have no reason to doubt his statements. In fact he told me all about this some three years ago, when I happened to be talking to him about the injury done by squirrels to some trees in the park (Dalkeith), and when I asked him on Saturday, he repeated the whole, in, I believe, almost the same words as when he first told me."

As we have seen, they became so abundant by 1835, that orders went forth for their destruction at Wolfelee, near Hawick; but there is no record of their reaching southward at all, until we find that in 1841, "squirrels latterly have been seen in the woods" of Hobkirk parish,† a few miles south of Minto. ‡

There is no mention of squirrels in Wallis' "Nat. History of Northumberland," written in 1768 (p. 405), and even, as late as 1868, Tate (*op. cit.*) mentions that it had not then reached into East Northumberland.

No doubt the range of the Cheviots would, together with the natural disinclination of the species to travel southwards, deter them from a rapid extension into Northumberland. Mr A. Brotherston, of Kelso, considers that the most likely routes they followed from Minto into Northumberland was down the Teviot (north-east) to Jed-foot; then up the Jed valley,—most of which is wooded,—less or more; across the border by the road over Carter Fell to the head of Rede Water in

* Corroborative of this, curiously enough, I have another account from quite another source, which states: "It—the introduction—was due to a gardener at Minto of the name of Crichton, *who let go two pairs from a cage*" (Mr Smail enclosing a letter from Mr John Steele, factor at Minto, dated 24th December 1878), and I have other corroborative evidence besides.

† "New Stat. Acct." of county, p. 211.

‡ Unless indeed we accept Mr Jerdon's record ("Zoologist," 1843, p. 348), as applying to the south of the county also. He says (*op. cit.*), "Not common in Roxburgh until lately. Within the last ten years (say since 1833) or so, its numbers have much increased, and it is now spread over *nearly* the whole county." In 1845, a few are reported to have existed in the county, "but not plentiful," which remark probably applies to some of the outlying districts of the county.

Northumberland; or by descending still further to the Tweed at Carham, they would reach Northumberland and spread over the county without requiring to cross any bare hilly parts. This latter route, I think, is the most probable one.

Since this paper was first written out and communicated, Professor Duns has informed me of an earlier extension from the Minto Centre, reporting the squirrel to have been "not rare at Langton and Dunse Castle a year or two before 1832." Professor Duns also takes notice of having seen one himself there about that time "with a tail almost white and the rest of the body very light coloured," a variety which I have frequently myself observed in the Loch Ard and south-west of Perthshire district. Speaking of varieties, I can distinctly remember chasing a black squirrel in a hedge-row not far from Dreghorn Castle, near Edinburgh, in or about the year 1860, along with a schoolfellow.

Professor Duns' earlier date, I consider, comes still under the Minto introduction, and since this paper was read, and Mr Scot-Skirving and Professor Duns wrote to me on the subject, I have received additional evidence, which to my mind clearly shows that, *to the Minto Centre* belongs the extension through the whole south-east of Scotland up to the Kirkcudbrightshire March, and that North-east Northumberland also owes its squirrels to the same source.

Eastward, however, they reached the Rutherford estates, about the year 1831, when the first seen was chased for half a day by all the woodmen employed on the estate, which is about ten miles east of Minto. They were protected for a time, and increased in numbers. The first raid upon them was in 1837. Between that date and 1843, thirty-two days were devoted to killing squirrels by from two to five men. In 1844, forty-one were killed in six days. In 1845, two men in seven days killed 117. In 1846, eighty-eight were killed in seven days. From 1847 to 1855, thirteen days were employed by from three to six woodmen in killing squirrels. Since 1855, the keeper and forester, Maclean, who is my informant, keeps them down by his own exertions. He has never shot more than ten in a day. His terrier is trained to "tree" them.

Towards the north, the first squirrel was seen in Lauderdale in 1838 or 1839. About ten years afterwards they had increased to a considerable extent, not having been interfered with. Orders were, however, then given to kill them down. This route up Lauderdale appears to me to indicate that the squirrels which appeared at Galashiels in the parallel valley of the Gala also came northward, and cannot be assigned to Dalkeith origin.

Berwickshire.

They appeared in Penmanshiel wood, as I am informed by Mr James Hardy, somewhere about 1830-31. This is the largest collection of wood in the neighbourhood of Cockburnspath, being aboriginal wood planted over. It was noted for its abundance of hazel bushes, but they were cut down and other trees planted. A nest found was the first intimation of their presence. They are not, however, numerous even now.

But at the Hirsel, near Coldstream, in Berwickshire, they appeared not until about 1841, "to the great astonishment of the people in the neighbourhood, who had never seen one before."* At Dunse they were present in 1847, and shortly afterwards at Chirnside.

Of the former occurrence of the species in Berwickshire see under remarks on "Historical Evidence in Scotland."†

Mr Tate notes that one had been seen at Akeldene "about seventeen years ago" (*i.e.*, previous to 1868) say 1851, which probably was the beginning of them in Northumberland;‡ then that they were first seen at Coupland woods about 1858 ("ten years previous"); and Mr J. C. Langlands reported their appearance at Old Berwick in 1868.§

* Tate, *loc. cit.* † Part II., *antea*, p. 37.

‡ Mr Hardy writes to me, however, that with regard to the introduction of the squirrel into Glendale in Northumberland, bordering the Tweed, he had been told by people at Wooler "that a vehicle carrying squirrels from one part of the country to another had broken down on the public road on Milfield Plain, and some of the imprisoned inmates escaped;" but Mr Hardy appears to consider that there may be some invention in this report to account for their sudden appearance.

§ Tate, *op. cit.*

Peebles—Selkirk.

Northward and north-westward, we find that they rapidly pushed as far as Galashiels.*

Lanark.

More westward, we find them stretching to the confines of Lanarkshire at the Culter Plantations, on the eastern borders of Lamington parish, prior to or about 1841,† and Biggar,‡ and also reaching Crawfordjohn parish at the same time, where, however, it was "seldom" seen; § Walston parish ‖— "seen occasionally," and included in Douglas parish, ¶ in the west of the county. By 1868, we find they had become plentiful at this locality,** but it was not till 1870 that they were observed in the adjoining parts of South Ayrshire (q.v.). If Ayrshire was indebted to the overflow from this centre, I believe this to have been a likely avenue of advance into Ayr Water. But if due to a more southern centre—as Cumberland,†† then we must look for it from Dumfriesshire. But again I will show that it is more than

* As we have seen under Dalkeith Centre (*antea*, p. 118). In further support of this, Mr James Smail has favoured me with the following: "From a little below Selkirk there are almost continuous woods on the south side of the Ettrick, and thereafter on the Tweed, down to below Abbotsford, opposite to Galashiels, and about a mile from that town. All these woods would be excellent harbours for squirrels at that time (between 1827 and 1841). The country between Selkirk and Minto is much better wooded now than formerly, but between 1827 and 1841, there were very considerable woods here and there between the two places, which would afford suitable refuge for squirrels. The woods in the Lilliesleaf district on Ale Water, between Selkirk and Minto, were large and great in growth at the time between the years named, and like the fine woods at that time at Minto—in first-rate order for the abode of squirrels. I may mention that the old woods below Abbotsford lead, more or less, to Melrose Bridge, by which squirrels could cross into the woods between this (Galashiels) and Melrose."

† "New Stat. Acct.," Lanark, p. 811.

‡ *Op. cit.*, p. 358.

§ *Op. cit.*, p. 500.

‖ *Op. cit.*, p. 851.

¶ *Op. cit.*, p. 480.

** In a letter before quoted, written about that time (1868) by the Earl of Home to Mr Tate (*vide Proc. Berw. Nat. Soc., ut sup.*).

†† *Infra*, p. 126.

probable it was not indebted to either, but to an independent restoration. (See under *Ayrshire.*)

There is no mention of squirrels in North Lanarkshire made by Ure in his account of the animals of East Kilbride ;* nor in the "Old Statistical Account" is any notice taken of the species in the county.

North-west of England: Dumfriesshire and South-west of Scotland.†

There was an early introduction of the squirrel at Southwick, in Wigtownshire, about fifty years ago (but the exact time is uncertain), as I am informed by Mr Service. Mr Stewart, of Southwick, brought a number of squirrels from some part of England, and turned them out at Southwick. It seems that in that part of the country, they became dispersed for a time, but ultimately died out, no doubt from a

* "History of Rutherglen and East Kilbride." Glasgow, 1793.

† Since this paper was read, Professor Duns, of Edinburgh, has informed me of an earlier date for Dumfriesshire. He writes : "In 1843, I saw one cross the road near Springkell, Dumfriesshire. An incident occurred which makes this quite sure."

On the other hand, Mr Scot-Skirving assures me that he "*knows* there were no squirrels in Kirkcudbrightshire when he was a boy," which would date about the same time as Professor Duns' note above in the adjoining county.

If, as Professor Duns considers, "the Cheviots could be no bar to its spread from Roxburghshire or Berwickshire, by the banks of the Tweed from the one county, or by the woods at the top of the Merse in the other, it could easily find its way by Coldstream, Wooler, etc., into Northumberland ; then there seems an equal probability that it would press its way westwards into Kirkcudbright and Dumfriesshire, but I have shown that these are the points of greatest resistance to waves of distribution from Minto, and that, according to natural laws, in my opinion, the strongest waves would flow more to the north-west.

I am borne out in this view by Mr Robert Service, than whom I believe there is no better authority for the south-west of Scotland. He writes (Feb. 22, 1880) : "I am still of opinion that most of the Dumfriesshire squirrels originated from Cumberland. Springkell is only about ten miles north-west of Houghton House" (elsewhere mentioned in this essay), "in Cumberland, where I told you they were abundant in 1855, and had been so for, at all events, a good many years previously. Once on the move, there is nothing to prevent squirrels spreading all over Dumfriesshire, from north-west Cumberland, and, of course, the Kirkcudbrightshire squirrels could only come naturally from Dumfriesshire."

want of sufficient shelter, and scarcity of wood. A nest containing young was found at Mabie, which were probably descendants of the Southwick squirrels, as Mabie is ten miles from Southwick in a direct line, and Mabie is a locality in Kirkcudbright, about five miles south-west of Dumfries, and until the last ten years densely wooded.

These appear to be the only items we can glean of its appearance there until a very much later date. All the old people consulted by Mr Service—to whom I am entirely indebted for all data from the south-west of Scotland—do not remember ever seeing squirrels until within the last sixteen to twenty years. Mr John Heysham, M.D., of Carlisle, in "A Catalogue of Cumberland Animals," contained in "The History of the County of Cumberland" (1794), says: "The squirrel: this is a lively, active, and provident animal, but not very frequent, except in the neighbourhood of the lakes. In Cumberland and Westmoreland they are called *conns*." This shows their rarity in the north of England and south of Scotland at that date.

Mr Service says further: "I have no doubt that the Dumfriesshire squirrels [*i.e.*, of the present time], though supplemented by introductions, had their origin in Cumberland. They have increased much more rapidly than they could possibly have done were the several introductions the first of the race." I quite agree here with Mr Service, and I think the following data collected by him go to prove that Dumfriesshire and Kirkcudbrightshire owe their squirrel population to the combined dispersal naturally from the north of England, along with that from several small introductions.

However, in the south of Dumfries, Mr James Telford gives evidence of their appearing in Canobie parish, in 1837, in Liddleside. They then increased rapidly until last spring [1879], when they suffered sadly from the storms of winter, and a great many died. Mr Telford adds that a man in Langholm parish relates that he had hunted squirrels in Dean Banks about 1833. Another correspondent of Mr Service's puts the date much later for Canobie, and says that it was not till 1847; but of course we must accept the earlier positive date. It is quite the general impression that they came from

the south, and were seen in Canobie before they were known in Langholm to the north of Canobie. But Mr George Johnstone, forester, Castlemilk, Lockerbie, informs Mr Service that in 1854 there were a few in the Lockerbie woods, possibly a dozen. He was told by the older inhabitants that about ten years before that, a pair had been brought and let off—say 1844.* Mr Johnstone adds that they perceptibly increased every year up to 1878. "Their numbers might be about four times that of 1854. This year their numbers are much less, which I attribute to the long and severe winter."

Mr Dalziel, forester and gamekeeper at Hoddam Castle, says there were none there till 1850. "In that year a pair made their appearance. The old woods of Hoddam are very extensive, and abound with hazel, oak, and beech, which give the principal food of the species." Mr Dalziel thinks there may be 400 or 500 squirrels now upon the same number of acres of woodland. Mr Dalziel came to Hoddam in 1848 from Raehills estate. He says there were no squirrels on that estate or anywhere in the neighbourhood of Moffat† at that time.

Mr Robert Service—to whom I am entirely indebted for my data from Dumfriesshire—writes me as follows: "James Service (my father) never saw a squirrel alive until he went to Houghton House, near Carlisle, in 1854. He had been previously in Argyleshire, Bute, and twenty years in Ayrshire. My mother always resided in the neighbourhood of Dumfries, and never saw squirrels until she went to Houghton. They were strictly preserved there, and in winter were fed in front of the mansion." In the same year Mr John Croll reports having seen squirrels "when coming on the coach by the Langholm and Langtown road across by Gretna to Dumfries."

In the neighbourhood of Dumfries they seem to have appeared for the first time about 1860, according to evidence collected by Mr Service. Mr W. Lennon, Crichton Royal Institution, Dumfries, who was born and has resided in Dumfriesshire all his life (aged now sixty-five), says the first

* If an actual and successful introduction took place then, it is quite possible that even Carlisle owes its population to this centre.

† In the north of the county.

squirrel he ever saw alive was in 1860, in some trees at Mountain Hall, near Dumfries. It was also the first seen in the district by the late Thomas Aird, the Poet, who was with him at the time. In 1862, Mr Lennon saw his second squirrel on a tree near Bruce's Castle, at Lochmaben.

Mr James Graham, gardener, Marchbankwood, near Moffat, says: "The first squirrel I ever saw was at Symington, Lanarkshire, in October 1854. I came to this parish—Moffat—the following spring, and I am certain there were none here then. I entered on my services at Marchbankwood in April 1858, and I cannot be positive of ever seeing a squirrel earlier than 1862 in this place." He adds, "They have never been abundant here, and I have only seen one this summer. I think the past winter has had a severe effect upon them." *

"In 1867," Mr John Maxwell, Inspector of poor, Maxwelltown, Dumfries, says, "that he was at a funeral which was going to Morton Churchyard (in Upper Nithsdale), from Dumfries. When passing Ellisland (Burns' farm) a squirrel jumped from one tree to another across the road, and *over the hearse*, and so scarce were squirrels then that few of those present knew what it was." †

By 1870 we trace them into Tynron parish, in the west of the county, where they had not appeared before on the authority of Mr James Shaw, parish schoolmaster there, for seven years or so previous to that date.

In the south of the county they had become abundant, however, before this time. Mr David Cram informed me that in November 1861, he and a friend saw and counted seventy-one squirrels within a quarter of a mile of road lined with oak trees, in the middle of a wood in Canobie parish, at Langholm, Dumfries. In Dumfriesshire squirrels were "becoming very common in the neighbourhood of Dalscone wood, and are rapidly spreading over the county." ‡ They are still (1879) quite rare on the western side of the Stewartry, and in Wig-

* On the other hand, never have squirrels been so numerous in Perthshire as they are this season—1879—local migrations causing a crowding to the best sheltered places.

† Oral information supplied to Mr Robert Service.

‡ Newspaper slip: "Dumfries, Sept. 5, 1876."

townshire almost unknown. There are now, however, plenty of squirrels in the Camlougan woods (Earl of Mansfield's), and Mr Service thinks they probably made their first appearance about the same time that they appeared elsewhere in the county—*i.e.*, about 1862 or 1863.

Kirkcudbright.

Squirrels did not arrive in Kirkcudbright before 1860 or 1861. My correspondent, Robert Service, Esq. (Secretary, Dumfries and Galloway Naturalists' Club), tells me he did not see them commonly before 1868, and he is of opinion that they came "from Cumberland through Dumfriesshire," which, if it is the case—and I see good reason for the belief—points to a further exemplification of the strong north-westerly pressure, and the comparatively weak south-westerly.

Arriving in the south of Lanark as early as 1841, of course there appears the possibility that they might come southwards to Kirkcudbright by 1864; but I hold that this is contrary to all our experience of their pioneering movements, especially through an unwooded country, and when there was freer exit in more northerly directions, in better timbered tracts.

In 1861, they are reported as seen for the first time in Buittle parish;* and, in 1862, squirrels are reported as numerous in Carruchan, Dalscairth, and Hillswood, in Troqueer parish, in the east of the county.

In 1865-66, they were first observed in Parton parish, at Corsock, by Mr John Croll, and it is Mr Croll's impression that they came up the river Urr, as they were seen a twelvemonth before at Glenlair. Mr Croll further writes, regarding the direction from whence they came: "When I was in the Hawick district, or Teviotdale, they were very abundant, and larger than here, and it is said they went from there to the district of Langholm, and from there to the Annan, and from that again to Nithsdale, and round the Solway shore by Dalbeattie, and up to this quarter. Some years ago one was seen with a piece of stick drawing it to Urr. It then wrought it into the water, then leaped on it and crossed the Urr on it to

* *Auct.* James Matheson, Dalbeattie.

the other side, and when near the side leaped off the stick on to the bank."*

The above seems possible, but I take the parallel dispersals from other centres, and I think we are bound also to consider the natural barriers in the mountainous tract intervening and the natural faunal divisions. If introduced at Castlemilk, in Dumfriesshire, then the spread westward is easily understood; but we can hardly at present admit that they crossed naturally over from Roxburgh.

In 1875, the first squirrels were seen at Dildawn, in Kelton parish, but they are reported to have been seen at Argrennan a few years previous to that date. Argrennan is an estate on the opposite bank of the Dee from Dildawn, or west bank. Since then they have become numerous.

Mr Hugh Aitken writes from St Mary's Isle, parish of Kirkcudbright: "It is not more than four years since squirrels were seen here,"—say 1874 or 1875,—and he adds under Dumfriesshire, "There were none at Closeburn Hall, Closeburn parish, West Dumfriesshire, when I was there sixteen years ago."

The gamekeeper on Glenlee, Kells parish, states that squirrels first made their appearance there in 1867, but the keeper at Kenmure, adjoining, says, it is only about four or five years since they were first seen there. The latter informant thinks they came from Hensol—another property in Kells parish, where they were seen fifteen years ago—say 1864.

In 1869, squirrels had reached the south of the county, one having been seen by the gardener,† at Arbigland, parish of Kirkbean, in that year. Since then it has become very numerous, and orders for their destruction have gone forth.

Mr Service, however, believes that a pair of squirrels from Perthshire were turned out in a Kirkbean wood in 1867, and that these may have produced young.

* I am quite unable to give any thoroughly reliable evidence, from an actual eye-witness, of this method of crossing rivers as reported by several correspondents. Many similar reports have reached me. I have, however, received undoubted evidence of their crossing water by swimming (*vide infra*, p. 169).

† Mr Charles Black, a well-known naturalist and botanist (*vide* "Good Words," April and May 1878).

In the neighbouring parish of Colvend no notice is taken of squirrels in a list of the animals in a history of the parish, published in 1870, but they are reported as having been observed there, "about eight years ago, and then only a single pair,"—say 1872. These were in Barnbarroch woods, and were supposed to come from the adjacent and larger woods of Munches. It has been conjectured that they came there from the woods of Chambellie, in New Abbey (*auct.* James Frazer). To this Mr Service adds: "Munches is in Urr, Chambellie is in New Abbey, the next parish to Troqueer, and if the Colvend squirrels came from Chambellie they may have gone by way of a wooded glen in the Criffel range of hills, which is almost in a direct line to Colvend."

In Rerwick parish we have no accurate record of their first appearance, but it being a sea-board one, the squirrel would have to come over a range of bare hills from the eastward, or down the valley from Galston or Dalbeattie direction by north or north-east.

About six years ago—say 1873—squirrels were first seen at Cardoness in Anworth parish, near Gatehouse, in the south-west of the county.

Another of Mr Service's correspondents, however, claims to have turned out an old squirrel and some young ones about fourteen or fifteen years ago—say 1867-68—at Cally, near Gatehouse.* Yet another informant agrees with the latter statement, saying that "I think it was about fifteen years since the first was seen at Cally." The latter adds, "I believe there was one killed at Bargaly. There was also one seen as far west as Cumloden Cottage about a year ago." Mr Service adds to this note: "Bargaly and Cumloden are away near the borders of the Stewartry with Wigtownshire, and indicate the western limits of the distribution of the squirrel, I think, at the present time."

It will be seen from the above that considerable difficulty attends a minute investigation of the lines of dispersal in the south-west of Scotland, owing to various minor introductions; but the district so populated, can, with sufficient accuracy, be mapped out.

* *Auct.* Thomas Millar, late gardener at Cally, now at Strathallan Castle.

Wigtownshire.

I have received, up to date of 1879, abundance of negative evidence from this county. The squirrel as yet is unknown, or next to unknown, in the county.

In 1873 also, they are reported to have reached to the Wigtown Border on the banks of the Cree, as a few were seen that year in Cumloden wood, parish of Minnigaff, opposite to Penninghame, in Wigtown.

Bute.

An unsuccessful introduction was made in Bute, about seven years ago, by Lord Bute. Mr John Wilson informs me that it is believed they are all dead.

Ayrshire Centres.

INTRODUCTION AND EXTENSION IN AYRSHIRE.

The history of the squirrel in Ayrshire, as far as I am able to learn, is as follows.

There is no mention of it in the "Statistical Account" of the county (1845). In 1867 it is said not to be found in Ayrshire.*

I am able exactly to place the introduction of the squirrel in North Ayrshire. Mr David Landsborough informs me that Mr Taylor, factor at Barskimming, Mauchline, brought a pair of them from Dumfriesshire thirteen years ago—say 1866. One soon made its escape (presumably the female), and afterwards, Mr Taylor began to hear of the squirrel being seen in Barskimming woods, where before long they became abundant. *Now* they are abundant in Barskimming woods, and prove a great nuisance. They are also abundant in Dundonald and Eglinton woods.

In the Hunterian Museum there is a squirrel which was presented by Mr Allan Walker, Kilbirnie, Ayrshire, in 1869; and Mr John Young informs me that Mr A. Walker was a medical student, and his father was then medical practitioner at Kilbirnie. The ticket states that it is in its autumn coat,

* "Zoologist," 1867, p. 668.

so it was probably killed in the autumn of that or the previous year.

"They first made their appearance in South Ayrshire up the Water of Ayr, about eight or nine years ago (*i.e.*, 1870). Next at Martinham estate, between Joppa and Dalrymple. Next at Cassilis estate, and about the same time at Culzean, where the first seen was caught in a rabbit stamp about seven years ago (*i.e.*, 1872). They are numerous on Cassilis now (1878-79). They have increased greatly within the last three years (1876-79), and the keepers kill lots of them now, and they are seen daily. My opinion is, they come from Dumfriesshire."*

Further, another correspondent writes: "There are none at Monreath or neighbourhood as yet (1878-79). This is conclusive," says the writer, "they must have come in from the east side of the county." A Mr M'Crerich, however, rather upsets all this by the statement that "they were introduced by navvies who came to work at a viaduct on the Water of Ayr some eight or nine years ago (*i.e.*, about 1870). They brought them as pets, and they escaped." Mr M'Crerich says also: "The first squirrel seen in Ayrshire was at Gadgirth, about seven years ago (say 1871), and was brought into my shop to be stuffed. Then they spread to Ochiltree, and every year, becoming more and more common, have now reached as far as Muirkirk (1878)."† This lumping of localities all south of Ayr Water certainly is puzzling, unless, as Mr M'Crerich says, they were introduced by the navvies, in which case the one got in 1870 "up the Water of Ayr," probably came *up* the river, and they "now have reached as far as Muirkirk" (1878), which locality lies still further up the Ayr Water, not far from the boundary of the county, and not far distant from Douglas Castle, in Lanark. It is thus more than probable that Ayrshire is indebted to two separate introductions for its population. They have also been seen on Bargany estate, adjoining Kilkerran (1878-79), and Dalgharroch on the Stinchar, and once on Glendoune, near Girvan, in 1880.

* Letter from Mr J. Cox to Mr J. G. K. Young, 19th Dec. 1878.

† Letter from Mr J. Cairns to J. G. K. Young, Esq., 21st Dec. 1878.

An account gleaned on the spot by Mr Robert Gray, however, differs somewhat from any of the above accounts, in so far that the introduction is believed to have been made, in the first instance, by a butler in the service of the Marquis of Ailsa about 1872. The dates given above, however, prove an earlier presence of the species.

FURTHER EXTENSION FROM DALKEITH AND MINTO CENTRES TO THE COUNTIES NORTH OF THE FIRTHS OF FORTH AND CLYDE.

Stirlingshire.

Following the combined armies from Dalkeith and Minto, we find them pressing northward through the isolated portion of Dumbartonshire into Stirlingshire. Seeing, however, that squirrels had reached as far north as Kincardine parish in the south of Perth, by 1821, and only got westward to Campsie about 1827—the year of the introduction at Minto—it is perhaps more correct to assign the population of the following counties direct to the earlier restoration at Dalkeith, only *assisted* by the later fresh blood and vigour of Minto.

The earliest negative evidence of the squirrel in Stirlingshire, which I have been able to get is from an old woman still alive, who relates that when she was young she had heard of the "strange beast;" and who, in her ignorance, had pursued and captured a weasel, believing it to be a squirrel, which latter she was desirous to have, *because she had heard* that they made fine pets. She got well bitten, and found she had caught a Tartar. This was somewhere about the year 1810. Somewhat later than this, another person was bitten by a tamed squirrel, and bears the mark to this day, which mark I have seen. This would be about the year 1820 or 1825.

Squirrels are well remembered to have entered the county in the beginning of this century, according to various accounts sometime between 1810 and 1815. One was seen crossing the Forth and Clyde Canal going north, and coming from the isolated part of Dumbartonshire. It was sitting upon a chip

of wood, according to my informant.* Mr William Rennie, Tipit Craig, was born in 1793, and he never remembers the squirrel as *absent* from the south of the county. Smidy Hill, where he was born, is in the parish of Kilsyth. In 1809, squirrels were plentiful at Burnhouse, in Skiperton Glen, and Castlecary woods. Mrs Spiers says her father used to tell the family at home that he saw a squirrel on a piece of wood crossing the Forth and Clyde Canal towards the north.† Burnhouse is in Falkirk parish, and Bendomina, Mr Spiers' father's farm, is in the parish of Cumbernauld, in the isolated portion of Dumbartonshire. I am particularly indebted to Mr David Cram, Bonnybridge, for assistance in the above, and much other information he has collected. Others likewise testify to their abundance seventy years ago in the south of Stirlingshire.

I have evidence of the occurrence of the squirrel at Dunipace as early as 1822, and my father shot one there in 1835. Westward they did not reach Campsie till 1827, and had populated that district by 1842.‡ Thus the Dalkeith army had reached Campsie about the same time that the Minto army was being marshalled, and this date, as will be seen, serves for a stepping-stone to West Dumbartonshire, and Killearn parish, in the west of Stirlingshire, where they first appeared in 1830. Here the apparition caused much excitement at the time, as I am informed by Mr Blackburn of Killearn.

Northwards they had reached to the confines of the county and penetrated to Kincardine parish, in the south of Perthshire, by about 1821 (see under South Perthshire, *infra*, p. 138), from the Dalkeith and Minto Centres. We then find that Buchanan parish, in the north-west of the county, was reached in 1830.§ A correspondent writes to me: "When I came to live at Plean" [which is between Denny and Stirling, —J. A. H. B.] "in 1828, squirrels were not very numerous.

* I have heard the same related several times by others as actually happening at the present time, but no instances can be said to be authentic.

† See further on p. 169.

‡ "New Stat. Acct.," Stirlingshire (1842), p. 238. The writer says: "Are now abundant. They were first observed in this district about fifteen years ago"—*i.e.*, about 1827.

§ "New Stat. Acct.," Stirlingshire (1842), p. 91.

It was reported then that their headquarters was at Plean Bank. At that time the gamekeeper had orders not to kill them. Later, when the Plean woods increased in size, they became more plentiful, coming from Auchenbowie woods, adjoining."

In 1842, we find them plentiful in Polmont parish in the east.* Thence through Gargunnock,† St Ninians,‡ Logie,§ and Fintry.‖

Thus it appears that one branch—or the left Stirlingshire wing of the army—pushed north-westwards *via* Campsie, and rounded the western end of the central range of Stirlingshire hills, reaching Killearn in 1830, and even Luss in Dumbarton at the same time, and also Buchanan in Stirlingshire; and the right wing took a more due northerly course at first, towards Stirling, and rounded the eastern end of the same central range of hills, joining forces again probably about Buchanan.

Dumbartonshire.

An isolated part of Dumbartonshire lies to the south of Stirlingshire, and between it and Lanarkshire, squirrels passing from Lanark to Stirlingshire would therefore find their most direct route through it.

No mention is made of the species in a very full and able list of the Mammals and Birds of the Parish of Luss, in the "Old Stat. Account" (1796).¶

From the account under Stirlingshire it will be seen that squirrels were far from uncommon in this isolated part of Dumbartonshire as early as 1809 to 1815. The "New Stat. Account" also speaks of them as common in 1841. Thus they abounded in 1841 in Kirkintilloch** parish, and they were also found in Cumbernauld†† and Castlecary‡‡ [but read also under Stirlingshire].

* *Op. cit.*, p. 194.
† *Op. cit.*, p. 50.
‡ *Op. cit.*, p. 312.
§ *Op. cit.*, p. 224.
‖ *Op. cit.*, p. 41.
¶ "Old Stat. Acct.," vol. xviii., p. 247.
** "New Stat. Acct.," Dumbarton, p. 183.]
†† *Loc. cit.*, p. 137.
‡‡ *Loc. cit.*, p. 137.

According to J. Colquhoun, Esq., they were first seen in the western and major part of the county in 1830.* In 1863, in consequence of damage done to larch trees, orders were given to destroy them on Sir James Colquhoun's estates—Rossdhu parish—and many hundreds were killed.† In 1864 they were still abundant there, and in 1877, Mr James Lumsden reports that "they were still extending their distribution." ‡

We thus find that another flank movement is made into Dumbarton, and we find them recorded from localities on either side of Loch Lomond, almost opposite one another; in Luss and Buchanan about the same time—viz., 1830.

From Stirlingshire we now follow the more widely spreading army; First, eastwards and north-eastwards, populating Clackmannan, and Fife, and Kinross, and rounding the north-east end of the Ochils, or penetrating across them by the various valleys.

We will then, so far as practicable, trace their advance through the southern parts of Perthshire until they meet the army from another centre at Dunkeld (*vide* under Dunkeld Centre, p. 142).

We will find them also pushing their way through the mountain passes of the Trossachs and Aberfoyle, reaching the head of Loch Lomond and here joining forces with the Dumbartonshire wing, and with the westerly extension of the Dunkeld army,—yet to be spoken of,—meeting also an extension in all probability from an introduction at Minard, in Argyleshire (q.v.).

Clackmannan and South Part of Perth.

In Clackmannan a squirrel was killed on the coronation day of her Majesty—June 20, 1837—by one of a party of some twenty bark-peelers, in the Dollar district; and James

* *In lit.*

† R. Gray, "Quadrupeds, Birds, and Fishes of Loch Lomond, etc.;" Maclure & MacDonald's "Guide to the Trossachs, etc.," 1864, p. 2.

‡ J. Lumsden, "Zool.," 1877, p. 225.

Syme found a nest the year before in Comrie Dean, Perthshire, adjoining.

In Clackmannan, we find that, while unknown around Alloa, when the "Old Stat. Account" was written, it had become numerous by 1841.* The Rev. P. Brotherston,† who writes a somewhat able article on the natural history of the parish of Alloa, takes occasion to notice the service done by the squirrel in planting acorns, thus supplying future oak trees for the British Navy.‡

I have been unable to obtain, as yet, any other statistics from Clackmannan to enable me to fix an earlier date for their arrival, but if numerous in 1841, it is reasonable to suppose that they arrived sometime sooner—say 1837. We have before seen that in the space of three or four years they increase largely.§ Very probably, however, it arrived even earlier than this.

Fife.

No mention of the species is made in the "New Stat. Account" of the county. The earliest date I have is 1825, when they appeared upon the estate of Lord Rosslyn, near Dysart. The species at this time, and even for some years later, must, however, have been far from generally known in any of the country north of the Firth of Forth.

Another correspondent assigns the date of the first appearance of the squirrel in Fifeshire to 1834, remembering in connection therewith a very animated discussion which took place concerning it. He saw the squirrel himself, but the

* "New Stat. Acct.," Clackmannan, p. 9.

† The Rev. P. Brotherston, later, was Mr A. G. More's authority for the county, while the latter gentleman was compiling his paper "On the Distribution of Birds of Great Britain during the Nesting Season" (*vide Ibis*, 1865).

‡ This reference to the planting of acorns was no doubt called forth by Lord Melville's remarks on the subject of the British Navy supply of timber, written in 1810, and referred to and quoted by Sir Walter Scott in 1836 (see "Misc. Prose Works of Sir W. Scott, Bart.," vol. xxi., p. 4).

§ *Vide* under Roxburgh—Mr Jerdon's note and other evidence (*antea*, p. 122).

fact was hardly credited by the rest of the party who were shooting in the neighbourhood of Markinch, and who considered "that no such animal as a squirrel existed in Fife." Before the following spring, however, another squirrel was killed at Falkland, and since then they have constantly increased, and are now—1880—very numerous.

Captain H. W. Feilden writes, under date of 15th December 1878, and gives me the following account of the species in the county.

"Thirty years ago there were no squirrels in the East Neuk of Fife—(*i.e.*, say 1848). They had not extended so far as Kinglassie wood, a large fir and spruce-covered area which lay between St Andrews and Crail. I understand this wood has been felled.* Neither were there any squirrels in Airdrie wood, not far from Crail. The absence of these animals in the East Neuk, thirty years ago, was impressed on my mind by my father bringing a couple of dead ones from beyond Cupar. These were stuffed and cased in the hall of Cambo House, Sir Thomas Erskine's residence, where we then lived.

"Five-and-twenty years ago (say 1854), squirrels were very numerous in the Howe of Fife (*i.e.*, the fertile Strath drained by the Eden) to the eastward of Cupar. They were abundant amongst the timber of Rankeilour Park, and the large woods which clothed the Mount-Hill, an eminence in the parish of Monimail, on which the Hopetoun Monument stands. They were common in a large wood near Springfield, at Lower Rankeilour (Creighton-M'Gill's), in the woods around Ladybank Junction, and at Melville (Lady Elizabeth Cartwright's). I never remember seeing them at Wemyss Hall (my uncle's, now my cousin's). I cannot help thinking that squirrels were found at Birkhill (Wedderburn's) near Taymouth; but, remember, it is five-and-twenty years since I lived in Fife."

"Twenty years ago," writes Dr Mackintosh of Murthly

* Kinglassie wood was cut down in 1848-49, as I am informed by Mr W. J. Kerr. Mr Kerr has been told that squirrels had reached Kinglassie wood, and were numerous there before it was cut down; but we have Captain Feilden's record to the contrary.

(*in lit.*), "They were common all over the county of Fife,"—say 1859.

At present there appear to be no squirrels in the East Neuk of Fife. Doubtless the plantations are too small, and not continuous enough.

They have, however, arrived near Newburgh-on-Tay, as I am informed by Alexander Laing, Esq.

Perthshire.

EXTENSION FROM DALKEITH AND MINTO CENTRES.

The route which would most easily lead them from Stirlingshire into Perthshire, by the date of 1821, would be across the Old Bridge of Frew,* which connects Kippen and Gargunnock parishes with Kilmadock and Kincardine, in which latter parish we find the first record of them in the south of Perthshire.† The uniformly deep, ditch-like river Forth would offer a natural barrier to their advance, except where the Bridge and Ford of Frew, and Bridge of Drip, near Stirling, afforded them a means of crossing,‡ but I have no data showing their advance over the latter, except that of their arrival in Clackmannan. To reach Clackmannan they must have crossed the Forth.

The whole of the south of Perthshire no doubt owes its squirrel population to the southern centres at Dalkeith and Minto.

From Kincardine parish, in lack of more continuous data, we go on till we arrive at Crieff, where its occurrence is mentioned, and its rarity indicated by being classed as a "foreign animal," along with the pheasant and woodcock,§ and thence we may, perhaps, follow them, as still coming from Dalkeith

* The Bridge of Frew was built over the old Ford of Frew in 1876. The only other bridge between that and Stirling—the Bridge of Drip—was built early in the present century.

† "New Stat. Acct.," Perthshire, p. 125. The passage is: "Although the squirrel was unknown in this parish till about twenty years ago, yet it now abounds in almost all our plantations."

‡ See remarks under "Laws regulating the Extension of Range of the Species," further on, p. 165.

§ "New Stat. Acct.," Perthshire, p. 495.

and Minto, as far as Monzie parish.* Though indeed it is somewhat uncertain whether this record and the Crieff one are not due to the overflow from an increase at Methven. †

The occurrence, as early as 1821, in St Madoe's parish, in the Carse of Gowrie, is due, I believe, to the pressure from Dunkeld, as will be further pointed out on p. 147. ‡

RESTORATION AND INCREASE.

Perthshire—Continued.—From the Dunkeld Centre.

We are told that an early introduction took place at Dunkeld some time prior to 1793, for we find it thus recorded in the "Old Stat. Account:" "It was introduced at Dunkeld by the late Duke of Athole, and has unfortunately done much harm to the singing birds;" § and all the data at my command certainly go far to prove that the Rev. William M'Ritchie of Clunie—the only person, as far as I can discover, who recorded the fact—was correct in his statement. He also adds, that it was beginning to breed in the woods at Clunie, || and in 1798 we find it again recorded that squirrels were numerous in the plantations around Dunkeld. ¶ Mr Duncan Dewar **—my correspondent for the Taymouth district—assures me they were never introduced at Taymouth nor in Breadalbane, and that an old man, still alive, and who was born at Taymouth, corroborates this, but distinctly remembers the first squirrel he had ever seen, which was at Dunkeld; and the first ever seen at Breadalbane was in 1828. ††

Mr John Macgregor, at Ladywell, informs me that he has heard from old people that the squirrel was introduced at Dunkeld by the fourth Duke of Athole, who succeeded to the

* "New Stat. Acct.," Perthshire, p. 267.

† See "Perthshire—from the Dunkeld Centre" (*infra*).

‡ "New Stat. Acct.," Perthshire, p. 619.

§ *Op. cit.*, ix., p. 236. || *Loc. cit.*

¶ *Op. cit.*, xx., p. 439.

** Mr Dewar has a fine collection of birds and animals shot in the neighbourhood, and is an intelligent, able, and careful observer and recorder.

†† It is only right to notice in this place, that in a somewhat full list of animals of Dunkeld in Campbell's "Journey from Edinburgh to North Britain" (vol. i., p. 270) in 1811, no mention is made of the squirrel.

dukedom in 1774, and died in 1830. Colonel Drummond Hay suggests what seems extremely probable, viz., that the growth of the larch plantations, some time prior to 1820, caused their rapid increase around Dunkeld, which was the first locality where he had seen a squirrel in a wild state; and Colonel Drummond Hay has never known that district to be without them.

They were introduced to Perthshire, according to the account of an old man still living upon the Moncrieffe property, by a young nobleman of the Athole family—Lord Glenlyon—who was an invalid, and who brought them from Sweden about the beginning of this century. Here our informant's memory is doubtless a little at fault, as we know of their earlier introduction from the "Old Stat. Account" (*ut sup.*).

In a letter, signed John Robertson, Calvine, Struan, occurs the passage: "Charlie Don (a wood-forester, aged about sixty) was in just now, and he says that squirrels do not claim their origin in Great Britain, and that they came from Norway." This is happily corroborative of the other statement as proving their actual introduction,* and doing away in great measure with the idea that they lingered in the remnant of the Blackwood of Rannoch, which is entertained by some of my correspondents.

In a southerly direction from Dunkeld, they appear to have come further from this centre, than from any of the other centres of restoration (as will be seen further on); which phenomenon, however, I think, can be perfectly explained by the mountainous country shutting them in and retarding their progress in the north and north-west, combined, to some extent, with the scarcity of suitable plantations for some time after the date of their restoration at Dunkeld.† Increasing rapidly at the centre, and at Clunie, and the population becoming too great, the pressure outwards exerted itself, in a direction contrary to that exercised by the populations of the southern centres; and the consequence was, an unusually

* *In lit.* to Mr James Macpherson, 24th March 1878.

† I have elsewhere quoted a passage from Mr Brown's standard work on Forestry, showing the dates of plantations on the Breadalbane property (*vide* "The Capercaillie in Scotland," p. 33, Edinb., 1879).

large wave rolled to the southward, and finally flooded the Carse of Gowrie, and all east of the Tay; and passing eastward through Strathmore and Forfar, again pursued a northerly course. But before following them in this direction, we will first show the slowness of their advance north-westward by Dunkeld, and westward.

It was not till a comparatively late date that they reached into Logierait * and Moulin † parishes, as we find them *abundant* only in 1841; not till the same year that they became *established* in Blair Athole;‡ and in Fortingall parish they had only "lately made their appearance in our woods and plantations." §

In 1827, the Rev. George Gordon of Birnie, Elgin, when returning to Inverness from Edinburgh, "saw a squirrel in the woods north of Dunkeld, from the top of the Highland coach." ‖ In 1836, John Colquhoun, Esq., rented the shootings of Kinnaird, and he tells me that squirrels were then most abundant; and he adds: "Some ten or fifteen years after, I saw a large table-cover which contained skins of some 200 squirrels shot at Taymouth." ¶ My Taymouth correspondent —Mr Dewar—corroborates this. After telling me that the first seen at Breadalbane was in 1828 (*vide antea*, p. 142), he goes on to say: "They began to kill them down at Taymouth in 1848, but more so in 1849. There was a bazaar in Perth about that time, and the Marchioness was there, and had a stall. She had about 500 skins for sale."** In 1852, it was numerous at Dunkeld.†† Now—1879—there is not one for a hundred formerly. ‡‡

On Stobhall about 100 were killed annually, some years ago. They were killed regularly for eighteen years, and sixpence per tail was paid.

By this time they had reached Glendochart; as my informant, now living at Luib, assures me that he has "known

* "New Stat. Acct.," Perthshire, p. 687.
‡ *Op. cit.*, p. 563.
‖ Extract from Mr Gordon's Note Book.
¶ J. C., *in lit.*
†† Morris' "Naturalist," vol. ii., p. 109.
‡‡ D. Dewar, *in lit.*
† *Op. cit.*, p. 643.
§ *Op. cit.*, p. 543.
** D. Dewar, *in lit.*

them to be in the Glen for the last forty years *at least*,"—say as early as 1839,—and he adds: "Ten or twelve years ago I was on the hill between Balquhidder and Glendochart, and came upon one on the very top of the hill, where there was neither house nor tree of any kind within miles." This leads up to the treatment of the subject under Argyleshire (q.v.).

This appearance, so early, indicates a westward movement from Dunkeld and Taymouth. At this time they must have been still rare at Crieff and Monzie (see further on, p. 146), and we have seen that they had become abundant at Taymouth.

In evidence of their slow advance into the districts west of Methven (*i.e.*, Crieff and Monzie), the late Sir Thomas Moncrieffe's head gamekeeper, who is a very observant man, and has a capital memory, and who takes great interest in natural history objects, was born at Logiealmond Lodge in 1828. "The only old wood then existing in the district was composed of three small patches of old Scotch fir, two of them lying between Logiealmond Lodge and the river Almond to the south and east, the other about two miles to the westward, near the Bridge of Buchanty." The keeper, when six years old, viz., in 1834, remembers his father killing a squirrel in one of the woods called the Craigend. There, they were not uncommon, but appear to have been rare elsewhere in the neighbourhood. The late Sir Thomas Moncrieffe's gamekeeper also relates that a tailor, when going to his work at his father's house, about the year 1832 or 1833, lost a day's work by chasing and trying to catch a squirrel, believing it to be a fox, for which he naturally got well laughed at. The late Sir Thomas Moncrieffe gives me the further information: "That his keeper tells him there was no wood on the range of hills between Birnam, near Dunkeld, and Crieff, except some very young larch plantations about Glenalmond. These," continues the late Sir Thomas, "were probably planted subsequent to 1825. It must be remembered, however, that squirrels often travel across country far from wood." One seen by him, more than a mile from any wood, took refuge in a cairn, and like most squirrels found upon open moors, and far from wood, was travelling in a northward direction.

It is worthy of notice in this connection that, with scarcely an exception, when squirrels are thus found on moorland, they are travelling in a northerly direction; in this matter my correspondents' observations coincide in every case which I have been able to inquire into.

We have evidence also that planting to any great extent did not take place around Crieff until the end of last century. Torlum Hill, now said to be the highest hill in Scotland, which is covered with wood to its summit, was, before being planted, a singularly bare hill, as indeed its name signifies. All the woods for some distance eastwards are of comparatively young growth, and the country was not nearly so well wooded as it is now.

The above would, in some measure, appear to indicate that Crieff and Monzie parishes owe their population to the southern army; but it is almost impossible to decide whether —taking 1821 as the date of their first appearance in the south of Perthshire, and 1812 as that of their first appearance at Methven (*vide infra*)—they would take longer to press northward and eastward to Crieff from Kincardine, or southward and westward from Methven. The distance between Frew Bridge and Crieff is eighteen miles as the crow flies; that between Methven and Crieff about twelve. We know that they abounded in the woods of Kincardine in 1821, and so, probably, arrived there some years earlier; and we also know that the first seen at Methven was in 1812, and that they were rare in Crieff and Monzie even as late as 1841, and were only locally distributed,—as proved by the late Sir Thomas Moncrieffe's notes on the specimen chased by the tailor in 1832 or 1833, and the one shot by his gamekeeper's father in 1834, near Logiealmond.

My idea at present is, that the southerly wave from Dunkeld had not passed much beyond Methven between 1812 and 1845 in the directions of Crieff and Monzie, but had rolled on in greatest force in a more south-easterly direction; and that these Crieff and Monzie records apply really to a northern offshoot of the southern army, indicating, perhaps, the furthest north point the Dalkeith and Minto army had reached before mingling with the Dunkeld southern division.

The first squirrel seen about Moncrieffe was in the year 1818, and the person who now records the fact has lived on the property for eighty years, and was born there, as I was informed by the late Sir Thomas Moncrieffe. He writes that that year was a memorable one, because "*this* [referring to the severe winter of 1878-79] is the longest storm since that time." A companion when chasing the said squirrel had his thumb nail bitten through, and had good cause to remember it for some time afterwards, as he was off work.

About 1852, squirrels had become abundant at Abercairney, for in three months nearly 100 were killed, so that they must have increased rapidly in the Crieff district between 1841 and that time, as I am informed by Mr Duncan Dewar, who was there during that year. This was undoubtedly owing to the growth of wood and increase of shelter; but I believe the Crieff and Monzie districts to have been primarily populated from the south.

Having thus indicated the rate of increase and extension of range around Dunkeld, and to the northward and westward, we must take up the loop to the south, and then proceed towards the Forfar march and the Vale of Strathmore.

Mr P. D. Maloch, of Perth, to whom I am indebted for many useful notes in this and other matters, informs me that the first squirrel killed at Methven was in 1812, and as this is an important record I am able to give the following particulars through Mr Maloch's carefulness. "It was shot by a Mr Alexander M'Lean, Lochend Cottage, Almond Bank. People came a great distance to see it. Since then it has increased very rapidly. Nowhere more common than on Methven. Any day thirty could be shot." * Then we find them occurring in St Madoe's parish,—part of the southerly wave which broke and rolled back at Methven—going on down the Tay on the left or east bank.

The late Sir Thomas Moncrieffe also considered that squirrels populated his district—Moncrieffe House and neighbourhood—from the north and west, because there are no plantations of any age between Perth and Stirling along the range of the Ochils.

* I have every reason to believe that this record is strictly and exactly accurate.

Colonel Drummond Hay writes to me that he can recollect when the first squirrel that had been seen in the Carse of Gowrie was killed at Megginch, in the autumn of 1822, or at latest, the following year. They were present in the woods of Dunsinane in 1836, but had not then become plentiful in the low carse. Soon after this, however, there must have been a large irruption of them. They have been numerous for the last twenty years (1859-79). Every one speaks as to its marvellous increase in all parts where it existed, within the last fifty or sixty years.*

Our next available date is 1838 in Bendochy parish, in the east of the county, where one was found "plundering a spotted flycatcher's nest."†

This leads us up to the Forfarshire march.

Forfarshire.

In 1813, Don makes no mention of the species as occurring in the county. ‡

In 1817, Captain Mackenzie, of Arbroath, remembers that some of his crew brought over eight or nine squirrels from Riga in small cages, and he is sure that some of these were let away or escaped into the woods about Arbroath. Another correspondent tells me that—"about fifty years ago, a brother of my wife remembers them coming in boxes from Riga to Arbroath. He and others attempted to catch some which had escaped in Guymel plantation."§

* *In lit.* † "New Stat. Acct.," Perthshire, p. 1183.

‡ "Fauna of Forfar," in Headrick's "View of the Agriculture of Forfar." "George Don died at Forfar on the 15th January 1814, of a sore throat" (*vide Farmer's Magazine*, 1814, vol. xv., p. 131).

§ There appears to have been a demand about this time for squirrels as pets, as we are told that there was a great sale of them in London: "As many as 20,000 being annually sold for the *menus plaisirs* of cockneys, a great part of which are brought in by labourers to Newgate and Leadenhall Markets, where any morning during the season 400 or 500 may be bought. Once in seven years the breed of squirrels entirely fails" (Hon. and Rev. W. Herbert in White's "Selbourne," 8vo, London, 1832—quoted in Rennie's "Field Naturalist," 1833, p. 129). My friend—Mr Howard Saunders—however, consulted Messrs Jamrach and Castang, well-known importers of live animals, and they assure him that no such immense sales of squirrels ever took place in London as the quoted account says.

We have no sufficiently accurate data available to show, however, that any increase of the species in Forfarshire was due to any of the above introductions; indeed we have, I think, sufficient proof that the population of the county was due to a natural extension from the Duke of Athole's plantations, and most of my correspondents appear to be of this opinion. In 1833, we find they had reached Glamis, but were rare then, and by 1843, they were plentiful,* and are reported from parishes of Ruthven † and Airlie ‡ ["where they have made their appearance within the last twenty years, and are now very common"]; also in Kinnettles, "though seldom to be seen in some adjoining parishes."§ Eastwards it had reached Inverarity, of which locality the authors write: "The small squirrel not mentioned in the former account ('Old Stat. Account'), is found on Fotheringham Hill." ‖ North-eastward we find record of them in Careston parish,¶ but nowhere else in the county at this date. In a very full list of the quadrupeds of Kirriemuir parish by Mr Kinloch of Kilry, it is not included.**

No doubt in some cases they have been overlooked by the writers of the "New Stat. Account." Still, the lines of advance indicated by these records are those which it would be most natural for them to follow, and they would not penetrate so rapidly northward through the hilly country, and the glens, which have only been planted with wood in comparatively recent years. Thus, I am informed, there was no wood in Glenshee till within the last fifty or sixty years. Mr Paterson of Dalnaglar considers that even now the winters are too severe for the squirrels, "and that they leave Glenshee when winter sets in, and retire down to the lower districts, at least they are not seen till May, except in very early seasons."

I lack accurate records from the northern parts of Forfarshire, but under Aberdeenshire it will be seen that they entered that county, coming from Perth and Forfarshire about 1856 or so.

* "New Stat. Acct.," Forfar, p. 343.
† *Op. cit.*, p. 414.
‡ *Op. cit.*, p. 676.
§ *Op. cit.*, p. 212.
‖ *Op. cit.*, p. 223.
¶ *Op. cit.*, p. 523.
** *Op. cit.*, p. 167.

We have record of them, however, as early as 1844 in the Forebank wood—Kinnaird, Brechin district—as I am informed by the head gamekeeper to the Earl of Dalhousie. We are thus able to trace their advance with some degree of accuracy in this direction, and from evidence given under Aberdeen, it appears likely that they came thus far before entering Aberdeen.

Aberdeen and Kincardine.

In order rightly to understand the influx and increase and spread of the squirrel in this county, it may be well if the reader would consult the useful little map given in the first volume of the *Transactions of the Nat. Hist. Soc. of Aberdeen,* and the description of Deeside and Braemar which accompanies it.* The author thus describes the district of Deeside, which is marked 3 on this map: "The 3d district is sub-alpine and alpine in character, and no part of it is under 600 feet above the sea-level, while several of the hills exceed 4000 feet in height above the sea-level. It is characterised by very extensive moors, with forests of birch and fir along the slopes of the hills, and narrow strips of cultivation in the glens. Here and there also—*e.g.*, in Glen Callater, on Little Craigandal, on Lochnagar, etc.—occur patches of alpine flora, etc."

Any one looking at this map of the natural divisions of Dee, cannot fail to be struck with the precipitous nature of the hills which surround the sources of the river—as indicated by the narrowness of the river-basin; and will in great measure cease to wonder that the squirrel took a long time to surmount such a barrier. The main avenues of advance from Perthshire and Forfar are as follows: Through

* "Sketch Map, showing the Divisions of 'Dee'" (*Trans. Nat. Hist. Soc., Aberdeen*, 1878, vol. i.). It becomes necessary to explain here the term "Dee," which can best be done in the author's own words. He says: "In the following lists I have restricted myself to the district between the basin of the North Esk on the south, and the basin of the Spey (including the Deveron) on the north and west. This tract was first defined as one of the zoological provinces of Scotland, in the 'Scottish Naturalist' (vol. i., p. 161) by the name of 'Dee,' alike for brevity, and to distinguish it from the county of Aberdeen, with which it is not equivalent" (*op. cit.*, p. 24).

the Forest of Athole, by Glen Tilt, and Pol Tarff, and down the Bynack Water. By this route there are fully ten miles of open moor between Forest Lodge, and near to Linn of Dee. The next route is by Glenshee, and this appears to be a feasible route, as the distance of open moor is considerably less. In Glenshee, the furthest wood is not quite so far up as the Spittall of Glenshee, and between that and the woods on the north side, about twelve miles intervene of moorland road 1200 feet above the sea.* Another advance is by Glen Isla, on the Forfar side, into the same valley on the Aberdeenshire side, by a pass of about the same height, but with a longer stretch of moorland. The next line of advance is by Glen Clova, descending into Glen Muick; the next by Glen Esk into Glen Tanar; and the last—and most easterly—along the lower wooded country of Kincardine descending into Glen Dye, or spreading more widely over the foothills through Kincardine into Aberdeenshire.

Perhaps, nowhere in Scotland do the pine forests reach so far up the glens and along the hill sides, or attain such an elevation as they do in Aberdeenshire, even at the present day; and as already seen under "Early Chapters," we have abundant evidence of what a richly clothed valley the Dee must once have been.

I will now proceed to record all that I can gather regarding the early appearance of the squirrel in Aberdeenshire.

I have in the meantime refused to credit their appearance so early as 1853,† in the absence of distinct data, and with Macgillivray's observations as a guide (see Part II., *antea*, p. 49).

I am again obliged to Mr George Sim for the following remarks. He writes: "It is now (1879) much more widely distributed over the country than it was twelve or fifteen years ago (say 1864). At that time it was confined to the upper parts of Dee and Don.‡ In the *Aberdeen Herald* of Jan. 20th, 1873,

* The squirrel is known to occur at an altitude of 1400 feet in Aberdeen (Dr Dickie's "Botanist's Guide to Aberdeen, Banff, and Kincardine," 1860), and perhaps at even greater altitudes.

† In the "New Statistical Account" of Aberdeen the squirrel is not once mentioned.

‡ I cannot obtain any satisfactory evidence of its occurrence at so early a date on Don.

there appeared a paragraph, in which it was stated that the first and only squirrels—a pair—were introduced into the woods of Braemar only half-a-dozen years before that date (say 1866), "when only very faint hopes were entertained that they would survive." Replying to this statement, the following week, Mr George Sim stated that he "had seen squirrels in the woods of Aboyne, more than twelve years ago (*i.e.*, prior to 1872; say 1860, or before that date), and all up the valley of the Dee to the woods named by the writer (*ut sup.*); and from a period prior to that named in the paragraph (1866) they have been comparatively common all along Deeside down to the neighbourhood of Aberdeen. In Strathdon they have been for a like period, probably much longer, but I only speak 'within my own ken.'* That squirrels have increased very much on Deeside within these few years is very true, but the increase certainly is not the progeny of the one pair spoken of."

The squirrel appeared in Glen Tanar Forest, Aboyne, for the first time in 1857 (*i.e.*, "about twenty-two years ago"), "and was seen on the Black Craig." Mr John Milne writes to me: "I think the squirrel crossed from Forfarshire into Deeside considerably lower in the valley than Glen Tanar, because the distance between the woods on each side of the hills there is too long. I think the most likely place is at the lower end of Durris and Maryculter parishes, there being continuous woods all the way from Deeside to the plantations of Kincardine." Mr Milne, who has been for many years forester at Glen Tanar, adds: "In Glen Callater they have never been found, as there are no woods there. In Glen Muick they appeared about the same time as in Glen Tanar. In Glen Feugh, or the woods of Banchory, they appeared several years earlier, and they were first seen in the woods of Invercauld in the year 1857, and very soon after at Old Mar Lodge, near the Linn of Dee."

My obliging correspondent in Braemar—Rev. W. Gordon—sends me the following notes from Upper Dee: "By a pretty general consensus of opinion, the squirrel was not seen or known in this district (*i.e.*, Upper Braemar) till

* But to this, as above stated, I take exception.

about fifteen or sixteen years ago—say 1863. The first seen in Invercauld was in 1864:* it was shot by John M'Hardy, and was given to Dr Marshall for the purpose of stuffing. It is true that one of the very oldest natives of this place —Mr John Lamont, long forester upon the Invercauld property—informs me that squirrels were seen in the woods about Clunie and Mar Lodge in 1858,—'the year,' he adds, 'the new Bridge of Dee was built.'" A gamekeeper—a keen observer—informs me that he saw one—the first he had ever seen—near "The Lion's Face," in 1862. The old man Lamont, to whom I have referred, says, that during his professional duties as forester in the Blelloch and Cromar woods, he had seen squirrels some years previous to 1858; also in the Birkhall woods, Glen Muick. It may be safely asserted that previous to 1862, no squirrels have been seen on the upper reaches of the Dee, and while almost all are agreed as to the time of the first appearance of the squirrel, all are also pretty equally agreed that the *line of advance was up the Dee.* As will be seen, this on the whole agrees with the evidence given me by Mr Milne from Glen Tanar, and the opinion expressed by him that they came *up* the Dee. My own belief is that they entered Aberdeen *via* Kincardine, the same route by which capercaillies arrived,† and that others reached in at Glens Tanar and Muick, and that thence they spread *both up and down* the valley of the Dee. There seems to me nothing improbable in their reaching over even by the direct route from Athole to Braemar, beyond the fact that, by the date of 1844, they had reached Brechin in Forfar, and from Brechin would, at that time, find a continuously-wooded avenue of approach into Aberdeen *via* Kincardine, which they would not find *via* Glen Tilt, or *via* Glenshee. By this, I do not mean to say that mountains will deter them, but I certainly believe that they will not cross deserts if they find more suit-

* But Mr Milne says they appeared "in the woods of Invercauld in the year 1857, and very soon after, at Old Mar Lodge, near the Linn of Dee;' and Mr George Sim was accustomed to see them commonly in 1859 and 1860 in all the woods between Aboyne and Invercauld.

† *Vide* "The Capercaillie in Scotland," by the author, pp. 94-97. Douglas, Edin., 1879. Also Appendix to same ("Scottish Naturalist," July 1880, p. 5).

able avenues of advance. In other words, I believe the pressure was strong enough to force a few over the mountain passes between the rivers Esk and Muick, also between Glen Muick and Glen Tanar, while the wave rolled onward into Kincardine ; but I doubt if the pressure was sufficient to make them encounter the longer journeys *via* Glen Tilt and Glenshee. The comparative absence of wood in the northern glens of Forfar at an early date caused the strongest wave to set more to the eastward.

At the same time, it is right to mention one of the most striking instances of the species surmounting difficulties with which I am acquainted. The Rev. W. Gordon relates as follows: "Some years ago, probably ten or twelve—say 1867—Lord Sandys, then the guest of Lord Holmesdale at Old Mar Lodge, was out shooting, accompanied by his Lordship's head gamekeeper and two young men who are now gamekeepers in the district. While they were crossing one of the highest peaks of Ben-y-Bhrotan, they were surprised to come upon a squirrel. Being unable to catch it, they unleashed two staghounds, one of which speedily arrested the squirrel's progress by putting his paw gently upon it. One of the men was severely bitten by it." This squirrel was taken to Mar Lodge, but a terrier scraping open the box, the squirrel escaped into the woods. The nearest tree to the peak of Ben-y-Bhrotan, on which it was found, was at least nine miles distant—viz., in Glen Derry—and the height of Ben-y-Bhrotan is 3825 feet (*vide* remarks under Strathdon, next page).

Mr James A. Haldane's keeper at Keith Lodge, Banff, who was born on Crathes estate on Deeside, killed a squirrel there when he was underkeeper about twenty years ago—say 1859. He had never seen squirrels before, and shot one for a weasel, for which he was reprimanded, as only two (both of which he saw) were known on the place ; but before he left, about three years later, there was any amount to be seen. Thus it would appear that an almost simultaneous advance was made into Aberdeenshire at various points along the range of hills between Aberdeenshire and Forfar, and through Kincardineshire. The natural advance from these points would probably

be either up or down the valley of the Dee, or both. There seems, at any rate, to be scarcely a doubt that the entry took place in the south of the county.

The advance of the species *up* the valleys is supported by evidence of their arrival and dispersal in Strathdon. Mr George Sim, with his usual care in such investigations, has obtained for me much information from Strathdon, most of which I give here. Mr Sim writes: "Let us begin at Kintore, on the estate of Shainstone, which is beside Kintore. Squirrels were first seen there on May 16th, 1862, heading *up* the Don. They were first seen on the estate of Monar, July 1868. In the Vale of Alford, in the summer of 1859, one was killed by a dog on the farm of Hylogs, parish of Tough. Shortly after this, another was taken alive on the same farm by the farmer—Mr Reid—and given by him to Mr W. Beveridge, who kept it a long time as a pet. The latter gentleman was at that time living in the parish above mentioned, and was making a collection of objects of natural history. Now, link this with the information you received from Mr Robb, gamekeeper, Kildrummy, 'that squirrels arrived there about twenty years ago.' They were seen at Glenkindie—Inverkindie, Strathdon—about seventeen years ago, as I am informed by the proprietor." It will thus be seen that the species has steadily travelled *up* the Don valley.

It is believed that the squirrel came from Dee to Don, coming across what is known as "the Red Hill." They were known by Mr Beveridge—curator of the museum in the Free Church College, Aberdeen—to have been in Dee some years before that date. Yet 1859 appears to me to be a somewhat early arrival for Donside. The possibility exists that the influence of the Rothiemurchus resuscitation (*vide* p. 157) may have extended as far south as the head waters of Don by this date, but absence of sufficient data makes it impossible to determine this with any certainty at present.

Argyleshire—Minard Centre.

I have to record the introduction of the squirrel at Minard. My obliging correspondent—the Rev. M. MacPherson, of

Inverary—informs me that the squirrel was introduced from England to the woods of Minard by a Mr Asken, who resided at Minard Castle a long time ago. He brought the squirrel and the rabbit there about thirty-two years ago—say 1847. Mr MacPherson has been told—and believes—that the squirrels dispersed from Minard woods as their centre. In about six years—say 1855—[another account says 1853] they reached Inverary. Fourteen years ago (1865) three were seen in Glenorchy at Stronmealachair, north of the Orchy River, and about the same time one was seen at Coille-nach-Eirriden, south of Port-nach-Errich on the east side of Loch Awe.

It was some time before they were found in the country lying between Loch Etive on the north, and the lower end of Loch Awe. They appear only to have reached the woods of Glenmore, near Kilmel fort, this spring (1879). I have, however, a record of one squirrel having been seen at Barbreck in the spring of 1870.

The Rev. A. Stewart of Ballachulish informs me that he has a note to the effect that "the late Campbell of Monzie shot two squirrels in the woods of Inverawe between Loch Etive and Loch Awe about 1860. The exact date he probably could not tell me, for otherwise it would almost of a certainty be found in my jottings at that time, which it is not."

The dispersal appears to have followed the lines thus indicated, pushing northwards most rapidly, *via* Cladich, to the localities in Glenorchy, and thence descending the Pass of Brander,—a branch stream turning southward at Cladich—whilst another army more slowly advanced westward from Minard, and rounded the lower end of Loch Awe, reaching Barbreck in 1870, and Glenmore woods not till 1879. The squirrels which descended the Pass of Brander appear to have detached colonists at the Bridge of Awe at a late date, which, turning back along the south side of the Awe, reached the woods of New Inverawe in the year 1870, when I learned that the first one was seen. When staying at Taycreggan this spring (1879) I had this route confirmed by the general impression in the district, that squirrels at New Inverawe and Haymount came up from the Bridge of Awe.

I believe that as yet the two armies have not quite succeeded in again joining forces in the extreme west, although squirrels are now pretty continuous along all the west shore of Loch Awe. This winter they appeared within six miles of Oban, and—as I am informed by Mr Carmichael, Duncreagan, Oban—some have been seen in Baggcaldine woods within the last few years, while I also hear of two having been killed at Dunolly, and more having been seen. These are doubtless extensions from the Brander Pass army. Squirrels also occur at Dunách, and at Glen Feóchan, which they reached about 1878 or 1879, but they do not occur yet—1879—at Gallanach, which is over the hill from Dunách and nearer to Oban. It is difficult to say whence these Glen Feóchan and Dunách squirrels came, but I think probably *via* Taynuilt and Glen Lonnan. We may, I think, safely accept the almost straight line of the footpath over the moor, between Taycreggan and the head of Glen Feóchan, as the probable limit of both armies before they again coalesce.*

Their advance in a southward direction from Minard has been comparatively slow, as Sir John Campbell Orde, Bart., tells me that in 1877-78 one or two only are seen at Kilmory in the season.

Their present distribution in the Cowal country is confined to the east shore of Loch Fyne from Ardkinglas to the woods of Ballemore, south of Otter. The principal intervening stations between these points are Strachur woods and the woods around Castle Lachlan in Strathlachlan.

RESUSCITATION IN INVERNESS-SHIRE—ROTHIEMURCHUS.

Inverness.

Captain Dunbar-Brander is of the opinion that Ross-shire obtained its squirrels from Beaufort Castle restoration, but Inverness and Speyside (*i.e.*, the lower reaches of Speyside, as well as Strathspey and Badenoch) received them from Perthshire. I have, however, I think, shown with sufficient clearness in a former part of this paper,† that no extension

* *Vide* Black's "Large Map of Scotland."

† It may be well here to read this consecutively with the last part under Inverness-shire (Part II., *antea*, p. 58).

took place into Inverness from Perthshire. Another writer (or the same) in the *Elgin Courant* appears to be of this opinion also. The passage is quoted in the "Scottish Naturalist" (vol. i., p. 49), and I give it again here:

"Squirrels, we believe, first appeared north of Spey some twenty years ago"* [referring to the lower reaches of the river, not to Badenoch or Strathspey,—J. A. H. B.]. "Writers of Natural Histories, not so long ago as that, tell us that squirrels were unknown in the north, and they certainly were very few. Half a century has, however, elapsed since there were squirrels in Roxburghshire, into which a nobleman is said to have introduced them. † In that county, as also in Perthshire, they are now a great pest, and hunted down without mercy. The squirrel is a creature known to have a propensity to migrate, persistently pursuing its course over river, mountain, and moor. They came here from Perthshire, by the way of Glen Truim, getting to the top of that glen, we know not how, through the wilderness on both sides of Dalwhinnie. At all events that was the route of the squirrel invasion, for they made their first appearance amongst the trees about Invereshie and Aviemore, and the woods of Rothiemurchus. From Badenoch, or rather Strathspey, they crossed into Nairn and Morayshire, and their multiplication has been so rapid, that now scarcely a wood in the two counties is free from their ravages. In the woods of Cawdor, Darnaway, and Altyre, they were numerous fifteen years ago, but it is not more than five years since they came to the woods on Heldon Hill, and the Oak Wood, near Elgin. From Elgin they have gone to the woods about Gordon Castle, and the extensive plantations about Cullen House will soon receive a visit from them."

The above seems to be the view taken of the dispersal and lines of advance by Captain Dunbar-Brander and others (putting aside, as already disposed of, the erroneous source,

* *i.e.*, Twenty years previous to 1871—1870 being the date of vol. i., "Scot. Nat."

† Dalkeith introduction is no doubt intended. Squirrels did not appear in Roxburgh till 1827, as has already been shown; or it is possible also that Minto *is* intended, and that the date is not accurately given.

and *accepting the resuscitation:* and *not the restoration at Dunkeld*). In support of this view of the advance we find that thousands of acres of young wood have been planted between Perth and Forres—for our present purpose between Kingussie and Forres is more correct—and a specimen of the squirrel was killed at Dulnan Bridge in 1855, on 13th October, which probably came down the Spey. The Rev. Wm. Gordon saw a squirrel shot in the neighbourhood of Grantown on the Spey, in 1855 or 1856 (*in lit.*), and as early as 1844 the Rev. George Gordon writes that it was "occasionally seen in the woods of Strathspey" (*i.e.*, between lower and upper Craigellachie). This last date is the important one, as it was upon this date also that the restoration took place at Beaufort.

The Rev. George Gordon, however, produces a very clear and consecutive record of dates going to prove an advance through the northern parts of Nairn, Elgin, and Banff, *from Beaufort*, which it is hard to put aside, so perfectly chronological do they appear to be;* and this record would be still more difficult to set aside, were it not for the above important date of 1844, which makes it appear extremely unlikely and improbable that squirrels "occasionally seen in the woods of Strathspey" could have come from Beaufort, where they were only introduced in the same year. Notwithstanding the consecutive nature of the data stretching eastward from Inverness, and the absence of more complete chronological data along the valley of the Spey, I am almost inclined to accept the dispersal from Rothiemurchus as populating the whole of the country east of Inverness, and along the south shore of the Moray Firth. There is much in our evidence to favour such a dispersal. If we compare the areas populated from other centres, and the time taken in each case in doing so, we find that the four oldest restorations—natural and artificial—viz., Dunkeld, Dalkeith, Minto, and Rothiemurchus, with equal—or nearly equal—advantages of fresh young wood, and available avenues of advance, should populate about equal areas, while the younger or more recent restorations of Beaufort Castle (1844), and Minard, Argyleshire (1847), ought in

* "Zoologist" (1844), p. 423.

like manner to populate lesser areas, and areas of similar magnitude with one another; and the still more recent restoration in Ayrshire ought, on the same principle, to populate a *still smaller area* than any of the above. If we, therefore, refused to credit Beaufort Castle with any share in populating any of the country east of Inverness, and added that to the Rothiemurchus area, the above condition of things would be more nearly carried out. Yet it is extremely difficult to lay aside the data which I will give under the Beaufort Centre. I feel bound to admit that my opinions, after going carefully over the evidence, weigh almost equally for either side of the question.

Whether the dispersal from Rothiemurchus also reaches as far east as the heads of Don, and there mingles with the advancing armies from Dee and up the Don, I cannot say; but I have not succeeded in obtaining any information from Upper Donside which would lead me to think that it had.

Beaufort Castle Centre.

Of the former distribution and resuscitation of the squirrel in this county, I have treated as fully as I am able with the materials in hand. It now remains to record its restoration to the northern parts, and follow its tracks outward from Beaufort Castle Centre until, towards the east, they meet with the northern extension of the Rothiemurchus indigenous army, and towards the north, they reach into Sutherland in 1869.

They were introduced at Beaufort Castle in 1844. The Rev. George Gordon, writing in Knox's "Autumns on the Spey," says: "Squirrels, which now (1872) abound on both sides of the Moray Firth, were introduced into this district of Scotland in 1844, when Lady Lovat turned out a few at Beaufort Castle west of Inverness."* Mr Gordon has since seen no reason to alter his opinion that Beaufort has been the centre of restoration of the Nairn and Elgin squirrels.†

In 1845 they had not yet reached into Kiltarlity parish,‡ but in 1848 Mr Archibald Hepburn found them common in many

* "Autumns on the Spey," p. 50. † *In lit.*

‡ "New Stat. Acct.," Inverness-shire, p. 493.

parts of the north of Inverness-shire,* and evidence of it in Ross-shire and Cromarty shows that it had travelled steadily northward from the centre. But the richly cultivated, level, and well-wooded country east of Inverness, and along the south side of the Moray Firth, seemed to invite a more rapid extension, as we find them arriving at the confines of the county as early as 1851, and passing into

Nairn

"at Kilravock, and at Cawdor in 1855." By 1862, it became necessary to destroy them on several estates, notwithstanding which they appeared still to increase in numbers, if we judge of the numbers killed at Cawdor plantations by shooting alone. As pointed out, however, "the numbers killed depend a good deal upon the qualifications of the men employed, and on the price paid for each tail." † Nor can we trust implicitly such records, because, as Captain J. Dunbar-Brander of Pitgaveny assures me, "on the estate of Cawdor many thousands of tails were paid for, supposed to have been killed in the district. One day the factor saw a bunch of squirrels' tails arrive at the station addressed to one of the keepers; a day or two afterwards they were presented to be paid for."‡

Having passed through Nairn, still travelling eastwards, "they spread so far into Elginshire in 1860 as to have been observed at Birchfield in the Glen of Rothes."

Banff and North Aberdeenshire.

After their appearance at Kilravock (Nairn) and Cawdor, "they were seen to move eastward to Forres in Elgin, and to Gordon Castle, and other parts of Banffshire." They "crossed the Spey a few years previous to 1872, and were met with on the banks of the Doveran in the east of the county."§

Mr George Sim, of Aberdeen, here takes up the thread with

* "Zoologist," 1848, p. 2010.

† The above account of the squirrel in Nairn is taken almost entirely from Knox's "Autumns on the Spey," p. 50, *et seq.*

‡ For list of squirrels killed in seventeen years at Cawdor see further on, p. 175.

§ Rev. G. Gordon in Knox's "Autumns on the Spey," p. 50.

great exactness, enabling me to trace their further eastward progress. Around Huntly, at Dunblade, they appeared "about fifteen years ago"—say 1864; and on the estate of Haddo, parish of Forgue, south side of the river Doveran, and in parish of Inverkeithnie, about the same time. Then at Lathers, parish of Turriff, and Netherdale, parish of Marwick, "about thirteen or fourteen years ago"—say 1865-66. In about the year 1867 ("about twelve years ago") they appeared at Fyvie and Delgaty, in the parishes of Turriff and Fyvie (Aberdeenshire), which "are the most easterly localities where they at present (1879) occur."* In about the same year, they also appeared in Auchterless parish, at Ardmiddle, and on the estates of Forglen and Carnoustie (Banffshire). Here the Rev. W. Gregor gives me the further note, that "some sixteen years ago they were not seen at Duff House, near Banff, but are now said to be there." And, subsequently, he adds, that he has found the squirrel in Deer parish.

We will now cry back again, and in order to trace their advance to districts south-west of Beaufort on both sides of Loch Ness, I give the record supplied to me by Mr Morrison, factor on the Dochfour estates, that "about the year 1848, it was first seen on Loch Ness side [north side] in the hazel plantations belonging to Lord Seafield, about four miles west of Dochfour, and it was supposed to have crossed the hill from the plantations near Beaufort. It, of course, speedily increased in numbers, and in course of twelve months later it was first met with on the south side of Loch Ness, in the plantations of the late Sheriff Tytler of Aldourie, and in 1850 it had spread over the Ness Castle plantations east of Aldourie; and by this time it was discovered that its introduction into the north was likely to prove seriously injurious to plantations generally."

The above, I think, goes to prove its eastward advance

* Since the above was written, I have learned that two squirrels were killed upon the Aberdour portion of the Brucklay estates, in a deep wooded glen called the Den of Glasslaw, three or four years ago—say 1875 or 1876. They have not as yet been seen at Brucklay. The Aberdour part is close to the sea, and about twelve miles from Brucklay Castle, and adjoins the estate of Troup, where there are also a few reported to have appeared. I am indebted to my friend, Mr W. Horn, for this additional note.

from Beaufort,* and also indicates its advance southward along the south side of Loch Ness. One was taken on board the sloop "Maithe Dhu," of Peel, in the spring of 1850, at Dochgarroch Lock. They can easily pass across the canal locks.

Following up the valley of Strathglass (*i.e.*, in a south-westerly direction), Sir Dudley Marjoribanks supplies the following information: "The squirrel was unknown here [at Guisachan] previous to 1857, when a few were observed. They were supposed to have come from the east (*i.e.*, Beauly), it being generally reported that Lady Lovat had, a few years previously, turned out three or four pairs at Beaufort. . . . Squirrels became very numerous and troublesome at Guisachan in 1862, and were destroyed in considerable numbers. In that year from twelve to twenty could be shot in an afternoon, within a mile of the house. They have now either left this district, or have died out. Though one or two can be seen at any time in their more favourite haunts, they are no longer destructive."

South-west from Beaufort along the north side of Loch Ness, I have abundance of evidence of their progress. Mr P. Burgess, factor for Glen Morriston, writes: "It is supposed—indeed almost certain—that squirrels came from Glen Urquhart into Glen Morriston (*i.e.*, from the north-east). I am informed that it is about thirty-five years since squirrels were first seen in Glen Morriston" [say 1844, a very early date.—J. A. H. B.]. "For the first five years or so, few of them were to be seen, until about fifteen years ago (1864), when they became very numerous. Steps were then taken to destroy them, and now there are not many to be met with."

Mr Alexander Frazer, who has been forty years gamekeeper at Fort Augustus to Lord Lovat, whose lands extend southward from Glen Morriston, and round the southern end of the loch, writes further in reply to a letter from Mr W. A. Stables, who has given me much assistance in working this district, that he "was not aware of any squirrels being

* Taken in conjunction with their having reached the eastern confines of the county in 1851, before passing into Nairn as already related.

around Fort Augustus in 1848. Two or three years after, to my knowledge, they first made their appearance. I find they were seen about the same time on the south side of Loch Ness, and were supposed to be seen in Invergarry woods to the west of this about twenty-four years ago [say 1855]. They are not so numerous as they were twelve years ago."

My thanks are due to my friend Mr Stirling of Gardèn, for obtaining for me further particulars regarding their extension along Loch Ness on the north side. In Glengarry, squirrels first appeared between 1853 and 1855, and are believed to have spread from Beaufort. The woods in Glengarry are so extensive that attempts to keep their numbers in check have not been very successful, the rough nature of the ground also acting as their safeguard. They rapidly became very numerous soon after their appearance in the district. The severe winter of 1878-79, it is reported, does not appear to have diminished them in Glengarry.

It now occurs also near the head of Glen Grivie and Glen Urquhart, as I am informed by Mr J. M'Gregor, Ladywell, Dunkeld.

Ross-shire and Cromarty.

The first date I have for Ross and Cromarty is a somewhat late one—1858—at Kilmuir Castle and Tarbert House about the same time, having come round along the shores of the Firth.

Sutherland and Caithness.

The squirrel reappeared in the county of Sutherland in 1859, at Clashmore, on the authority of Mr Thomas Mackenzie,* and he believes that the first squirrels entered the county across Bonar Bridge. It was not, however, until after the railway bridge was built at Invershin, in 1869, that squirrels became plentiful in the east of Sutherland. Squirrels are particularly fond of running along roads or rides in forests,—or even in open country,—or along rails or stone walls; and I have often met with squirrels far from wood in the low-lying carse lands

* *Vide Proc. Nat. Hist. Soc. of Glasgow*, vol. iii., p. 229. Also "Scot. Nat.," vol. i., p. 82.

of Stirling; so that bridges, roads, rails, and "dykes" may be considered as great aids in the extension of their range.*

This concludes my account of the extension of range of the squirrel throughout Scotland, and it will be observed that I have treated the subject on a plan almost uniform with my account of the Capercaillie in Scotland.† I would have preferred to indicate upon the map accompanying this portion, the dates of the "steps of advance," as I have done in the map of the Capercaillie, but the scale of this map scarcely admits of a sufficiently minute treatment in this way.

GENERAL REMARKS ON THE LAWS REGULATING THE EXTENSION OF RANGE OF THE SPECIES.

It has been pointed out in the foregoing pages, *First*, The localities where the squirrel is supposed to have become extinct, where it lingered longest before it became extinct, and those where it lingered and revived again; and, *Second*, The lines of advance, and the areas at present occupied by the species. The history of the species is almost identical with that of many others whose natural habitat is a forest-clad country. It is found to have lingered longest where the forest remained longest, and to have revived most rapidly (or spread most rapidly after restoration) where forest trees had been planted. The lines of their advance have been influenced principally by the various barren chains of mountains adverse to their conditions of life, and by the growth and increase of wood, favourable to their increase and extension of range. Where trees have lingered, amidst the Highland glens, they lingered too; and where trees have led them of late years they have reached considerable altitudes. "The recesses of the Highlands have ever proved the shelter and protection of the descendants of the older tribes of the country, and the limit to the advance of a stranger population." These words, applied to the human races that inhabited the several kingdoms of "Ancient Alban," are equally applicable to many races of animals which have

* And see also under General Remarks on Extension of Range, *infra*.

† David Douglas, Edinburgh.

become extinct in Scotland, or are approaching extinction at the present day.

I have already pointed out the causes which I believe brought about their decline or extinction. The circumstances which have attended their increase present almost the converse state of things.

They have pressed forward in a general northerly direction from all their various centres of restoration; and I believe this northward tendency in their advance is due to the combined physical features of the country as explained above; ranges of mountains checking their advance *south* of the earlier centres in the south of Scotland, and easier outlets being found towards the north. As the wave gained impetus and strength, obstacles which would, perhaps at first, seem insurmountable, became easier from the increasing inward pressure, and even mountain passes of some altitude were threaded, and the first ripplings of the pioneer waves consequently overflowed into the valleys beyond. We have proof that the squirrel is not unfrequently found far away from wood, and upon the open heaths. One was seen in 1830 on the moor between Kenmore and Glenqueich, four miles away from wood, as I am informed by Mr D. Dewar. Mr Dewar saw one "about sixteen years ago, between Killin and Glenlyon, half-way across, where there were ten miles of moor. It was going north: when pursued it took to a hole." We have also the anecdote related by Mr Knox, when a Highlander, who had never seen a squirrel before, discovered one out upon an open moor, and the animal, mistaking him for a tree, mounted rapidly to the top of his head, to the no small fear of the native, who believed it to be "*a thing wi' horns.*" * Nor is it unusual to find squirrels down in the flat "carses" † far from trees, having followed a road or a hedgerow perhaps for miles. Roads assist them; for, as is well known, they are fond of running along rides in forests, or rail tops; and if roads be made into a wild mountainous country, there can be

* "Autumn on the Spey," p. 51.

† "Carses," the name given to the rich level tracts of country below Falkirk and Stirling and along the Tay—viz., *Carse of Falkirk*, *Carse of Stirling*, and *Carse of Gowrie*.

little doubt they will act as aids to their advance.* Upon Quarter estate, near this, there is a dyke or wall which, it is well known, constitutes the squirrel's highway between the Quarter covers, and those of Daleswood on the adjoining property of Denovan. They are seen constantly passing from the one cover to the other along the top of this dyke, which forms the march wall between Quarter and West Plean on the north. Other more extraordinary instances are given of their curious wandering propensities. Mr Clark, jun., Glenfeshie, relates how one once came down a chimney in his house, "and alighted on a girdle that was on the fire for baking purposes, and eventually, not relishing its position, landed with one bound in the window, only to meet a worse fate, being speedily torn to pieces by the terriers." Another squirrel which got shut up in a new house that was being built in the same glen, made its exit and escape by the same route that the other made its entry.

It is worthy of record that, as far as I have been able to ascertain, in all instances in which squirrels have been found on open moors, at long distances from wood, they have been travelling in a *northerly* direction at the time when discovered. This apparently inborn tendency to press northward may be traced from early (*i.e.*, Geological) times, and is common to many animals and birds.

The Rev. W. Gordon, Braemar, relates another instance of the peculiar habit the squirrel seems to have of getting into and out of scrapes. In this case Mr Robert Grant captured a squirrel when a lad, but on its escape immediately after, it suddenly climbed up the inside of the legs of its captor's trousers, which, having been "made down," were unusually wide.

Rivers do not invariably deter them. Long ago this was known to the writer of the curious metrical emblems; for he says:

> The squirrel, when she must goe seeke her food
> By making passage through the angry flood,

* And we find it recorded of the common brown hare, that it appeared in the mountainous districts of Lismore and Appin "not until after roads were made, which opened communication with the low country" ("New Stat. Acct.," Argyleshire, p. 233).

(And feares to be devourèd by the streame),
Thus helpes her weakness by a stratagem.
On blocks or chips, which on the waves doe flote,
She nimbly leaps : and making them her boate,
(By helpe of winds, of current, and of tide)
Is wafted over to the other side.
Thus, that which for the *body* proves unfit,
Must often be acquired by the *wit*.*

But our author, though aware of the fact that they cross streams, here awards too much credit to the squirrel's sagacity. It will travel miles to find a bridge, and prefer that mode of crossing to risking being "*devourèd by the streame.*"

Broader kyles or arms of the sea, or deep sluggish streams, without shallow fords or bridges, appear almost always to afford a barrier to their progress, or the larger rivers, with a great body of water. Nearly all quadrupeds can swim if put to it, but it is remarkable that I have never yet met with any person who can say that he has seen a squirrel voluntarily enter

* This old tale has descended from a very early date, even to the present time, as there are still people living whom I have heard relate it as an existing fact in the natural history of the squirrel, even to the detail given by the early writers, of its carrying a supply of food in its mouth, "to prevent famine whatsoever befall them." Olaus Magnus describes it in his description of Scandinavia, and the tale is taken up by Gesner ("Nat. Hist.," Zurich, 1820). It is repeated in the above emblem (1634). Translated from Gesner by Topsell ("Hist. of Four-footed Beasts," 1658). Quoted again by the author of "The Gentleman's Recreation," 4th edition, 1697.

I here quote Topsell's account, which fairly represents the legend :

"If they (*i.e.*, squirrels) be driven to the ground from the trees to creep into hedges, it is a token of their weariness, for such is the stately mind of this little beast, that while her limbs and strength lasteth, she tarryeth and saveth herself in the tops of tall trees, then being descended, she falleth into the mouth of every cur. The admirable wit of this beast appeareth in her swimming or passing over the waters, for when hunger or some convenient prey of meat constraineth her to pass over a river, she seeketh out some rinde or small bark of a tree which she setteth upon the water, and then goeth into it, and holding up her tail like a sail, letteth the wind drive her to the other side, and this is witnessed by Olaus Magnus in his description of Scandinavia, where this is ordinary among squirrels by reason of many rivers, that otherwise they cannot passe over, also they carry meat in their mouth to prevent famine whatsoever befal them, and as peacockes cover themselves with their tails in hot summer, from the rage of the sun as under a shadow, with the same disposition doth the squirrel cover her body against heat and cold" (*op. cit.*, pp. 509, 510).

deep water and swim,* nor have I been able satisfactorily to authenticate any of the related occurrences of the squirrel crossing canals or rivers upon blocks or chips of wood, although many of these are related with minuteness of detail, having an apparent genuineness and authenticity. My strong conviction is, that all these instances only illustrate a popular superstition, acquired originally by the earlier writers, who were puzzled to account for the crossing of rivers by the species, and who forgetting or ignoring the fords or rocks left bare in time of drought by which they crossed, thus accounted for it. These accounts, quoted and re-quoted, we find even adhered to at the present time.

I find that rivers in some localities have been most effectual in barring their advance, whilst others have not in any way affected it, and an examination into the circumstances in many of these instances has shown that only where the rivers are deep and unfordable have the squirrels failed to

* Since writing the above, however, I have received satisfactory proof of the squirrel swimming. On August 12th, 1880, a very hot, still day, three ladies and a collie were idling in a boat on Loch Voil. The loch was glassy calm, and their attention was attracted by a ripple in the water about 200 yards off, as of some small animal swimming across towards them. They rowed towards it, and found it to be a squirrel steadily making its way to the opposite shore. They rowed so that it might pass as close as possible, and kept quite still—so close that it clambered up the bow and sat panting and chattering on the gunwale, evidently tired with its swim. The collie began to get excited, and was with some difficulty kept quiet; however, the squirrel evidently suspected some evil, for after sitting about three minutes it dropped over the side, holding on to the gunwale, so that only its head showed. The ladies then began to row gently towards the shore it had been making for, but it dropped off, and again steadily swam for the point it had at first been making for, and which they had slightly passed. They saw it safely land on a rock and scramble up. The loch is about a quarter of a mile broad, and the squirrel was about three-parts of the way across when first seen swimming from north to south. It appeared like a strip of fur on the water; head very erect, the tail being most noticeable; the straightness of its course marked by its wake being remarkable. This is the only instance, which I consider perfectly authentic of the British squirrel having been *seen* swimming; and it is the only instance I have come across of the squirrel migrating over a large extent of surface *in a southerly direction.* The note, originally published by Mr Godwin Austen, in "Nature," 1881, is therefore most interesting. We find, however, a perfect parallel in the habit of other species of *Sciurus*, as it is well known that certain species of American Sciuridæ swim freely across rivers and lakes.

make their crossing, or if they have crossed, it has been by means of a bridge. I am able, in many instances, to trace the exact path by which squirrels advanced through this country, and that, in some instances, as long as fifty years ago. The crossing from Stirlingshire into Perthshire by the Bridge of Frew, over the Forth, as shown before, and the entrance of Sutherland by the bridges over the Kyle, instance the above remarks.

The extensive planting of wood which took place in the south of Scotland at Tynninghame, where large areas of ground were planted in 1707—towards the end of last century and beginning of the present century—was no doubt a most important factor in aiding the increase of the squirrel; and we have evidence in the foregoing pages that, in many localities, to the new feeding grounds thus opened up, the squirrel is indebted for its increase and prosperity.

Large tracts of country were also planted in Perthshire by the Duke of Athole and Lord Breadalbane, which would afford abundant feeding grounds for the species. We have seen already that the exception to the general rule of the northerly waves being the strongest, is exemplified at Dunkeld Centre, high mountains and scarcity of wood, at that early date, combined, checking their advance to the northward, and forcing them to roll southward, until the force of the pressure being exhausted, they recovered, and again advanced north-eastward through Strathmore and Forfar.

Similar planting took place on the Spey, and favoured their northward advance, when at last they revived in the old forests of Rothiemurchus.

Finally a comparison of the boundaries of the several areas populated from the Centres of Dalkeith and Minto, Dunkeld and Beaufort, and other minor tracts, with the map in Skene's "Celtic Scotland" "showing mountain chains," will result in very approximate results; showing that to a considerable extent the advances of the species have been checked and delayed, regulated or influenced, more or less, by the various ranges of hills, though a continued pressure has in many places, as already explained, caused an overflow, and the surmounting of unusual difficulties. It may be well also in this

place to read pp. 7-13 of the Introduction to Mr Skene's work (*op. cit.*), descriptive of the great natural features of Scotland. I would also recommend an examination of the county maps published in the "New Statistical Account," to those who desire to follow, as I have done, the minute details of their advance. In these maps the parishes are all distinctly shown.*

Every one agrees apparently in the marvellous rapidity with which the species increased in various parts of Scotland, especially within the last fifty or sixty years. The planting of wood, as we have already seen, was the chief factor in their *advance*, which advance resulted from the increase of their numbers, influenced and brought about by the increased area of suitable food. It is only necessary further to say as regards their increase, that statistics will be found in the preceding pages, which it is unnecessary here to repeat.

We have discussed already the effects of severe winters upon their numbers under Part II. (*antea*, p. 40). A succession of such, doubtless, would decrease their numbers to quite an appreciable extent, or, at all events, drive them by local migration to seek the warmer shelter of the great pine forests.

FOOD AND DAMAGE DONE TO TREES AND FORESTS.

Perhaps the earliest notice taken of the destructive habits of the squirrel in Scotland is in a letter to the Editor of the *Farmer's Magazine* (vol. iii., p. 14, 1802), in which the necessity of "destroying, instead of fostering," squirrels is pointed out; and, as already noticed, the restoration of the species at Dalkeith is mentioned. Since that time innumerable complaints have been made, and letters written, and means taken for their destruction. Unanimously, my correspondents condemn the squirrel as one of the most destructive animals which frequent our forests. Scarcely one has a good word to say for it in this respect, and it would, I imagine, be very difficult to undertake, with any chance of success, a case in defence of it. So abundant, indeed, is the proof given of its destructiveness, and, I may add, so patent is the destruction

* For a short account of the planting which took place between 1750 and 1806, see "Notes and Sketches of Northern Rural Life," pp. 102, 103.

done, to any one accustomed to travel in the woods, that it might hardly be considered worth while to give these proofs in detail. Nor shall I bring forward more than a very small portion of the evidence at my command.

Perhaps all that can be brought forward in its defence is that, to some extent, it may act as a *nature's-pruner* of the trees, but I believe any forester, or person who has been in daily and yearly observation of their habits, would gladly dispense with their services in this respect. True, also, one correspondent writes as follows: "The squirrel is now very numerous in this county (Dumbartonshire), and is sometimes very destructive to firs. It is only, however, when firs are planted too thickly, and when there is a lack of branches, that they are so, from nipping off the shoots. If the branches were allowed to spread as they ought to, they will find food enough without mounting up for the top shoot." But judging from a large mass of correspondence, this is not always the case, or if so, only to such a very infinitesimal extent, that the good done by *nature's-pruners* is swamped by the much greater amount of harm.* Of course it is needless to point out that if large extents of young wood are planted for profit, in a country inhabited by the species whose food consists of these woods, or their cones, and bark, and shoots, an increase in the numbers of these animals must be expected. One does not hear much of damages done to natural forests, as those of Norway, Sweden, or Russia, by birds or animals. As *nature's-pruners*, the squirrels usually lop off the cones, which, on discovering that they contain no seeds, they drop to the ground; this does no harm to the tree, if it does no good; and, as believed by more than one of my correspondents, the seeds of the cones form the natural food of the species, and the saccharine inner bark is an acquired taste.

In this connection it may be also well to consider if, in some cases at all events, the damage done to shoots and bark does not result from the fondness of squirrels for certain

* Several others of my correspondents share this opinion—that as a rule the tops are not injured to any appreciable extent; but, as stated in the text, by far the larger number—quite eight-tenths of my correspondents—hold a very decidedly different opinion.

minute and superficial fungi, which grow closely upon the said shoots and bark, and which, as has been pointed out to me by the late Sir Thomas Moncrieffe, Bart., is a favourite part of the food of the squirrel (see also further on, p. 177).

Mr C. Y. Michie, forester, Curr Bridge, Morayshire, wrote a prize essay in 1865 upon "Diseases of Forest Trees," and as he treats fully of the damage done by squirrels, I quote at length his remarks: "The greatest of all enemies to the Scotch pine, and by which more real injury is inflicted upon the tree than by any other agency with which I am acquainted, is the squirrel. The injuries are at once incurable, and the extent to which they are committed in Scotland is indeed alarming. About the month of April, the squirrel, in order to reach its desired food, peels off the bark from the trunk of the tree generally within a few feet of the top. The bark is peeled off with the teeth of the squirrels in shreds about half an inch broad, and generally from 3 to 4 inches long.* The part upon the tree where the bark is peeled off frequently goes right round; in other cases a square piece is neatly peeled off, as if performed with a sharp knife. The squirrel does not devour the bark, but peels it off that it may regale itself with the saccharine matter contained between the last-formed wood and the bark. It is most active in hot dry weather, and usually in the morning a little after sunrise, or after a warm shower of rain. The age of the tree which the squirrel prefers for peeling is usually from fifteen to twenty-five years; it prefers the smooth clean part of the trunk after it has shed its leaves, and selects the most healthy and vigorous growing trees, and will seldom attack trees of sluggish or stunted

* Another correspondent writes: "I have seen hundreds of larch trees in Athole, of forty to sixty years of age, with their tops entirely barked, as completely as could be done by rabbits to deciduous trees within a foot of the ground." He adds: "This occurs, I think, when cones are scarce. They also nip off small branches of spruce trees, though I have not noticed any spruce trees peeled by them. They feed on the cones of all the pine tribe." —John M'Gregor, Ladywell, Dunkeld. Spruce is attacked by them to quite a small extent. Though fond of the cones, or rather the seeds of the spruce fir, they have in some localities, at all events, scarcely been known to touch its bark. But larch in some places suffers exceedingly. I have seen scores of larch trees with the tops broken down, and lying at right angles with the stems, having been broken over by the wind after having been peeled by the squirrels.

growth, or in any way diseased, unless pinched with hunger. The bark, on being peeled off the pine-tree, does not again close up, nor the wound heal as in hardwoods, in consequence of which the sap, though allowed to ascend in the inner layers of the wood, and thus reach the extreme top of the tree, is nevertheless entirely obstructed in its descent, *hence*, that portion of the tree below where the bark is peeled off, from that time ceases to enlarge, except what is elaborated by the few remaining branches below the wounded part. Though the Scotch pine is undoubtedly the squirrel's favourite food, yet in dry warm seasons it attacks indiscriminately the larch, silver fir, spruce, and even poplars. The greatest amount of damage done to trees is by peeling off the bark during spring and early in summer, but in districts where the pine sows itself, the loss sustained by the squirrel devouring the seed is very considerable. The squirrel also destroys the young shoots, which causes double tops on trees. . . . When we consider the enormous amount of property annually destroyed in Britain by squirrels, and the rapidity with which they are increasing in numbers, it is certainly the interest and duty of every proprietor of woods in Scotland to adopt means for their extirpation."

So much for Mr Michie's report, which may be taken as fully illustrating in a general way the damage done.

I have not obtained many actual estimates of damages done on different estates simply because of the difficulty of making such calculations, but the following is one I have received from a forester of experience—Mr T. Milne, Forest of Glen Tanar, Aberdeenshire. He writes to me as follows: "In 1874, the year in which we commenced to kill them, I considered that they destroyed 1000 trees. I would put it down at a loss of £500 upon the woods of Glen Tanar." Mr Milne then adds: "About 1000 squirrels have been killed from 1874 until now—1879." It may be imagined what destruction must have taken place upon the Cawdor estates, where as many as 1100 or 1200 have been killed in one season, and where 14,123 were killed and paid for during seventeen years.

Adjoined is a list of the squirrels killed and paid for on the

Cawdor estates between 1862 and 1878, for which I am indebted to Mr W. A. Stables, factor at Cawdor.

SQUIRRELS KILLED IN THE CAWDOR PLANTATIONS.

1862.—	469	Squirrels,	at	3d.,		£5	17	3
1863.—	617	,,	,,	3d.,		7	14	3
1864.—	620	,,	,,	3d.,		7	15	0
1865.—	609	,,	,,	4d.,		10	3	0
1866.—	956	,,	,,	4d.,		15	18	8
1867.—	1164	,,	,,	4d.,		19	8	0
1868.—	1095	,,	,,	various rates,		23	8	0
1869.—	503	,,	,,	,,		7	1	4
1870.—	1045	,,	,,	,,		21	13	10
1871.—	1026	,,	,,	,,		13	2	2
1872.—	1223	,,	,,	,,		18	18	11
1873.—	1012	,,	,,	,,		13	15	1
1874.—	1171	,,	,,	,,		14	16	7
1875.—	492	,,	,,	,,		6	1	6
1876.—	175	,,	,,	,,		2	2	6
1877.—	884	,,	,,	,,		12	10	0
1878.—	1062	,,	,,	,,		13	7	1
Total,	14,123*	in seventeen years, for which was paid the sum of				£213	13	2

About the year 1856, the order went out to kill down the squirrels on Thirlstane Castle estates, in Lauderdale. In the autumn of the same year, over 100 were killed, and since then, thirty or forty yearly. They first appeared there about 1838 or 1839, and had increased and become plentiful by 1849.

I have, in another place, given a list of squirrels killed, as illustrating the rapidity with which they increase. These numbers will give some idea also of the amount of damage done, and of the necessity arising for their destruction. A plantation near Kingussie had to be cut down, owing, it is said, to damage done by squirrels. On Kildrummy estate, Aberdeenshire, about five years ago, great damage was done by squirrels to Scotch fir plantations. The average killed since then per annum, by shooting alone, has been 100.

* To the excellence of the squirrel as an article of food I can myself testify. The flesh is pinky-white, like young rabbit, and sweet. The epicure has only once to taste them, and if he possesses a squirrel-haunted wood, he won't grudge the squirrels a fair share of his filberts, hazel-nuts, or cherrie-stones. They can afterwards be cooked in as many ways as a rabbit, and are wholesome and excellent food.

During the severe winter of 1878-79, squirrels were observed for the first time on Donside, feeding upon the buds of spruce trees. Cones, or the seeds of the cones, seems to be favourite food when they can obtain them. In the winter of 1878-79, during the severe frost they were busy with the cones in the Asylum grounds at Murthly, where, as Dr MacIntosh of Murthly informs me, they have just arrived, the trees having only lately attained a suitable age and size.

Nor do squirrels confine their attacks to the pines and firs. Many of the hardwoods suffer. Mr Malcolm Dunn, of Dalkeith Gardens, writes to me: "We have plenty of evidence in the Park here of the injury done by them to trees. Just now (December 1878), in this severe storm, you will find one in almost every plane tree; and if you stand quietly and observe his movements for a little while, you will see the nimble little rogue leaping from twig to twig and biting off the buds by the hundred—I may safely say hundreds daily, as the snow below is *thickly strewn* with the *débris*. He appears to eat only the tender heart of the buds, and to discard the outer envelopes."

A writer in *The Field* (November 20th, 1878), speaking of the food of the squirrel, includes the young shoots of horse-chestnut trees. He says also that in Nairn, twenty-year old firs are attacked, and every third or fourth tree "ringed" round by them where the branches radiate. Effect described: The tree-tops rot and the wind breaks them over, but the writer does not think much damage is done to old fir, that is, fir over fifty years' growth, as in them they seem to "shred down the cones and extract the seed." Trees under 5 feet, damaged, he considers the work of roe or red-deer. If a 20-feet fir or spruce, it is probably done by a wood-pigeon perching on it. But this opens out a wide field for discussion, which I think is hardly necessary in this place.*

In the pages of the "Journal of Forestry"† much informa-

* I mean,—if the trees be weakened by the squirrels nibbling the circumference of the bark near the top, wood-pigeons alighting thereon afterwards will the more easily break them down by their weight.

† Vide *Journal of Forestry*, June 1879, p. 88—quotes *Live-Stock Journal;* also July 1879, p. 209, chestnut trees.

tion is given regarding the destructive powers of the squirrel, and nowhere can I find anything said in its favour.

Amongst the food-stuffs of the squirrel I may instance the following. It might prove interesting to make the list as complete as possible.

Various kinds of mushrooms and agarics,* including truffles, for which they scrape in the earth below trees.† It is not yet known how many species of fungi are used by the squirrel as food, nor all the names of them. Some, however, and especially the red agarics, appear to be rejected as food, and only carried by the animals and placed in clefts of the trees. "They are placed in the fork of a branch with the stalk down, like an umbrella set up to dry."‡

This is probably simply exhibiting an inherent curiosity common to most animals (see further on, p. 179). The smaller fungi which cover the bark of trees are also eaten by squirrels, as has been pointed out to me by the late Sir Thomas Moncrieffe, Bart., who, in one of his last letters to me, stated that he intended further to investigate this matter, with a view to discovering whether or not any of the damage done to trees did not result from this fondness for these minute fungi. In nibbling at these close-growing superficial fungi on the branches and shoots of trees, the squirrels' teeth might reasonably be supposed to penetrate deeper till it affected the bark itself. Mr R. M. Barrington has also witnessed the squirrel descend a larch tree, and picking up a mushroom (species not noticed) run up and eat it leisurely on a branch. Mr Barrington also notes, "they eat many of the toadstools in our pleasure grounds."§

Of seeds and nuts and kernels of stone fruits, a large variety occurs, amongst which I may mention the following: Seeds of apples,‖ fir-cones, burr-thistle, agermony, horehound,

* Personal observation and that of correspondents. Early notice of the fact in "Zool.," vol. v., p. 1820.

† Von Tschudi, "Thier. der Alpenwelt," and "Zoologist," 1865, p. 9560.

‡ Mr J. Anderson in *Proc. Berw. Nat. Club*, vol. vii., Part 1., p. 127. See also *op. cit.* (1879).

§ Further *vide Science Gossip* (1865), p. 40; 1866, p. 138 (squirrels eating toadstools).

‖ F. Norgate, *in lit.*

haws, the seeds of caraway-sweets in confinement—the sugar being rejected and the seeds eaten,—hazel-nuts and filberts, etc.; acorns, beech-nuts (or beechmast), kernels of apricot,* plum, etc.; walnuts, etc.†

Of berries, fruits, etc., amongst others—blackberries, strawberries, bilberries, briar, juniper. ‡

Shoots and buds of fir, larch, spruce (not so commonly), chestnut, sycamore.

Inner bark of fir, larch, young birch, silver fir, poplar. §

Besides the above they are apparently fond of a few other odds and ends. Mr T. Milne, forester in Glen Tanar, writes me that he has "often trapped squirrels with a piece of fried bacon, which they appeared to relish." They are accused of eating birds' eggs and young birds, and having other carnivorous inclinations, but that will be now fully discussed.

DAMAGE TO GAME, BIRDS' EGGS, ETC.

The question of to what extent the squirrel is destructive to birds' eggs has several times before now come up for discussion. The results of my correspondence and search into the subject is, that by far the larger number of individuals who have had ample opportunities of observing the squirrel in Scotland, either deny that the damage so done is appreciable, or state that no instance of the squirrel eating eggs has ever been witnessed by them. Mr Robert Mackintosh, gamekeeper, Grandtully Castle, never knew them to do any harm to game, or destroy eggs, but he says: "I have seen them play with the empty shells of wood-pigeons' eggs, but never was certain that they broke them. Never saw them touch pheasants' eggs." On the other hand, there cannot be a shadow of a doubt that eggs are destroyed and eaten by squirrels occasionally. My friend Mr A. Burn-Murdoch gives

* *Auct.* Captain Dunbar-Brander.

† Actual observation of squirrels burying nuts and walnuts, and their *modus operandi* described (Henry H. Higgins, "Nature," vol. xv., 1876, p. 117).

‡ *Journal of Agriculture*, 1865, p. 471.

§ The American species—*Sciurus Hudsonicus Pallas*—is recorded as eating flowers, especially cherry blossoms (F. H. Storer, Bussey, Institution of Harvard University, in "Nature," vol. xiii., p. 26).

me a well-authenticated instance of its doing so—carrying away partridges' eggs. The person who saw the squirrel carrying an egg in its mouth "gave chase, and made it drop its burden, which proved to be a partridge's egg. He found the nest from which it had been taken in the hedgerow root, and on the other side of the road he found the two eggs which had been removed on the two previous journeys which he had witnessed. The eggs were all punctured by the squirrel's front teeth, but merely enough to afford a catch for carriage." Mr Frank Norgate, of Norwich, also sends me a note as follows: "At Hethersett, Norfolk, I saw a squirrel sitting on a blackbird's nest with its head hidden in the nest, and the blackbird flying at it and making much noise; one egg in the nest had two holes in the shell, and the white was oozing out. Fresh remains of one or more other eggs were in the nest."

There is no doubt a deep-rooted prejudice against the squirrel and its öological tendencies, as we find, as early as the date of the "Old Stat. Account" that it received censure for "doing much harm amongst singing birds," and taking pheasants' eggs;* and every now and then, no doubt, we do meet with instances in which they are guilty of misdemeanours. But I cannot admit that the damages done are appreciable. If it were so, far more observers would be found to record these damages. I agree entirely with Captain Dunbar-Brander of Pitgaveny, that "some few squirrels have learned that eggs are good, and will destroy them; the great majority do not. One dog in ten will eat an unbroken egg; one cat in fifty has found out that eggs can be broken. There is nothing a cat likes better than an egg, but it must be broken for her. If an unbroken egg be put in a ferrets' cage, they won't meddle with it, but, break the egg, and they will fight for the contents. Egg-eating does not come naturally to the squirrel any more than to the cat or ferret, but they may be educated to it. Perhaps one squirrel in thirty eats eggs. Though often trapped with an egg, that proves nothing. They are inquisitive. Just now, as the snow lies, one might trap every quadruped, and a good many birds besides, with *an old boot* as bait! I think

* "Old Stat. Acct.," vol. ix., p. 235 (1793).

the birds themselves bear me out in my opinion, that squirrels are harmless to eggs or young. A blackbird takes no more notice of a squirrel than it does of a rabbit, but if it sees a cat, weasel, or rat, it begins *swearing*" (*in lit.*).

Many correspondents, in some form or other, bear out the above remarks by their experience; only a very few instance cases of damage done. One of the latter is as follows: In Lauderdale squirrels appeared for the first time about 1838 or 1839, and were ordered to be destroyed about 1849, which was done by the gamekeepers. At that time there was nothing against them as game-destroyers, and consequently they were not killed down very assiduously. About the year 1856, when stories were told of their fighting with birds, and taking their eggs, they got a little more attention, and it was found to be true: *they will take eggs.* I am obliged to Mr Peter Scott, gamekeeper, Thirlstane Castle, Lauder, for the above (see also further on what is said of their carnivorous propensities, p. 182).

Mr C. Y. Michie, in his prize essay already quoted, makes some startling statements regarding the carnivorous propensities of the squirrel. The fact that squirrels do eat birds' eggs occasionally is well known, and we have abundant proof of the fact; but I cannot, with all the evidence, negative and positive, at my command, conclude that this is a common practice, nor that the habit of devouring young birds is freely indulged in by the species. I quote here Mr Michie's observations on this head. He says: "Where squirrels are most numerous, woodpeckers are most scarce. In conversation with a sawyer, a man of observation, a few days ago, he told me that near to a sawpit where he was at work, a woodpecker hatched its eggs, and when the young ones were nearly full-fledged, he observed one morning a squirrel enter the nest and carry off a young bird; this was again and again repeated by the squirrel till the whole brood was destroyed. It is now," continues Mr Michie, "pretty generally known that squirrels eat the eggs of wood-pigeons, from which it may pretty safely be inferred that the eggs of the woodpecker and other insect-devourers will share a similar fate." Mr Michie also makes the further

statement that "where squirrels abound the ravages committed by this (a certain) insect are greatest, and at the same time where squirrels are most numerous, woodpeckers are most scarce." Mr Michie then tells us: "In Strathspey, about twenty years ago, woodpeckers were very numerous; the holes which they burrowed in the trunks of old trees may be seen at the present day in hundreds, whilst now not a single woodpecker is to be seen in the whole forest. About the year 1840, the first squirrels were seen in Duthel Forest, and now they are seen in hundreds, and appear on a rapid increase."

Further inquiry certainly brings out the fact that this is the general belief amongst the old people of Inverness-shire and the northern forests of Scotland. Sir Dudley Marjoribanks writes (*in lit.*): "The old people say the squirrel drove away the red-headed woodpecker [*i.e.*, *Picus Major*, L.] from Guisachan. Certainly," continues Sir Dudley, "its holes in the trees are very numerous, and yet I have never seen a single specimen. I heard of one being seen in 1869, in the spring."

It seems quite unnecessary to criticise this at length. If the first squirrel appeared in the neighbourhood only about the year 1840, and Mr Michie wrote his paper in 1865, and if woodpeckers were very numerous in Strathspey about twenty years before, but "now are extinct, or nearly so," surely he cannot mean to say that the extinction of the woodpeckers took place by the squirrel's agency in such a short time. Even supposing squirrels could always gain easy access to a woodpecker's nest, I don't believe such could have taken place. The great spotted woodpecker does not make a hole, however, large enough to admit a squirrel's body. However correct Mr Michie no doubt is as regards the damage done to forests, and in relating the evidences of his own senses, I cannot, in absence of fuller data, and the testimony to the contrary by many others, agree that the scarcity of woodpeckers is owing to the abundance of squirrels. He states the two facts of the scarcity of the one and abundance of the other, and arrives at the somewhat hasty conclusion that the latter has produced the former state of things; while all his proof

rests upon a single statement of a single instance by a single individual.

It is only just, however, here to relate what additional evidence I have of the carnivorous propensities of the species, at the same time repeating that such records are rare and decidedly exceptional, going to prove—I consider—that the taste for eggs and young birds is not a natural, but only an acquired and very exceptional one. Mr Peter Scott, already mentioned in this paper, writes to me as follows: "As to their taking game or eating carrion I am not sure, only I have known of ugly things being found in their nests, such as a pheasant's head, rabbits' and other kinds of bones." This evidence appears to me in no way whatever to prove a carnivorous desire, but simply the gratification of that inherent curiosity, mentioned above by Captain Dunbar-Brander. Much more likely that a weasel, or stoat, or other carnivorous animal slew the pheasant, and left the head lying, and that our little friend, happening to pass that way, or having watched the weasel or stoat at its meal, descended afterwards from its arboreal perch, and pouncing on the pheasant's head, bore it away to its "dray." Mr Duncan Dewar, gamekeeper at Remony, Perthshire, during the severe winter of 1878-79, found two cole tits in a squirrel's nest, which had crept in for warmth and died there; their flesh was quite dried up and preserved by the frost, and left untouched by squirrels, which were also in straits during the winter.

It would be almost endless to multiply the evidence relating to this part of our subject, or at least to go into minute detail concerning it. Below, however, I give a list of references in one journal alone—*Science Gossip*—if only to show how voluminous is the literature.*

* "Carnivorous Propensities, and Egg-eating and Nest-robbing," *Science Gossip* (1871), pp. 131, 189, 214 (H. C. Sargent, Penkeith, near Warrington); 237, 238 (Rev. J. G. Wood); 256, 257 (seen to attack a young rabbit); 278 (R. M. Barrington; C. Kingsley, Eversby, Hants; Grantly F. Berkeley, Alderney Manor, Poole).

Parallel Propensities of the grey squirrel of the United States, given in *Science Gossip* (1872), p. 199 (Charles C. Abbott, Trenton, New Jersey, U.S.); 261 (reply to C. A.'s letter); Waterton quoted by H. C. Sargent against carnal propensities of the squirrel in a wild state.

X. *On the Presence of the Scattered Skeletal Remains of Holothuroidea in the Carboniferous Limestone Series of Scotland.* By R. ETHERIDGE, jun., Esq., President. [Of the Museum of Natural History.] [Plates V. and VI.]

(Read 16th March 1881.)

1. *Introduction.*—The soft and destructible nature of the body in the Holothuroidea, would, on first thought, give little hope of traces of this group ever being found in the fossil state, except under the most favourable circumstances.

The only detailed and reliable instance of this with which I am acquainted is that of the *Synapta Sieboldii,* described and figured by Von Münster,* from the *Scyphia* Limestone of the Jura Formation at Streitburg.

Several other problematical fossils have been referred to the Holothuroidea by various authors, but in all probability without sufficient justifiable evidence. The following may be referred to in passing. Dr E. Rüppell† figured, as long ago as 1829, a nondescript body from the Solenhofen Slate, of an elongated sack-like form, and which he appears to have considered of this nature. Its true nature is, however, dubious, although Professor Zittel‡ states that its proper place will perhaps be in Geibel's genus *Protoholothuria.*

Science Gossip (1874), p. 118 (Elizabeth Edwards); thirty squirrels semi-dormant in an old oak, at Cudham, Kent, on Feb. 7th, p. 143; (same commented upon by W. H. Warner, Kingston, Abingdon).

Science Gossip (1867), p. 69, disease called "rot" in squirrels.

Science Gossip (1867), p. 141, a remark on Tate's paper in *Popular Science Review* (April 1867), criticised by Fras. Bucknell, M.R.C.S. Mr Tate's paper is on the "Flint-Flakes of Devon," and the remark made is "perforations in the nuts demonstrates that squirrels skipped among the branches of the trees that grew there." Fras. Bucknell states he has kept both dormice and squirrels, and states the differences in the mode of extracting the kernels. Thinks nuts alluded to by Mr Tate were attacked by dormice.

Science Gossip, p. 165, Mr Bucknell's remarks confirmed by Helen Watney.

Science Gossip (1869), p. 235, an observation by W. Hambrough Worthing rather in favour of squirrel being an öophagist.

* Beitrage zur Petrefact. (1843), 9 heft, p. 42.

† Abbild. und Beschreib. einiger neuen oder wenig Gekannten Verstein, aus der Kalkscheiferformation von Solenhofen (1829), p. 10, t. 3, f. 3.

‡ "Handb. der Pal.," p. 560.

The Chevalier d'Eichwald held * that the small bodies described by Dr Pander as Conodonts from the Orthoceratite Limestone of St Petersburg, were fragments of the calcareous anchors and plates similar to those found in the skin of *Synapta* and other Holothuroidea. It is hardly necessary to mention that Pander's view of the affinity of these little bodies is that generally accepted.†

In 1865 Mr C. Schwager‡ described some microscopic bodies from the Oolitic Rocks, which he considered to be the wheels of *Cheirodota*. One of these is named *C. Sieboldii*,§ and the other is specifically undetermined.‖ Without expressing a decided opinion, these bodies appear to me to have more affinity with Polyzoa than with the Holothuroidea, although they seem to be so regarded by Professor Zittel in his recently published work.¶

A paper which I believe contains references to fossil Holothuroidea, by Messrs Terquem and Jourdy, entitled, "Monographie de l'Étage Bathonien de la Moselle," I am sorry to say I have not been able to consult.

The bodies described by Von Münster from the Jura Limestone of Streitburg, and which I believe to be the only definite remains of Holothuroidea yet noticed in either Palæozoic or Secondary Continental Rocks, are of two kinds. The first (*Synapta Sieboldii*) consists of a well-formed anchor with a long shaft, non-serrated flukes, and a small transverse terminal piece,** corresponding quite with the anchor spicules of many recent *Synaptæ*. With these occur little hammer-like bodies, having a long shaft,†† which, although not so clearly Holothuroid as the anchors, may still be of that nature. Professor Zittel regards the anchors of *Synapta Sieboldii* as the spicules of sponges,‡‡ a view which may have some force in it from the three-fluked nature of the pieces. No notice of the occurrence of Holothuroid remains in the rocks of our own country

* "Lethæa Rossica" (1860), i., p. 661.
† See G. J. Hinde, Quart. Jour. Geol. Soc., 1879, xxxv., p. 351.
‡ Jahr. für Vaterlandische Naturkunde, xxii., p. 82.
§ *Loc. cit.*, p. 144, t. 7, f. 26. ‖ *Loc. cit.*, p. 144, t. 7, f. 30.
¶ "Handbuch," p. 560.
** Beitrage zur Petrefact., p. 92, t. 4, f. 9.
†† *Loc. cit.*, p. 93, t. 4, f. 10. ‡‡ "Handbuch," p. 560.

appears to have been given until Mr Charles Moore, of Bath, read a paper before the meeting of the British Association in 1872, "On the Presence of Naked Echinodermata (Holothuroidea) in the Inferior Oolite and Lias."* In this communication he drew attention to certain minute wheel-like bodies, about the 40th of an inch in diameter, which he had met with in these deposits. The spokes of the wheels are from five to thirteen in each, and the tires are toothed. Omitting the questionable reference of Von Münster, I suspect Mr Moore's discovery is the first reliable notice of the remains of this interesting group of animals in any Rocks older than those of the Tertiary Period.

I was much gratified, in 1873, to have brought under my notice by Mr James Bennie certain calcareous microscopic organisms, found by him in the Carboniferous Limestone Series at Limekilns, East Kilbride, and Williamwood, near Glasgow. These I briefly noticed in the same year,† but the absence of sufficient material did not permit further investigations being made. Of late, however, Mr Bennie has met with similar remains at Fifeshire localities in such quantity, that a notice of them should no longer be delayed. The present communication will embody a description of these organisms.

2. *The Skeletal Remains of Recent Holothuriæ.*—The descriptions to follow will probably be more intelligible if a few brief notes are given on the form and appearance of the spicular skeleton in the recent Holothuroidea.

The body in this group is enclosed in a coriaceous skin usually containing scattered calcareous grains, plates, and spicules of various forms. They are likewise present in the tentacles. No other form of skeleton exists, except a ring of calcareous pieces at the base of the latter, and around the æsophagus,—whilst in some genera a smaller circlet surrounds the anal or cloacal opening. The ambulacral tube feet occasionally have perforated discs.

The calcareous pieces forming the anterior ring "have often been called the dental ring, or even the teeth,—having at first

* Brit. Assoc. Report for 1872, pt. 2, p. 117.

† Mem. Geol. Survey of Scotland, Expl. Sheet 23 (1873), p. 98.

sight a resemblance to the maxillæ of the Echini. But as they cannot be used for mastication,—being scarcely movable upon each other, and nowhere reaching the central cavity of the mouth—this appellation is improper."*

The form of the calcareous plates in the Holothuroidea is very varied; in some genera they are quite simple, but in others more complex. It has been shown by the late Messrs S. P. Woodward and Lucas Barrett† that in *Synapta* the pattern of the anchors and anchor-plates is characteristic of the species to which they belong. In this statement they are supported by Dr W. B. Herapath.‡ It is clear, therefore, the study of these plates is of the greatest importance to the palæontologist, for by means of them only can he gain any knowledge of pre-existing forms.

In *Synapta* the calcareous plates are usually more or less elongately oval, pointed-ovate, leaf-shaped, obovate, or obcordate in outline; the external margin being either plain or serrated (*S. Galliennii*, Herapath). The attenuated end of the plate is produced in a few species into a handle-like process (*S. dubia*, Semper, *S. Buskii*, M'Intosh, etc.). The perforations vary much in number in one plate; usually they are few, but in some species (*S. pseudodigitata*, Semper, *S. similis*, Semper) they are very numerous, and much crowded. The margins of the perforations may be plain and entire (*S. digitata*, Montg.), or they may be scalloped (*S. inhærens*, Müller), or the central hole only may be in this condition (*S. vittata*, Forsk.). In other forms the perforating holes, instead of having the margins serrate, are subdivided by projecting processes (*S. Astrolabi*, Held, and *S. Beseli*, Held). As a rule the perforations are on the same plane, or nearly so when the surface is a little convex, but in one species at least they are arranged in a pyramidal form (*S. Thomsoni*, Herapath). Those placed at the attenuated end of the plate are smaller and more crowded than on any other portion, although in certain forms the marginal perforations are the smaller (*S. digitata*, Montg., *S. Galliennii*, Herapath). The "anchors" of *Synapta* are

* Pourtalés, Proc. American Assoc. Adv. Science (1851), p. 9.

† Annals Nat. Hist. (1859), iii., p. 214.

‡ Quart. Jour. Micro. Science (1865), v., p. 3.

attached to the smaller end of each plate, by means of an articulating process, of more or less complex form, and either on the convex or concave side (*S. Galliennii*). This process is at times simple, or it may possess a slit like the eye of a needle (*S. digitata*, Montg.), or it is in the form of a raised arch (*S. vittata*, Forsk.), or, again, the plate is devoid of any process at all (*S. inhærens*, Müller).

The anchors themselves vary much in minute structure. They are plain and simple (*S. vittata*); long or short; and stout and straight (*S. bidentata*, W. and B.). The flukes are plain, or barbed on the convex margin (*S. inhærens*), or both in the same species. The apices of the flukes are occasionally reflexed (*S. Galliennii*), and at other times bifid (*S. bidentata*, W. and B.). In one species the anterior or convex border is marked by a central depression (*S. Thomsoni*, Herapath). The shaft is terminated by a plain crosspiece, with recurved ends, or it may be serrated, and sometimes deeply divided. Lastly, in *S. Goddefroyi* (Semper), the proximal termination of the shaft in the anchors is triradiate. Generally speaking, the discrepancy in size between the plates and anchors is considerable, the latter being the larger.

The skin of the *Synaptæ* also contain additional particles termed by Woodward and Barrett "miliary granules." They vary considerably in size.

In the genera *Thyone* (*T. fusus*, Müller) and *Thyonidium* (*T. pellucidum*, Vahl) the calcareous plates are of a more irregular form than in *Synapta*, and have usually a much greater number of perforations. The latter are also plain and non-serrate, and are by no means as large in proportion to the size of the plates they pierce. Some of the plates in *T. fusus* are provided with an elevated and arched process, which subdivides into two outstanding limbs, each bifid at the free extremity. There is likewise a well-developed, œsophageal ring, or spurious lantern, composed of long, elongated, tooth-like pieces. The spicula in the tentacles of *Thyone raphanus* are of a remarkably dendritic or aborescent form.

Most fantastic forms are assumed by the calcareous plates in some species of *Holothuria*, *Cucumaria*, *Mülleria*, and *Stichopus*. They are dendritic, star-like, irregular, or C-shaped,

whilst the perforations, unlike those of *Synapta* and *Cheirodota*, do not appear to be toothed or serrated.

The plates in *Holothuria papillosus* are flat and fiddle-shaped. In other species they are circular, with a stellate center, or with a spine projecting from the middle (*H. intestinalis*, Ascanius). The integument of *H. (?) floridana* (Pourtalés) is filled with spicules in the form of an irregular cross or star, whilst other Holothuriæ possess bundles of calcareous bodies like a slightly curved rib, with a small perforated expansion at each end. In *H. tremula* the plates are small and oblong, with a series of perforations arranged in lines, giving to the organisms much the appearance of a portcullis door.

The genus *Cucumaria* possesses spicules of varied form. In *C. frondosa* (Linn.) they are plume-like, with slightly serrated edges. *C. Hyndmanni* (Forbes) has strange looking bodies like a bent dumb bell, with a perforated enlargement at each end and in the centre. Similar spicules exist in *C. canescens* (Semper), but they are rather more curved.

Some plates in the British Museum, labelled *Cucumaria*, possess wheel-like plates resembling those of *Cheirodota ;* the perforations, however, are less regular, and the central space is subdivided.

The anchors and anchor-plates of *Synapta* are replaced in the genus *Cheirodota* by peculiar wheel-spicula scattered throughout the integument. They are composed of a central axle-hole, from which radiate spokes, uniting with the outer margin or tire. The apertures or spaces thus enclosed are triangular, and have the inner margins of the tire notched or scalloped. In *C. violacea* the spaces are five or six in number ; in *C. lævis* there are very regularly six.

The dermal plates of *Myriotrochus Rinkii* (Steenstrup), an arctic form, are more complex, although on the same plan. The radiating subdivisions are from eighteen to twenty-three in number, with other intermediate shorter projections, and very elongated and narrow enclosed spaces.

Lastly in *Haplodactyla molpadioides* (Semper) are four-radiate spicula resembling those of some sponges.

The foregoing is only an outline of some of the more interesting forms of plate-structure amongst recent Holothur-

oidea. Many more might be cited, but I have entered thus minutely only with a view of showing with which type the fossil remains about to be described approximate closest.*

One fact may perhaps have a tendency to render the researches of the palæontologist amongst the extinct Holothuroidea of less value than they otherwise might be—the alteration which takes place in the form of the plates and spicules during development. It has been shown by M. Quatrefages † that in *Synapta* the plates before full development do not possess their characteristically ovate outline, but are wanting in an entire and defined margin, the plates being thus irregularly formed. Similarly, the anchors are at first represented only by the shaft, the flukes and the proximal transverse piece being afterwards acquired. On this subject Messrs S. P. Woodward and Lucas Barrett remark—"*First*, We find a simple and slender spiculum, then another,

* The particulars here cited are to be found in the following works and papers: Quekett, J.—"Lectures on Histology," 8vo, vol. ii., 1854, pp. 236-247; Griffith, J. W.—"The Micrographic Dictionary," 1856, p. 624, etc.; Herapath, Dr W. B.—On the Genus *Synapta*, with some new British Species (Quart. Jour. Micro. Science, 1865, v., pp. 1-7); Woodward, S. P., and L. Barrett—On the Genus *Synapta*, etc. (Annals Nat. Hist., 1859, iii., pp. 214-221); Gray, Dr J. E.—Description of *Rhopalodina*, a new Genus of Echinodermata (Annals Nat. Hist., 1853, xi., p. 301); Koren, J.—Beskrwelse over *Thyone fusus* og *Cuvieria squamata* (Nyt Magazin for Naturwidenskaberne, Christiania, 1845, iv., pp. 203-225); Quatrefages, A. de—Mémoire sur la Synapte de Duvernoy (*S. Duvernœa*, Quat.), (Ann. des Sc. Nat., Zoologie, 1842, xvii., pp. 19-93, t. 2-5); Duben, M. W. von, och J. Koren—Om Holothuriernas Hudskelett (Kongl. Svenska Akad. Handlingar, 1844, pp. 211-228, t. 4, 5); Held, J.—Ueber die in die Haut der Synapten einige lagerten Kalkörper (Viertel jahrs Naturforsch Gesellsch, Zurich, 1857, ii., pp. 243-271, t. 2); Pourtalés, L. F.—On the Holothuriæ of the Atlantic Coast of the United States (Proc. American Assoc. Adv. Science, 1851, p. 8); M'Intosh, Dr W. C.—Observations on the Marine Zoology of North Uist, Outer Hebrides (Proc. Roy. Soc., Edinb., 1866, v., pp. 600-614); Semper, Dr C.—"Reisen ein Archipel der Philippinen—Holothurien, 4to, Leipsig, 1868; Frey, H.—Ueber die Bedeckungen der Wirtellosen Thiere (Gottinger Studien, 1847, pp. 709-810; Echinodermen, p. 748); Forbes, Professor Edward—"British Starfishes," 8vo; Lesson—"Centurie Zoologique," 8vo, Paris, 1830; Jaeger—"De Holothuris," 4to, Turici, 1833.

I am also indebted to my colleague Professor F. J. Bell, etc., for an opportunity of examining a number of recent examples of Holuthuroid plates in the National Collection.

† Ann. de Science Nat., Zoologie, 1842, xvii., t. 2-5.

longer and expanded at one end; those only which have attained their full length begin to develop flukes; and it is not until the anchors are completely grown that we detect any trace of the anchor-plates." *

The same authors describe a corresponding development in the wheels of *Myriotrochus.* These "first appear as little stars, with rays or spokes of variable number, which increase until they attain their normal length, and then expand at their ends, until they join and form a rim (or tire) to the wheel." †

3. *The Plates and Spicules from the Carboniferous Limestone Series of Scotland.*—As before stated, remains which we considered referable to this group first came under the notice of Mr Bennie and myself in 1873, from the localities named, but in small numbers. Since then Mr Bennie has met with these plates and spicules in quantity at two localities in the East of Scotland—at Woodend Quarry, near Fordel, Fife; and in a section on the river Avon at Kinneil Mill, near Linlithgow. The fossiliferous shale at Woodend is above the limestone, the latter being the No. 2 Limestone of the Lower Carboniferous Limestone Group (= Hosie Limestone of Lanarkshire). The stratum yielding the remains at Kinneil Mill is, Mr Bennie believes, the shale above the Dykeneuk Limestone (= Gair Limestone of West of Scotland) of the Upper Carboniferous Limestone Group.

The microscopic organisms may be described as follows:

a. Perforated Plates of various sizes.—By far the commonest forms are irregularly rounded and slightly convex plates, with a diameter varying from $\frac{1}{40}$th to $\frac{1}{50}$th of an inch. When perfect, the marginal outline is undulating, but as a rule the plates are imperfect and broken. Each plate is pierced by a variable number of perforations giving to the entire organism the appearance of a network with the finest possible mesh. The perforations are circular or oval, vary in size in the same plates, and have entire edges. They are usually largest in the centre, and decrease towards the margins of the plate, or sometimes towards one end, although neither of these rules always holds good. They vary in size from ·005 downwards.

* Annals Nat. Hist., 1859, iii., p. 217. † *Ibid.*, p. 220.

The smallest number noticed in an entire plate was nine. The interspaces between the perforations forming the mesh vary a good deal in breadth; some are comparatively narrow, in others the divisions are broader.

Of these plates there are certainly two well-marked varieties in the size of the perforating holes, and perhaps a third. Beyond mere size, no difference can be indicated between the three kinds, except that, perhaps, in the intermediate variety the perforations are less rounded than in the first, or that possessing the largest holes. The measurements of the two varieties may be taken as follow:

1. Size of Plate averaging about $\frac{1}{50}$ inch = ·02 in., longest diameter.
   Size of perforations about $\frac{1}{200}$ inch = ·005 in.
2. Size of Plate averaging about $\frac{1}{40}$ inch = ·0255 in., longest diameter.
   Size of perforations about $\frac{1}{250}$ inch = ·0045 in.

b. Hooks or "*Anchors.*"—Accompanying the foregoing plates are simple, generally plain hooks. The shaft has a length of about ·0232 inches, and is terminated at the proximal end by an eye, formed by the shaft being bent back upon itself. The distal end is recurved and forms the hook, terminating in an attenuated point. The shaft is quite plain and simple in all the examples examined, but in one specimen the fluke or hook was observed to be dentate, or slightly serrated, on the concave side. These anchors are always single and never doubly fluked. In appearance they are white, glistening, and semi-transparent.

In two instances the hooks have been observed attached to the first variety of perforated plate, in such a manner as to clearly prove their relation one to the other (Pl. V., Figs. 5 and 6). There is, however, no trace of any process or extension of the plates to which the hooks could have been attached. No doubt this was effected by means of the eye at the proximal end of the shaft in each hook. As compared with the perforated plates the hooks are rare.

c. Wheel-like Plates.—Very minute circular, concavo-convex, wheel-like plates are met with intermingled with those first described. On the convex face the surface is gently rounded from the margin to the centre, which forms an inner ring, and is either subdivided or entirely hollowed out, ac-

cording to the state of preservation. The space between the outer margin and the inner ring is pierced by a series of circular perforations, seven, eight, nine, ten, eleven, or twelve in number. The margins of the perforations are plain and non-serrated. The central space, when perfect, is occupied by four smaller holes, but usually appears as a single large vacuity. In the perfect plate the outline is somewhat undulating, the undulation answering to the convexity of the marginal perforations. On the under or concave side the margin of these wheels is prominent and rim-like, and the central portion also projects more or less. On the whole the general appearance of these plates is very wheel-like, the external rim or margin answering to the tire, the subdivisions between the perforations to the spokes, and the central four perforated space to the axle-hole.

Several modifications have been observed, and will be described later.

d. Cross-like Bodies.—Associated with the foregoing remains are spicules in the form of a cross with equal prolongations, originating in a central body pierced by four holes in the form of a triangle. The longest diameter of these measures about ·0215 in., while the apertures are about ·001, or $\frac{1}{1000}$ of an inch. No other structure is visible, but they have the same pellucid semi-transparent appearance as the hooks and plates before described. The arms of the cross are sometimes a little curved, and enlarged at their distal extremities. One specimen has been met with in which two prolongations arise from the central space, and at right angles to the other portions of the cross in question.

e. Other forms of Spicular Bodies.—The remains described in the foregoing passages are accompanied by two other forms having the same mineral condition and general appearance, but the affinities of which it is difficult to explain.

The first of these resembles in form some fish teeth, especially those of the genus *Lamna*. They are triangular generally, but with the longer margins concavo-convex, terminating above in a more or less acute point. In some the concave side is serrate only, whilst in others both margins are so. The surface appears to be slightly imbricato-striate,

the striæ bent, which would, perhaps, indicate that the surface was to some extent angulated (Pl. V., Fig. 12).

The second of these peculiar bodies is club-shaped, convex, and tapering downwards. The surface is either smooth, or imbricato-striate, probably dependent on the state of preservation (Pl. V., Fig. 11).

4. *The Nature and Affinity of these Plates and Spicules.*—On comparing the perforated plates (Pl. V., Figs. 1-4) with the anchor-plates of the genus *Synapta* (Pl. VI., Fig. 10), a general resemblance will undoubtedly be admitted. The nature and appearance of the perforations, and the undulating outline, when perfect, show this. On the other hand, the irregular form, the number and arrangement of the holes, their simple margins, and last, though not least, the entire absence of any articular process for the anchors, show a decided departure from the structure of the *Synapta* skeleton; or, at any rate, of the majority of the species assigned to that genus. It appears to me there is a much closer resemblance with the plates of such forms as *Thyone fusus*, Müller (Pl. VI., Fig. 13), or *Thyonidium pellucidum*, Vahl (Pl. VI., Fig. 12), in which the plates are figured by Düben and Koren as simple and irregular, with innumerable perforations, as in our specimens. Our Pl. V., Figs. 5 and 6—representing specimens from Woodend and Kinneil—clearly demonstrate the relation of the anchors to the perforated plates, and in the former we again meet with a departure from the *Synapta* type. The anchors discovered by Mr Bennie are simple, without serrations of any kind, one-fluked, and the proximal end of the shaft terminated by an eye in the place of a small transverse piece. Arguing from the researches of Messrs Woodward and Barrett, we can do no less than accept these hooks as those of the adult condition of the organism to which they belonged. These writers have shown that in *Synapta* the anchors are developed first, and afterwards the plates;* they say, "it is not until the anchors are completely grown that we detect any trace of the anchor-plates." It follows from this that the one-fluked hooks from the Carboniferous Strata are adult, and hence a further divergence from the *Synapta* type.

* Annals Nat. Hist., 1859, iii., p. 217.

Messrs Woodward and Barrett have likewise pointed out how the form of the plate and anchor is in *Synapta* of specific importance, and I think we may be justified in extending this principle by placing the present plates and anchors in a distinct genus. Especially may this be the case, when we recollect that little or no chance exists of our ever acquiring a knowledge of the complete animal. I therefore propose for the remains in question the name of *Achistrum.**

Little difference appears to exist between the wheel-plates of the recent *Cheirodota* and those now under description, and I shall content myself in this instance with simply referring them to this genus.

The remaining spicules offer greater difficulties in referring them to their recent analogues. The cross-like bodies have some analogy with spicules from the integument of *Cucumaria Hyndmanni*, Forbes (Pl. VI., Fig. 9), figured by Düben and Koren,† although the resemblance is only a general one.

Similarly, the serrated bodies previously described may be compared generally with calcareous elongated bodies, having an undulated or serrated margin met with in the integument of *C. frondosa*, Linn. (Pl. VI., Fig. 11). Figures of these are also given by Messrs Düben and Koren.‡

Lastly, the small tooth is quite analagous to the pieces composing the æsophageal ring in many genera—for instance in *Thyone fusus* (Müller), as figured by Koren.§

To conclude, the following are the abbreviated characters of the genus and species I propose to establish for these remains of Carboniferous Holothuroidea.

Genus Achistrum, *Gen. nov.*

Gen. Char.—Plates of integument irregularly oval in form; perforations variable in number and size; articular process for anchor absent. Anchor spicules in the form of a one-fluked plain (?) hook. Size of plates varying from $\frac{1}{40}$th to $\frac{1}{50}$th of an inch; size of perforations, from $\frac{1}{200}$ to $\frac{1}{250}$ inch.

* ἄγκιστρον, a fish-hook.

† K. Svenska Akad. Handlingar, 1844, t. 4, f. 13. ‡ *Loc. cit.*, t. 4, f. 1.

§ Nyt Magazin for Naturvidenskaberne, 1845, iv., t. 4, f. 4.

Achistrum Nicholsoni, Sp. nov.—(Pl. V., Figs. 1, 2, 5, and 6).

Sp. Char.—Margin of plates undulating; perforations plain, non-serrate or pectinate. Anchor hooks plain, or slightly serrate (?); distal end a little enlarged and perforated by a hole or eye.

Obs.—The plates are usually of a more or less oval form, sometimes becoming irregular. The perforations vary from something under a dozen to as many as forty-one, and perhaps more. The marginal holes in some examples are smaller than those over the body of the plate, in other examples they are crowded to one end. Both these characters are met with in *Synapta* constantly, but here they are very variable and inconstant. I have met with one or two examples amongst the fossils in which the large perforations are very much reduced in number, and all clustered towards the centre of the plate.

Omitting for a moment the presence of the one-fluked anchors these plates show a much greater affinity with some forms of the *Holothuria* and *Cucumaria* groups than they do with *Synapta*.

I have much pleasure in associating the name of my friend and co-worker, Professor H. A. Nicholson, M.D., with these plates.

The above description does not include the plates with the smaller perforations. They have already been described in the general body of the paper, and, with the exception of the much more numerous holes, smaller size, and more circular outline, they agree with the former. They may be only a variety, or plates answering to the "miliary granules" in *A. Nicholsoni*, or, on the other hand, quite a distinct species.

The average size of the plates in *A. Nicholsoni* is $\frac{1}{50}$th of an inch in their longest diameter. The largest perforations are $\frac{1}{200}$th of an inch in diameter. The hooks have an average length of ·0232 inches.

Loc. and Horizon.—River Avon, below Kinneil Mill, near Linlithgow; shale above the Dykeneuk, or Gair Limestone, Up. Carboniferous Limestone Group. Woodend Quarry, near Fordel, Fife; shale above a limestone, Lower Carboniferous Limestone Group.

Genus Cheirodota (Eschscholtz), 1829.

Cheirodota (*?*) *Traquairii*, Sp. nov.—(Pl. VI., Fig. 1).

Sp. Char.—Concavo-convex wheel-like plates, with a very slightly undulating margin, and a central space occupied by four more or less triangular perforations; outer zone subdivided by eight short septa or spokes, into a corresponding number of semicircular or semi-oval perforations, with plain margins. The diameter is about ·01, or $\frac{1}{100}$th of an inch; the central space is about ·0035, or $\frac{35}{10000}$ths of an inch.

Obs.—*C.* (*?*) *Traquairii* may be at once distinguished from the forms which follow by its scarcely undulating outline, semicircular perforations of the outer zone, and the four-perforated centre. The four perforations in the centre appear to correspond with every other subdivision or spoke. My indebtedness to Dr R. H. Traquair, for assistance and advice, always kindly rendered, affords me an opportunity of associating his name with this form.

Loc. and Horizon.—Limekilns, old quarry, near East Kilbride, Lanarkshire (the original locality), in shales of the Calderwood Limestones, Lower Carboniferous Limestone Group. Woodend Quarry, near Fordel, Fife, as before. Orchard Quarry, near Glasgow, shale above the Orchard Limestone, Upper Carboniferous Limestone Group (Mr D. Robertson, F.G.S.).

Cheirodota (*?*) *Robertsoni*, Sp. nov.—(Pl. VI., Fig. 2).

Sp. Char.—Wheel-like plate, concavo-convex, with a central undivided (?) space, separating spaces or "spokes," straight, and rod-like; perforations few in number, six to eight, and acutely triangular.

Obs.—This appears to be quite distinct from the last species in having the central space filled in, and the marginal perforations triangular in form. I am indebted to Mr David Robertson, F.G.S., of Glasgow, for specimens of this and the preceding species, and after whom the present one is named.

Loc. and Horizon.—Capelrig Old Quarry, near East Kilbride, Lanarkshire, in shales of the Calderwood Limestones, Lower Carboniferous Limestone Group.

Cheirodota (*?*) *primæva*, Sp. nov.—(Pl. VI., Figs. 3-8).

Sp. Chars.—Plates concavo-convex, margin undulating;

central space large and solid; perforations of outer zone, varying from eight to twelve in number, nearly circular. Diameter of plates from ·01 to ·0105 inches; central space has a diameter of ·0035 inches, and the side perforations from ·002 to ·0025 inches.

Obs.—This again appears to be a clearly distinct type from either of the preceding forms. It may be recognised by the increased number of perforations in the outer zone, their circular form, and the large circular filled-in space. The margin is much more undulating than in *C.* (*?*) *Traquairii*, the undulations corresponding to the perforations.

Examples sometimes occur with only the central part remaining, when they present a simple, multi-stellate appearance (Pl. VI., Fig. 7).

Loc. and Horizon.—River Avon, below Kinneil Mill, as before.

Description of the Plates.

Plate V.

Fig. 1. Portion of a plate of *Achistrum Nicholsoni*, probably from near the centre, showing the larger perforations. Woodend Quarry, near Fordel.

Fig. 2. An almost entire plate of the same species, showing the gradation in size of perforations towards the undulate margin. Woodend Quarry.

Fig. 3. Portion of a plate (*Achistrum ?* sp.), with perforations of intermediate size. Woodend Quarry.

Fig. 4. Larger portion of an incomplete plate, with the smallest size of perforations (*Achistrum ?* sp.). Woodend Quarry.

Fig. 5. Two almost entire plates of *A. Nicholsoni*, with, lying between them, one of its hooks. Woodend Quarry.

Fig. 6. Portions of another plate with the hook exposed *in situ*. Kinneil (R. Avon).

Fig. 7. Two of the hooks of *A. Nicholsoni; a*, fully developed individual; *b*, incomplete example; *c*, eye at proximal end of shank. Woodend Quarry.

Fig. 8. A small tooth-like organism found associated with these minute fossils. Woodend Quarry.

Fig. 9. Quadriradiate spicules, enlarged towards the ends of the branches, and with the centre occupied by four perforations, one corresponding to each branch of the spicule. Woodend Quarry.

Fig. 10. Another form of the same, from the same locality.

Fig. 11. Spatulate body, with fine transverse imbricating lines, of doubtful nature. Woodend Quarry.

Fig. 12. Triangular plates with serrate edges, and imbricating transverse lines, having a certain resemblance to plates in the body of *Cucumaria frondosa*. Woodend Quarry.

Plate VI.

Fig. 1. *Cheirodota* (*?*) *Traquairii*, single plate showing semicircular perforations and four triangular ones. Woodend Quarry.

Fig. 2. *Cheirodota* (?) *Robertsoni*, a single well-preserved plate showing the simple plain margin, triangular perforations, straight spokes, and central space. Capelrig, near East Kilbride. *Collection*—D. Robertson, Esq., F.G.S.

Fig. 3. *Cheirodota* (?) *primæva*, a plate with eight perforations round the margin. Kinneil (R. Avon).

Fig. 4. Reverse of another example, having eight perforations. Kinneil (R. Avon).

Fig. 5. Another plate of *C.* (?) *primæva* in which there are ten perforations. Kinneil (R. Avon).

Fig. 6. Another individual of the same exhibition, twelve perforating holes. Kinneil (R. Avon).

Fig. 7. The central non-perforated space of a twelve-perforated plate. Kinneil (R. Avon).

Fig. 8. A plate with ten perforations, having a portion of the outer undulated margin broken away. Kinneil (R. Avon).

Fig. 9. Spicules of *Cucumaria Hyndmanni* (Forbes), after Düben and Koren (K. Svenska Akad. Handlingar, 1844, t. 4, f. 13, pars).

Fig. 10. Plate and anchor of *Synapta*, after Düben and Koren (*loc. cit.*, t. 5, f. 59).

Fig. 11. Calcareous pieces from integument of *Cucumaria frondosa* (Linnæus), after Düben and Koren (*loc. cit.*, t. 4, f. 1).

Fig. 12. Plate of *Thyonidium pellucidum* (Vahl), after Düben and Koren (*loc. cit.*, t. 4, f. 17).

Fig. 13. Plate of *Thyone fusus* (Müller), after Düben and Koren (*loc. cit.*, t. 4, f. 41).

Pl. V., Figs. 1-12, and Pl. VI., Figs. 1-8, are all magnified about forty-five times the original size of the fossils.

N.B.—The originals of all the figures are in the cabinet of Mr James Bennie, except that of Pl. VI., Fig. 2, which is in Mr David Robertson's Collection.

XI. *Migration of Mammals.* By Professor Duns, D.D., F.R.S.E.

(Read 16th March 1881.)

Abstract.—Having stated that under this familiar title some of the most difficult questions in natural history fall to be discussed, the author introduced his paper by a series of queries, in which he indicated the aspects of migration, in regard to which we have yet much to learn. It was shown that, in attempting to answer these and kindred questions, natural science often steps into the sphere of metaphysics, unaware, the while, that in crossing the threshold it has parted with its distinctive character. The relations between migration and the geographical distribution of mammals were pointed out. The *a priori* method had been too much followed by students of the latter. Its weakness was shown, for

example, by the fact of the presence of one of the *Hystricidæ* outside of the sub-regions to which this family has been relegated. The term migration was used as inclusive, both of seasonal changes and of those which occur at irregular intervals. Schinz, of Zurich, had held that in the case of birds their breeding place should be regarded as their home. This is truer of mammals. In many instances birds occasionally nest far from the area of chief distribution, as in Scotland, the red backed shrike (*Lanius collurio*), the woodcock (*Scolopax rusticola*), the stockdove (*Columba œnas*), etc. The occurrence of the remains of the great extinct mammals in British deposits does not determine the question of climate, it only asks, is there anything in the migration of recent forms to shed light on this? It was pointed out how much light might be shed on some of those topics by a thoughtful estimate of man's migrations, looked at in the light of his relations to the *fauna* with which he comes in contact. "Avoiding '*stock*' illustrations," he said, "the subject falls to be considered under three heads—1. Periodic Migrations; 2. Seasonal Migrations; and 3. Partial Migrations, Seasonal and Periodic." The first was fully illustrated by reference to the wanderings of the northern grey squirrel (*Sciurus migratorius*) and the Lemming (*Myodus lemmus*). Olaus Wormius, Pontippidan, Linnæus, Cuvier, Audubon, and Bachman, etc., were cited as authorities. It was shown that neither the theory of temperature, nor of breeding, nor of food, sheds any light on these movements, because ten, thirteen, eighteen, or over twenty years are known to have intervened between one great migration and another. It was asked, "Is this the action of a check on over-productiveness—a provision for maintaining the balance among living forms? Have we analogous instances in recent years in the plagues of a related form (*Arvicola agrestis*) in France, Belgium, England, and Scotland? And are they drawn away from localities in which they have become too numerous, by an inherited impulse towards their ancestral homes?"

The reindeer (*Cervus tarandus*) was referred to in illustration of Seasonal Migrations. Von Wrangel, Richardson, and Nordenskjöld were quoted. Having noticed the explanation of

the easy swimming habits of the reindeer by the hypothesis of gradual growth throughout long generations, it was asked, how has the grey squirrel not become in the same way an adept? It has not profited by circumstances, but still continues a bad swimmer. The third head—Partial Migrations, Periodic and Seasonal—was taken up. The movements in this case are from one locality to another, within a comparatively limited area, yet they shed light on general migration. The habits of the varying hare (*Lepus variabilis*) show that breeding instincts are seasonally influential in its change of place. But the periodic wandering of the roe-deer (*Cervus capreolus*) cannot be accounted for either by the theory of breeding or food. An instance was given, and it was argued that, again, nothing affords a better explanation than the theory of an inherited drawing towards localities of ancestral distribution. Facts connected with the periodic visits of the raven (*Corvus corax*) were appealed to as illustrations. It was shown that this theory sheds light on far wandering, and may have important bearings on the presence of remote species in the quaternary deposits of Britain, and also on the relations of present forms to the great extinct mammals. The discovery of the tiger by Von Schrenck, as an ordinary resident in Amoorland, and as occurring in latitude 52° N., was mentioned in this connection as opposed to the temperature theory of migration. This view was illustrated by reference to the nesting of the eider duck (*Somateria mollisima*) in the Forth, and in the Outer Hebrides. The whole question of the influence of climate, as well as of the physical features of the surface, in determining the area both of the migration and of the geographical distribution of mammals, demands far more attention than has yet been given to it. The sharp lines which enclose the areas in which some of the bats live are suggestive on this point. Those animals possess all the advantages which the bird does, as regards power of flight. Yet many species do not avail themselves of this even for purposes of food. The mouse-coloured bat (*Vespertilio murinus*), which is one of the commonest bats of France, and lives, as it were, in the very sight of Britain, is rare in this country. If it be said this is the result of the water boundary, we have only to

refer to some of our own species, which are "keepers at home," where no formidable physical features intervene to narrow their range. The reddish-grey bat (*V. nattereri*) confines itself to a very limited area, and the serotine (*V. serotinus*) limits its flight to the neighbourhood of London. True, some of the bats are almost cosmopolitan. The large fox bat (*Xantharpia ægyptica*) ranges from Egypt and Palestine to Southern India. In conclusion it was asked,—Can the migration of mammals be studied to any profit without some knowledge of the area of their former general distribution? Have we data to warrant the temperature theory, and, so far as we have, what is their value? Is it not likely, from facts that have been given in this paper, that the territorial limits of the present migrations of mammals were once held by their ancestors throughout the year? Can we explain the phenomena of periodic migrations, except on the hypothesis that an inherited memory of ancestral home occasionally becomes active, and impells towards it? "These questions," it was added, "show my unwillingness to dogmatise. My scientific conviction, however, is, that while far too much weight has been given to climate, especially in accounting for the migrations of mammals, the hypothesis, warranted by many facts, of a hereditary drawing towards, mayhap, even the extreme limits of the area of original distribution, has been much, if not altogether, ignored in the literature of this interesting though difficult subject."

XII. *The Invertebrate Fauna of the Firth of Forth.* By George Leslie, Esq., Demonstrator of Zoology, University of Edinburgh; and W. A. Herdman, Esq., D.Sc., F.L.S. Part II., Comprising the Protozoa, Polyzoa, Crustacea, and Tunicata.

(Read 20th April 1881.)

PROTOZOA.

In this list the Foraminifera only are catalogued, the other Protozoan groups being omitted for the present, as

they require very special work. With the exception of a few species of Infusoria and Lobosa, noted by Dr Strethill Wright, they have been entirely neglected by workers in the Forth. The Sponges, now considered as a group of the Metazoa, will be treated separately.

In the preparation of the following list we were very largely indebted to a valuable paper by Mr H. B. Brady, F.R.S., on "Brackish-Water Foraminifera,"* one of the localities which he investigated being the upper basin of the Forth. We have also used the list published by Professor Franz Eilhart Schulze, in the report of the German Expedition of 1872.†

In the identification of the forms which we have ourselves obtained in the Forth, we have had the kind assistance of Mr Frederick Pearcey, to whom we would now express our thanks. Our material was dredged in 5 fathoms, on the oyster bank, near Inchkeith. We have added a number of forms to those previously recorded from the Forth, but do not doubt that further work will very largely increase the list. Mr Pearcey reports that the gathering in which the Foraminifera were found consisted of quartz grains, small and broken shells, Annelid tubes, and fragments of Polyzoa, Hydroids, and Echinoderms. Mr H. B. Brady's specimens were obtained about 20 yards from the pier at Bo'ness, in 3 to 4 fathoms, the bottom consisting of soft, slimy mud. Those in Franz Eilhart Schulze's list were got in the beach sand between Portobello and Fisherrow, and near the Bass Rock.

Mr Brady's specimens are marked (*H. B. B.*).

FORAMINIFERA.

I. Imperforata—

Miliolidæ.

Quinqueloculina seminulum (Linn.).

Off pier, Bo'ness (*H. B. B.*); beach sand between Portobello and Fisherrow (*F. E. S.*); off Bass Rock, 24 fathoms (*F. E. S.*).

* Ann. and Mag. Nat. Hist., 1870, p. 273.

† II. Jahresb. d. Komm. z. Untersuch. d. deutsch. Meere in Kiel, I., Protozoa. Berlin, 1874.

We found this species very abundant on the oyster bank off Inchkeith.

Quinqueloculina subrotunda (Mont.).

Off pier, Bo'ness (*H. B. B.*); beach sand between Portobello and Fisherrow (*F. E. S.*).

Spiroloculina limbata? (D'Orb.).

We obtained one dead specimen of *Spiroloculina* from 5 fathoms, off Inchkeith. It was somewhat damaged, so that the specific characters could not with certainty be made out.

Lituolidæ.

Lituola scorpiurus (Montfort).

Mr H. B. Brady found a single specimen of the stunted form of this species off Bo'ness, and did not obtain it from any other of the localities which he investigated for brackish-water Foraminifera.

L. canariensis (D'Orb.).

Off pier, Bo'ness (*H. B. B.*).

We found many specimens off Inchkeith.

II. Perforata—

Lagenidæ.

Lagena sulcata (W. and J.).

Off pier, Bo'ness (*H. B. B.*).

L. lyellii (Sequenza).

Off pier, Bo'ness (*H. B. B.*).

L. lævis (Mont.).

Off pier, Bo'ness (*H. B. B.*).

L. gracillima (Sequenza).

Off pier, Bo'ness (*H. B. B.*).

L. globosa (Mont.).

Off pier, Bo'ness (*H. B. B.*).

L. striata (D'Orb.).

Off pier, Bo'ness (*H. B. B.*); beach sand between Portobello and Fisherrow (*F. E. S.*).

Lagena distoma (P. and J.).
Off pier, Bo'ness (*H. B. B.*).

L. marginata (W. and J.).
Off pier, Bo'ness (*H. B. B.*).
Mr Brady also found at Bo'ness the sub-varietal form *Entosolenia marginata*, var. *lucida* (Williamson). We obtained the typical *L. marginata* off Inchkeith.

L. squamosa (Mont.).
A few specimens were found in the material from the oyster bank, 5 fathoms.

Nodosaria scalaris (Batsch).
Off pier, Bo'ness (*H. B. B.*).

Dentalina communis (D'Orb.).
Off pier, Bo'ness (*H. B. B.*).

D. guttifera (D'Orb.).
Off pier, Bo'ness (*H. B. B.*).

Polymorphina lactea (W. and J.).
We obtained this species off Inchkeith. Mr Brady found it in only two of his thirty-two brackish-water localities.

GLOBIGERINIDÆ.

Globigerina bulloides (D'Orb.).
We found many specimens of this widely distributed species off Inchkeith in 5 fathoms. It was not obtained by Mr Brady at Bo'ness, which is about fourteen miles further up the estuary than our locality.

Textularia sagittula (Defrance).
Plentiful off Inchkeith, 5 fathoms.

Verneuilina polystropha (Reuss).
Off Inchkeith, this species was fairly plentiful.

Bulimina marginata (D'Orb.).
Off pier, Bo'ness (*H. B. B.*).

B. ovata (D'Orb.).
Off pier, Bo'ness (*H. B. B.*); beach sand

between Portobello and Fisherrow (*F.E.S.*); Bass Rock, 24 fathoms (*F. E. S.*).

Bulimina elegantissima (D'Orb.).

Off pier, Bo'ness (*H. B. B.*).

Bolivina punctata (D'Orb.).

Off pier, Bo'ness (*H. B. B.*).

B. plicata (D'Orb.).

Off pier, Bo'ness (*H. B. B.*).

Discorbina globularis (D'Orb.).

Off pier, Bo'ness (*H. B. B.*); abundant, attached to Polyzoa, Hydroids, stones, etc., off Inchkeith.

D. rosacea (D'Orb.).

We found a few specimens on the oyster bank.

Planorbulina mediterranensis (D'Orb.).

Off pier, Bo'ness (*H. B. B.*).

We found a broken specimen of *Planorbulina*, which we have not been able to identify, on the oyster bank.

Truncatulina lobatula (Walker).

Off pier, Bo'ness (*H. B. B.*).

Rotalia beccarii (Linn.).

Off pier, Bo'ness (*H. B. B.*); near Bass Rock (*F. E. S.*).

This is a very abundant species in the Forth. We have obtained it repeatedly, and from many localities. In the material from the oyster bank it is very plentiful.

Tinoporus lævis (Parker and Jones, sp.).

Mr Brady obtained a single worn specimen in his material from Bo'ness. He thinks that it was probably a dead shell carried in by the tide from the deeper sea.

Nummulinidæ.

Polystomella striato-punctata (F. and M.).

Very plentiful off pier, Bo'ness (*H. B. B.*);

beach sand between Portobello and Fisherrow (*F. E. S.*).

Nonionina depressula (W. and J.).

Off pier, Bo'ness (*H. B. B.*); beach sand between Portobello and Fisherrow (*F. E. S.*).

N. umbilicatula (Mont.).

Beach sand between Portobello and Fisherrow (*F. E. S.*).

POLYZOA.

Polyzoa are abundant in the Firth of Forth, in the coralline zone, and especially on the oyster bank, where some species occur in profusion, and attain a large size. Notwithstanding this richness in specimens, the number of species hitherto recorded from the Firth is small, and the present list is probably far from complete. We believe that many of the smaller species will yet be found here, especially those formerly united under the generic title *Lepralia* (as used by Johnston in the "British Zoophytes").

We have followed the nomenclature and arrangement given in Hincks' recent work on the British Polyzoa.* From this exhaustive treatise we have derived much valuable assistance, especially in the identification of species and the determination of their synonymy.

We would tender our thanks to the veteran and well-known marine zoologist Mr C. W. Peach, to whom we are indebted for a list of the rarer species of Polyzoa which he has obtained from the Firth of Forth.

Several of our species are recorded on the authority of Dr Kirchenpauer's report on the Polyzoa collected by the German Expedition of 1872, which investigated the fauna of the North Sea.† These are marked (*K.*).

Dr M'Bain's lists in "The East Neuk of Fife" have again contributed largely to the number of the recorded species.

* "A History of the British Marine Polyzoa." By Thomas Hincks, B.A., F.R.S. London, Van Voorst, 1880.

† II. Jahresb. d. Komm. z. Untersuch. d. deutsch. Meere in Kiel, VI., Bryozoen. Berlin, 1874.

CHEILOSTOMATA.

Eucratiidæ.

Eucratea chelata (Linn.).

Among Zoophytes from the Firth of Forth.

Gemellaria loricata (Linn.).

This is one of the commonest species of Polyzoa in the Firth of Forth. It is recorded by Kirchenpauer from 24 fathoms near the Bass Rock, and we have dredged it in 26 fathoms, off the Isle of May. It occurs over almost the entire area, and in profusion on the oyster bank. It is often found washed up on the shore.

Cellulariidæ.

Cellularia peachi (Busk).

On the long-lines, Newhaven, very rare (*C. W. P.*); Firth of Forth, under the name of *Cellularia neritina* (*M'B.*).

Menipea ternata (Ell. and Sol.).

We dredged this species last summer in the Firth of Forth.

Scrupocellaria scruposa (Linn.).

Firth of Forth (*M'B.*).

Common in a few fathoms of water.

S. scabra (v. Ben.).

Firth of Forth, one specimen (*C. W. P.*).

S. reptans (Linn.).

Firth of Forth (*M'B.*).

The *Canda reptans* of various authors.

We dredged this species several times last summer, and have also found it among the refuse from the dredges on Newhaven pier.

Bicellariidæ.

Bicellaria ciliata (Linn.).

On roots of *Fuci* (*M'B.*); Firth of Forth (*C. W. P.*); off Aberdour, 5 fathoms (*nob.*).

We have dredged this species several times, last summer and previously.

Bugula avicularia (Linn.).

Firth of Forth (*M'B.*).

We dredged this species last summer to the west of Inchkeith in 5 fathoms.

B. plumosa (Pallas).

Dredged last summer.

B. murrayana (Johnst.).

Leith and Newhaven, on the fishermen's nets (*D. Landsborough, jun.*).

CELLARIIDÆ.

Cellaria fistulosa (Linn.).

This species is common in the Forth. We have dredged it frequently on the oyster bank, and took it last summer in 14 fathoms, off Longniddry.

The *Salicornaria farciminoides* of Johnston and others.

FLUSTRIDÆ.

Flustra foliacea (Linn.).

Common on the oyster bank. We have taken it lately from 12 fathoms, north-east of Inchkeith; 5 fathoms, west of Inchkeith; and 4 fathoms, off Aberdour.

F. securifrons (Pallas).

The *Flustra truncata* (Linn.) of Johnston, Busk, and others. Leith, Dirleton, and opposite the Bass Rock (*D. Landsborough, jun.*); Portobello and Firth of Forth, 30 fathoms (*K.*); Firth of Forth (*M'B.*).

This is a fairly common species in the Forth. We have dredged it west of Inchkeith in 5 fathoms, and north-east of Inchkeith in 12 fathoms.

F. carbasea (Ell. and Sol.).

Leith (*Colds.*); Leith Shore (*Mr Parsons*);

Firth of Forth (*M'B.*); oyster beds, Firth of Forth (*Grant*); Newhaven, on the fishermen's nets (*Dr Landsborough*).

This species is common. We have obtained it frequently from the dredges at Newhaven pier, and took it in 7 fathoms, off Fidra, last summer.

MEMBRANIPORIDÆ.

Membranipora catenularia (James.).

Firth of Forth (*Ed. Mus.*).

This is the *Hippothoa catenularia* of Johnston and other authors.

M. pilosa (Linn.).

On *Laminaria*, etc. (*M'B.*); Firth of Forth (*Ed. Mus.*); off Fidra, 7 fathoms (*nob.*).

This species is abundant, usually on the larger Algæ, in most parts of the Firth; it is often found cast ashore after storms.

M. membranacea (Linn.).

Also extremely abundant on Algæ, especially *Laminaria* fronds; on stones at low water (*M'B.*). Off Fidra, 7 fathoms (*nob.*).

M. lineata (Linn.).

Firth of Forth (*C. W. P.*); Firth of Forth (*M'B.*).

M. flemingi (Busk).

Newhaven (*C. W. P.*).

CRIBRILINIDÆ.

Cribrilina radiata (Moll).

On shells and stones (*M'B.*).

The *Lepralia innominata* of Johnston, etc.

C. punctata (Hassall).

Firth of Forth (*C. W. P.*); Firth of Forth (*Ed. Mus.*).

The *Lepralia punctata* of Johnston and Busk.

Membraniporella nitida (Johnst.).
Firth of Forth (*C. W. P.*) ; on shells, rocks, etc. (*M'B.*).
The *Lepralia nitida* of Johnston and Busk.

MICROPORELLIDÆ.

Microporella ciliata (Pall.).
Firth of Forth (*C. W. P.*); on rocks and *Fuci* (*M'B.*).
The *Lepralia ciliata* of Johnston and Busk.

M. malusii (Audouin).
Newhaven (*C. W. P.*); on shells, etc. (*M'B.*).
The *Lepralia biforis* of Johnston.

MYRIOZOIDÆ.

Schizoporella linearis (Hassall).
Newhaven (*C. W. P.*) ; Firth of Forth (*Ed. Mus.*).
The *Lepralia linearis* of Johnston and Busk.

S. auriculata (Hassall).
Firth of Forth (*C. W. P.*).
The *Lepralia auriculata* of Johnston and Busk.

S. hyalina (Linn.).
On Algæ, stones, and corallines (*M'B.*).

Hippothoa divaricata (Lamk.).
We dredged this species in the Firth last summer.

ESCHARIDÆ.

Porella compressa (Sowerby).
Fifeshire coast, rare (*J. G.*).
The *Cellepora cervicornis* of Johnston, Busk, and other authors.

Smittia trispinosa (Johnst.).
Firth of Forth (*C. W. P.*).
The *Lepralia trispinosa* of Johnston.

Mucronella peachi (Johnst.).
Firth of Forth (*C. W. P.*); on rocks and *Fuci* (*M'B.*); Firth of Forth (*Ed. Mus.*).
The *Lepralia peachii* and *L. immersa* of Johnston.

M. ventricosa (Hassall).
Firth of Forth (*C. W. P.*); Firth of Forth (*Ed. Mus.*).
The *Lepralia ventricosa* of Johnston and Busk.

M. coccinea (Abildg.).
On stones, etc., Firth of Forth (*M'B.*).

M. variolosa (Johnst.).
Firth of Forth (*C. W. P.*); on bivalve shells and stones (*M'B.*); Firth of Forth (*Ed. Mus.*).
The *Lepralia variolosa* of Johnston and Busk.

Palmicellaria skenii (Ell. and Sol.).
Firth of Forth (*C. W. P.*).
The *Cellepora skenei* of Johnston, Busk, and others.

Celleporidæ.

Cellepora pumicosa (Linn.).
Firth of Forth (*Ed. Mus.*); on corallines, stones, and *Fuci* (*M'B.*).
We dredged this species last summer.

C. ramulosa (Linn.).
Firth of Forth (*Ed. Mus.*).

CYCLOSTOMATA.

Crisiidæ.

Crisia cornuta (Linn.).
We have taken this species, the *Crisidia cornuta* of Johnston's "British Zoophytes," in the Firth.

Crisia eburnea (Linn.).
Firth of Forth (*M'B.*).

C. denticulata (Lamk.).
Firth of Forth (*M'B.*).
Not uncommon in the Firth. We dredged it last summer, south-west of Inchkeith, in 5 fathoms; off Aberdour, in 5 fathoms; and off Aberlady Bay, in 9 fathoms.

TUBULIPORIDÆ.

Stomatopora dilatans (Johnst.).
Firth of Forth (*C. W. P.*).

S. incurvata (Hincks).
Outside the Isle of May (*C. W. P.*).

Idmonea serpens (Linn.).
On Zoophytes, Firth of Forth (*M'B.*).
We dredged this species to the north-west of the Isle of May in 26 fathoms.

Diastopora patina (Lamk.).
On the fishermen's lines, Newhaven (*C. W. P.*); south-west of Inchkeith, 5 fathoms (*nob.*); on shells, Zoophytes, rocks, and Algæ, Firth of Forth (*M'B.*).

LICHENOPORIDÆ.

Lichenopora hispida (Flem.).
On Algæ, Firth of Forth (*M'B.*).

L. radiata (Audouin).
Firth of Forth (*C. W. P.*).

CTENOSTOMATA.

ALCYONIDIIDÆ.

Alcyonidium gelatinosum (Linn.).
Bass Rock, 24 fathoms (*K.*); Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*); off the Isle of May (*nob.*).
This species is common in the Firth, in a few fathoms, attached usually to dead

shells. We have also taken it at low water on Cramond Island.

Alcyonidium hirsutum (Flem.).

On *Fucus serratus*, Firth of Forth (*M'B.*); Entrance to Firth of Forth, 30 fathoms (*K.*).

We dredged this species last summer off Aberlady Bay in 9 fathoms.

A. mytili (Dalyell).

We have taken this species in the Firth.

A. parasiticum (Flem.).

Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*); entrance to Firth of Forth, 30 fathoms; Firth of Forth, 24 fathoms; Bass Rock, 24 fathoms (*K.*).

We have obtained this species north-east of Inchkeith, 12 fathoms; west of Inchkeith, 5 fathoms; off Aberlady Bay, 9 fathoms; Kirkcaldy Bay, 9 fathoms; off Aberdour, 5 fathoms; and frequently at Newhaven. It is common in the Firth.

A. polyoum (Hassall).

Firth of Forth (*M'B.*).

The *Sarcochitum polyoum* of Johnston and others.

FLUSTRELLIDÆ.

Flustrella hispida (Fabr.).

On *Fucus serratus*, Firth of Forth (*M'B.*).

Common on *Fucus* at low water mark, Aberdour.

VESICULARIIDÆ.

Vesicularia spinosa (Linn.).

Firth of Forth (*M'B.*); Leith shore (*D. Landsb., jun.*).

We have dredged this species in abundance west of Inchkeith in 5 fathoms, and have obtained it frequently from the dredges at Newhaven. It is often found

on the shore after storms, deprived of the polypites.

Amathia lendigera (Linn.).

Firth of Forth (*D. Landsb., jun.*); Firth of Forth (*M'B.*); Firth of Forth (*Ed. Mus.*).

The *Serialaria lendigera* of Johnston.

Bowerbankia imbricata (Adams).

This species is common in the Firth, usually in tangled masses among other Polyzoa or Zoophytes. We have dredged it frequently.

B. pustulosa (Ell. and Sol.).

Leith Shore, rare (*D. Landsb., jun.*).

Avenella fusca (Dalyell).

Newhaven, among rejectamenta of the oyster dredges, on corallines, etc. (Sir C. Wyville Thomson, *Ann. N. H.*, 1852).

Valkeriidæ.

Valkeria uva (Linn.).

Leith Shore (*R. J.*); Firth of Forth (*M'B.*). We have dredged this species frequently in the Firth, and have also obtained it between tide marks at Newhaven and elsewhere.

ENTOPROCTA.

Pedicellinidæ.

Pedicellina cernua (Pallas).

Firth of Forth (*M'B.*).

This species, the *Pedicellina echinata* of Johnston and others, is not uncommon in the Firth. We have taken both the echinated and the smooth (*P. belgica*, Gosse) variety. It occurs in profusion on the tests of *Styela grossularia* under large stones at Newhaven.

CRUSTACEA.

The groups which the following list overtakes are the Cirripedia, Amphipoda, Isopoda, Cumacea, Stomapoda, and Decapoda. A very full list of the Ostracoda of the east coast of Scotland, collected from the Aberdeenshire coast, Montrose, the Firth of Forth, etc., will be found in a paper by Professor G. S. Brady and Mr David Robertson, "On the Distribution of the British Ostracoda."* We shall not attempt at present to treat either this group or the Copepoda.

In the arrangement and nomenclature of the Amphipoda and Isopoda, we have followed Bate and Westwood's "British Sessile-eyed Crustacea," a work from which we have derived the greatest assistance.

We have used the lists, prepared by Metzger, of the Crustacea obtained by the German Exploring Expedition of 1872. Many of the species in that report were not previously recorded from the Forth.

CIRRIPEDIA.

I. Suctoria—

Peltogastridæ.

Peltogaster paguri (Rathke).

Firth of Forth, Joppa (J. Anderson, M.D., *Proc. Roy. Phys. Soc.*, vol. ii.).

We have found this species on *Pagurus bernhardus* not unfrequently.

P. carcini (Ander.).

Firth of Forth, Joppa (J. Anderson, M.D., *Proc. Roy. Phys. Soc.*, vol. ii.).

Sacculina carcini (Thomps.).

Trinity (*Com. Mar. Zool.*); Firth of Forth (*J. Anderson, M.D.*); Firth of Forth (*Ed. Mus.*).

Often attached to the abdomen of *Carcinus mœnas.*

S. triangularis (Ander.).

Firth of Forth (J. Anderson, M.D., *Proc. Roy. Phys. Soc.*, vol. ii.).

* Ann. and Mag. Nat. Hist., Ser. 4, vol. ix.

II. Thoracica—

Lepadidæ.

Lepas anatifera (Linn.).

Attached to floating timber, Firth of Forth (*Ed. Mus.*).

We have found this species cast ashore at North Berwick.

Conchoderma virgata (Spengl.).

On floating timber, Firth of Forth (*Ed. Mus.*).

C. aurita (Linn.).

On floating timber, Firth of Forth (*Ed. Mus.*).

Balanidæ.

Balanus balanoides (Linn.).

Firth of Forth (*Ed. Mus.*).

This is an exceedingly abundant species between tide marks, and we have dredged it very frequently in pretty deep water.

B. porcatus (E. da Costa).

Not uncommon attached to stones, etc.

B. crenatus (Brug.).

Portobello (*Ed. Mus.*).

B. tintinnabulum (Linn.).

Leith Harbour, foreign importation (*Ed. Mus.*).

This species is an inhabitant of the warmer seas, and its occurrence in the Forth is an accidental circumstance.

EDRIOPHTHALMATA.

AMPHIPODA.

I. Saltatoria—

Orchestiidæ.

Talitrus locusta (Linn.).

Firth of Forth (*Ed. Mus.*).

Very abundant about high tide mark among stones, sea-weed, etc.

II. Natatoria—

Gammaridæ.

Callisoma kröyeri (Bruzel).
Mouth of the Firth, 30 fathoms (*Metzger*).

Ampelisca macrocephala (Lilljeborg).
Firth of Forth, 24 fathoms (*Metzger*).

A. tenuicornis (Lilljeborg).
Bass Rock, 24 fathoms; off St Abb's Head, 40 fathoms (*Metzger*).

Protomedeia fasciata (Kröyer).
St Abb's Head, 40 fathoms (*Metzger*).

Melita obtusata (Mont.).
Bass Rock, 24 fathoms; off St Abb's Head, 40 fathoms (*Metzger*).

Gammarus locusta (Linn.).
Very abundant in rock pools, and generally between tide marks.

Corophiidæ.

Podocerus capillatus (Rathke).
We have dredged this species in 5 fathoms off Inchkeith.

Cerapus difformis (Milne-Edwards).
Bass Rock (*Metzger*).

Corophium longicorne (Latr.).
Dunbar (*Mr David Robertson*).

III. Aberrantia—

Caprellidæ.

Protella phasma (Mont.).
Isle of May (*Brit. Mus.*); Firth of Forth (*H. D. S. G.*).

Caprella linearis (Linn.).
Plentiful in the upper laminarian zone, and we have also dredged it in a few fathoms.

C. lobata (Müll.).
Firth of Forth (*Brit. Mus.*).
The *C. laevis* of Goodsir.

Caprella acanthifera (Leach).
Firth of Forth (*Bell Collection, Oxford,* Rev. J. Gordon).

C. tuberculata (Guerin).
Firth of Forth (*Brit. Mus.*).

C. typica (Kröyer).
Firth of Forth (*Bell Collection, Oxford*).

ISOPODA.

NORMALIA—

BOPYRIDÆ.

Phryxus abdominalis (Kröyer).
Off St Abb's Head, 40 fathoms (*Metzger*).

P. paguri (Rathke).
Firth of Forth (J. Anderson, M.D., *Proc. Roy. Phys. Soc.*, vol. ii.).

Cryptothiria balani (S. Bate).
The female of this species was described by Mr H. Goodsir, from the Forth, as the male of *Balanus balanoides.*

ASELLIDÆ.

Munna kröyeri (H. Goods.).
Firth of Forth (*Brit. Mus.*).
This species was discovered in the Forth by Mr H. Goodsir.

Limnoria lignorum (Rathke).
We obtained it at Elie.

ARCTURIDÆ.

Arcturus longicornis (Sowerby).
Firth of Forth (*Brit. Mus.*); Firth of Forth *Ed. Mus.*); Bass Rock, 24 fathoms (*Metzger*).
The specimens from which this species was described and figured were obtained by Mr Simmons, near Inchkeith. We have frequently dredged this species in many parts of the Firth.

Arcturus intermedius (H. Goods.).
Firth of Forth (*Brit. Mus.*).
This species was first found, opposite Anstruther, by Mr H. Goodsir, and was described by him as *Leachia intermedia.*

A. gracilis (H. Goods.).
Firth of Forth (*Brit. Mus.*).
Obtained by Mr H. Goodsir off Anstruther, and described by him as *Leachia gracilis.*

Idotea tricuspidata (Desmarest).
We have obtained this species in shallow water at various localities in the lower basin of the Forth.

CUMACEA.

Diastylidæ.

Cuma edwardsii (H. Goods.).
Firth of Forth (*H. D. S. G.*).
We obtained this species in Largo Bay.

C. scorpioides (Mont.).
Firth of Forth (*H. D. S. G.*).

C. trispinosa (H. Goods.).
Firth of Forth (*H. D. S. G.*).

Alauna rostrata (H. Goods.).
Firth of Forth (*H. D. S. G.*).

Bodotria arenosa (H. Goods.).
Firth of Forth (*H. D. S. G.*).

PODOPHTHALMATA.

STOMAPODA.

Mysidæ.

Mysis flexuosa (O. F. Müll.).
Rock pools, Seafield (*M'B.*); Firth of Forth (Leach, in *Brit. Mus.*).

Cynthia flemingi (H. Goods.).
Firth of Forth (*H. D. S. G.*); Firth of Forth (*Brit. Mus.*).

Themisto longispinosa (H. Goods.).
Firth of Forth (*H. D. S. G.*).
T. brevispinosa (H. Goods.).
Firth of Forth (*H. D. S. G.*).

DECAPODA.

I. MACRURA—

ASTACIDÆ.

Homarus gammarus (Linn.).
Firth of Forth at low water, many places (*Howd.*).
Caught in considerable numbers for the markets on all the rocky shores near the mouth of the estuary.
Nephrops norvegicus (Linn.).
Firth of Forth (Leach, in *Brit. Mus.*); Largo, Leith, etc. (*Howd.*).
Very abundant near the mouth of the Firth, where immense numbers are got by the trawlers for the markets. We have obtained it alive near Aberdour.

CRANGONIDÆ.

Crangon vulgaris (Fabr.).
On sandy beaches, Seafield (*Howd.*).
Common on all the sandy shores.
C. allmani (Kinahan).
Bass Rock, 24 fathoms (*Metzger*).
C. nanus (Kröyer).
Bass Rock, 24 fathoms (*Metzger*).

PALÆMONIDÆ.

Hippolyte spinus (Sowerby).
Newhaven (*Leach*); Firth of Forth (Dr Neill, in *Brit. Mus.*).
This species is rather common in the laminarian and littoral zones.
H. varians (Leach).
Firth of Forth, in pools (*Howd.*).

Hippolyte securifrons (Norman).

Off St Abb's Head, 40 fathoms (*Metzger*).

Pandalus annulicornis (Leach).

Black Rocks, Leith; Seafield (*M'B.*); Bass Rock, 24 fathoms; St Abb's Head, 4 fathoms (*Metzger*).

Common and generally distributed. We have dredged it off Inchkeith, 5 fathoms, and in Aberlady Bay, and in many other localities.

Palæmon squilla (Linn.).

Frequent in rock pools near the mouth of the Firth.

II. Anomura—

Lithodidæ.

Lithodes maia (Linn.).

Dunbar (*Ed. Mus.*); Firth of Forth (*Howd.*); young, from stomach of cod (Dr Neill, in *Brit. Mus.*).

This species is not uncommon near the mouth of the Firth. It is often obtained by fishermen near the Isle of May.

Paguridæ.

Pagurus bernhardus (Linn.).

Firth of Forth (*Ed. Mus.*); Firth of Forth common (*Howd.*).

Extremely abundant in the Forth, especially on the oyster bank, where it is found in numbers in every dredgeful. It attains a large size, and when adult usually inhabits the shell of *Buccinum undatum*.

P. ulidianus (Thompson).

Firth of Forth (*Howd.*).

P. hyndmanni (Thompson).

Firth of Forth (*Ed. Mus.*); Musselburgh and Prestonpans (*Howd.*).

Pagurus lævis (Thompson).
Firth of Forth (*Howd.*).

P. forbesii (Bell).
Firth of Forth (*Howd.*).

PORCELLANIDÆ.

Porcellana platycheles (Penn.).
Firth of Forth (*Ed. Mus.*); Crail and Fifeness at low water (*Howd.*).
We have found this littoral species at Elie, and on the shore near North Berwick.

P. longicornis (Penn.).
Upper part of the Firth (*Howd.*); Bass Rock, 24 fathoms (*Metzger*).
We have dredged it off the Isle of May in 8 fathoms, near Elie, and near Inchkeith.

GALATHEIDÆ.

Galathea squamifera (Mont.).
Common under stones (*M'B.*).
This is a very common littoral species, but extends into the laminarian zone. We have dredged it on the oyster bank.
We found this species frequently at low water on the shore near Elie.

G. andrewsii (Kinahan).
Firth of Forth (J. Anderson, M.D., in *Proc. Roy. Phy. Soc.*, vol. ii.).

G. strigosa (Penn.).
Firth of Forth (*Ed. Mus.*); off the Bass Rock (*Howd.*).
Not uncommon near the mouth of the Firth. Our friend, Mr Robert Gray, F.R.S.E., informs us that it is plentiful near Dunbar.

G. nexa (Embleton).
Off Portseaton (*Howd.*).

Munida bamffica (Penn.).
The *M. rondeletii* of Bell and other authors.

Mr Robert Gray found it not uncommon at Dunbar.

III. Brachyura—

Leptopodiadæ.

Stenorhynchus rostratus (Linn.).

Prestonpans (*Ed. Mus.*); Firth of Forth on mud and sand, generally distributed (*Howd.*).

This species, the *S. phalangium* of authors, is not uncommon. We have dredged it on the oyster bank at 5 fathoms, in Aberlady Bay, near Elie, and elsewhere.

Maiadæ.

Inachus dorsettensis (Penn.).

Deep-sea lines (*Howd.*).

Hyas araneus (Linn.).

Very abundant. We have often taken it between tide marks at Newhaven, Aberdour, and other places, and have dredged it off Longniddry in 14 fathoms, and in Aberlady Bay and on the oyster bank in 5 fathoms. It occurs in almost every dredgeful in the lower reaches of the Firth.

H. coarctatus (Leach).

Largo Bay, Inchkeith, etc. (*M'B.*); Firth of Forth (Leach, in *Brit. Mus.*).

This species was first discovered in the Firth of Forth by Dr Leach. It is fairly common but less plentiful than *H. araneus*. We have obtained it south-west of Inchkeith, 5 fathoms, in Aberlady Bay, 5 fathoms, and in many other localities.

Parthenopodæ.

Eurynome aspera (Penn.).

Prestonpans and Portseaton (*Howd.*).

This deep-water form is rare in the Firth.

CANCERIDÆ.

Cancer pagurus (Linn.).

Firth of Forth (*Ed. Mus.*).

Common in the laminarian and littoral zones.

PORTUNIDÆ.

Carcinus mœnas (Linn.).

Firth of Forth (*Ed. Mus.*).

Very abundant between tide marks, and in the laminarian zone, but not often found in deep water.

Portumnus variegatus (Leach).

Prestonpans and Portseaton (*Howd.*).

We have taken this species at Portobello.

P. puber (Linn.).

We obtained one specimen on the deep-sea lines, from the mouth of the Forth.

P. depurator (Linn.).

Firth of Forth (*M'B.*).

A very common species on the oyster banks, and often cast ashore.

P. marmoreus (Leach).

Portobello and Musselburgh beaches (*Howd.*).

P. holsatus (Fabr.).

Newhaven (*Brit. Mus.*).

This is the *P. lividus* of Leach, who found one amongst a number of specimens of *P. depurator* at Newhaven.

P. pusillus (Leach).

Off Prestonpans (*Howd.*); Firth of Forth (*Brit. Mus.*).

Fairly common in the Forth. We have very frequently dredged it near Inchkeith, etc.

PINNOTHERIDÆ.

Pinnotheres pisum (Penn.).

Firth of Forth (*M'B.*).

Not uncommon; we generally found it in the pallial chamber of *Modiola modiolus*. We have dredged it off Longniddry in 14 fathoms, and elsewhere.

LEUCOSIADÆ.

Ebalia cranchii (Leach).

Firth of Forth, rare (*H. D. S. G.*).

CORYSTIDÆ.

Atelecyclus septemdentatus (Mont.).

Firth of Forth (*Ed. Mus.*); Firth of Forth, rare (*H. D. S. G.*); Portobello beach (*M'B.*). The *A. heterodon* of Leach. This species seems to be a very favourite food of the cod. Dr J. A. Smith has recorded it from the stomach,* and we have found it in the same situation.

Corystes cassivelaunus (Penn.).

Firth of Forth (*Ed. Mus.*); Off Inchkeith (*M'B.*); Bass Rock, 24 fathoms (*Metzger*); Aberlady Bay (*Com. Mar. Zool.*); Newhaven (*C. W. P.*).

Generally distributed; we have dredged it in Aberlady Bay, 5 fathoms, and in Kirkcaldy Bay, 9 fathoms.

TUNICATA.

There is practically no literature on the Tunicata of the Firth of Forth. Comparatively few naturalists have worked at this interesting but obscure group, while amateurs, to whom we are so often indebted for valuable contributions to local faunas, invariably fail us when we come to the Ascidians.

The number of species recorded from the Firth of Forth is

* Proc. Phy. Soc., vol. iii., p. 214.

very small, but it must be further reduced, because of the impossibility of determining with certainty the species referred to by many of the older writers, on account of the confusion which has existed between some of the allied forms, and the tangled mass of synonymy in which other species have become hopelessly involved. Accordingly, with the exception of Alder's two species of *Parascidia* from the Isle of May, and of *Pelonaia corrugata* (F. and G.), which was first discovered by Professor Goodsir, in deep water, off Anstruther, in 1841, and which was dredged near the Bass Rock in 24 fathoms by the German North Sea Expedition of 1872, we have given in the following list only those species which we have ourselves collected in the Firth of Forth.

ASCIDIÆ SIMPLICES.

Molgulidæ.

Molgula citrina (Alder and Hancock).

This little species was first described by Alder in his "Catalogue of the Marine Mollusca of Northumberland and Durham," * and, so far as we are aware, it has not been mentioned since.

We have come upon it several times during the last two years, adhering to the under surfaces of large stones, about low water mark, between the Chain Pier and Granton Harbour.

Eugyra glutinans (Möller).

This species has a most extensive synonymy, and is usually known as *Molgula* (or *Eugyra*) *arenosa* (Ald. and Han.). Lately, however, Traustedt † has declared that it is identical with the species described in 1842 by Möller ‡ as *Cynthia glutinans*.

* Trans. Tyneside Nat. Field Club, vol. i., p. 199 (1850).

† Oversigt o. d. f. Danmark, etc., Asc. Simp. (Vid. Medd. nat. For. Kbhvn, 1879-80).

‡ Index. Moll. Groenl., 1842, p. 21.

This species occurs on sandy bottoms, and appears to be gregarious, as a considerable number of specimens are usually obtained together.

We dredged it plentifully last summer off Kirkcaldy Bay in 9 fathoms.

CYNTHIIDÆ.

Styela grossularia (van Beneden).

This species was formerly considered as the young of *Styela rustica* (O. F. Müller), and is probably the species referred to under the name of *Cynthia rustica* by M'Bain.

It is very common in the Firth of Forth, from the shore out to deep water. It occurs in profusion between tide marks at Newhaven, Wardie, Aberdour, etc., covering the under surfaces of stones, and often in such abundance as to form large masses of individuals adhering by their tests. The tests are frequently so closely united as to appear like a common investing mass in which a colony of individuals is imbedded. It is merely an aggregation, however, and gemmation seems never to take place. On the oyster bank this species is found on dead shells, etc. Here, though still common, the individuals are not crowded together, and each is enabled to preserve its characteristic blister-like shape, and to develop the spreading margin, which is rarely seen in specimens from Newhaven.

We have dredged this species in other parts of the Forth, such as—east of Inchkeith, 7 fathoms; off Kirkcaldy Bay, 9 fathoms; Aberlady Bay, 9 fathoms; off Longniddry, 14 fathoms; off Aberdour,

5 fathoms; and have collected it between tide marks at several points on both shores of the Firth.

Pelonaia corrugata (Forb. and Goods.).

This species was dredged by Professor Goodsir in deep water off Anstruther, and was described first in Jameson's *Edinburgh New Philosophical Journal* for 1841 (vol. xxxi., p. 29). The only occasion, so far as we are aware, on which it has since been taken in the Firth of Forth was in 1872, when it was dredged by the German North Sea Expedition in 24 fathoms, off the Bass Rock.* Dr M'Intosh informs us that he has obtained this species several times at St Andrews. It has also been found in Berwick Bay and down the Northumberland coast.

ASCIDIIDÆ.

Ascidia virginea (O. F. Müller).

This species, which is synonymous with *Ascidia sordida* (Ald. and Han.), is very common in a few fathoms of water and upwards in all parts of the Firth.

On the oyster banks it occurs in profusion adhering to dead shells, Algæ, Zoophytes, etc. The specimens are of large size, and often united in clumps. We have also dredged it plentifully in other parts of the Firth, viz., north-east of Inchkeith, 12 fathoms; Aberlady Bay, 9 fathoms; off the Isle of May, 8 fathoms; and off Fidra, 7 fathoms.

Young specimens of this species are often obtained adhering in clusters to masses of *Gemellaria loricata*, and in this condition are frequently found on the beach after

* Kupffer—Jahresb., VII. Tunicata, p. 227.

storms; they are probably what are referred to by Dr M'Bain as *Ascidia prunum*. These young specimens are perfectly transparent, and have a beautiful crystalline appearance. They are excellent objects in which to study the circulation in the living animal.

Ascidia depressa (Alder).

We obtained several specimens of this characteristic species, some years ago, at low water mark near Elie.

A. scabra (O. F. Müller).

This species we also obtained on the same occasion, near Elie, in considerable quantity.

Ciona intestinalis (Linnæus).

This beautiful species is fairly common on the oyster bank, and on muddy bottoms elsewhere throughout the Firth; it attains a large size. We have dredged it in various parts of the Firth, and have also taken it at low water mark at Elie and Aberdour, generally adhering to the roots of *Laminaria*.

ASCIDIÆ COMPOSITÆ.

Botryllidæ.

Botryllus schlosseri (Pallas).

This species is common at low water mark on the shores of the Firth. It is usually found on the under surface of large stones, or encrusting the roots and stems of *Laminaria, Fucus,* etc.

We have taken it at Elie, North Berwick, Aberdour, and other localities.

Dr M'Bain records this species in his list.

B. polycyclus (Savigny).

This species appears to be rarer than the last.

Dr M'Bain mentions it in his list, and we dredged some large specimens in 10 to 20 fathoms, east of Inchkeith, last summer.

Botryllus calendula ? (Giard).

We refer provisionally to this species some specimens of a rather delicate *Botryllus* which we dredged last summer in 14 fathoms, off Longniddry. The specimens were encrusting large individuals of *Ascidia virginea.*

Botryllus calendula was described by Giard * from Roscoff, on the coast of Brittany, where it is stated to be very rare.

Botrylloides rubrum (Milne-Edwards).

The specimens which we have found in the Firth of Forth have belonged to the yellow varieties † of the species, and not to the typical red form. They were from Elie, and were taken at low water mark at spring tides.

B. radiata ? (Alder and Hancock).

A few specimens which we found along with the last species may be referred provisionally to *Botrylloides radiata.* It is possible that this species may be merely a variety of *B. rotifera* (M. Edw.).

B. albicans (Milne-Edwards).

We have obtained this species at low water mark near Newhaven.

Polyclinidæ.

Aplidium caliculatum (Savigny).

We obtained a large specimen in an excellent state of preservation from the stomach of a cod last summer.

This species, having a long filiform post-abdomen, a channelled stomach, and a

* Recherches sur les Synascidies (Arch. Zool. expér., t. 1, p. 623, 1872).

† See Giard, *loc. cit.*, p. 632.

six-rayed branchial aperture, falls into the sub-genus *Amaroucium* of Giard's system of nomenclature.

Aplidium proliferum (Milne-Edwards).

This species also belongs to the sub-genus *Amaroucium*. It is not uncommon at low water mark and in the upper laminarian zone at Elie.

In the *Edinburgh New Philosophical Journal* for 1838 (vol. xxvi., p. 155), Sir John Dalyell gives an account, under the name of *Aplidium verrucosum*, of a compound Ascidian which was dredged to the south-east of Inchkeith, and brought to him by the fishermen.

Parascidia forbesi (Alder).

This species, the *Sidnyum turbinatum* of Forbes, and *Circinalium concrescens* of Giard, was obtained from the Isle of May.

P. flemingi (Alder).

Also from the Isle of May on rocks (*Flem.*).

DIPLOSOMIDÆ.

Pseudodidemnum gelatinosum (Milne-Edwards).

The *Didemnum gelatinosum* of Milne-Edwards and other authors.

We have taken small colonies of this species near low water mark at Wardie.

We hope in time to add largely to the above list of Tunicata. There are many species known to inhabit the North Sea which we may reasonably expect to find in the Firth of Forth, especially towards the mouth. *Clavelina lepadiformis* is recorded from St Andrews by Dr M'Intosh, and from the Northumberland coast by Mr Hancock; it will doubtless be found within our area also. Other species, such as *Botryl-loides leachi* (St Andrews, M'Intosh; and Northumberland, Alder), *Polyclinum aurantium* (Cullercoats, Hancock), and *Polycarpa tuberosa* (Aberdeen, Macgillivray; and Cullercoats, Alder), will, we expect, be also obtained when the Firth of Forth, and especially its outer part, has been more thoroughly worked.

XIII. *Notes on a Collection of Birds and Eggs from Central Uruguay.* By JOHN J. DALGLEISH, Esq., M.B.O.U. [Plates VII. and VIII.]

(Read 20th April 1881.)

The Republic of Uruguay, or Banda Oriental, has not hitherto received that attention from naturalists which has been bestowed upon its neighbour, the Argentine Confederation, where the recent researches of Burmeister, Hudson, Durnford, and others, not forgetting those of our townsman, Mr Ernest Gibson, have so far supplemented those of D'Orbigny, Darwin, and St Hilaire, as to render the ornithology of that great division of the old Spanish colonies in South America, almost as well known as that of the United States of North America.

Uruguay, although it appears on the map as studded with mountain ranges, is in reality a gently undulating country, whose hills do not rise above 200 or 300 feet above the adjoining valleys. These "cuchillas," as they are called, form, however, the main watersheds of what is generally a well-watered country, although themselves little higher in elevation than the downs or campos which form its great bulk.

A recent traveller, Dr David Christison, to whose comprehensive papers I am considerably indebted for these details, informs us that the country may be conveniently divided into four districts: 1st, the eastern, included between the main "cuchilla" or hill range—a prolongation of the coast line of Brazil—and the Atlantic, with an area of about 170 miles by 100, and drained into the ocean, principally by the river Cebollati; 2d, the southern, 200 miles by 60, forming the northern shore of the Rio de la Plata; 3d, the central and northern district, considerably the largest, measuring about 250 miles by 140, drained westwards into the Uruguay by the Rio Negro; and 4th, the north-western, 150 miles by 80, also drained into the Uruguay, but by a system of numerous and comparatively small streams.

It is of the second of these, or the southern division only, that we have any full and satisfactory account of its natural productions, it having been visited by the eminent naturalists Auguste St Hilaire, D'Orbigny, and Darwin, and later by Burmeister, the two last of whom also visited a portion of the lower Rio Negro Valley. The eastern district has only been glanced at in a cursory manner by St Hilaire. Of the remaining divisions we know but little.

I have lately received, from a correspondent residing in the province of Durazno, which is situated in the largest or central of the divisions above alluded to, a small collection of eggs, accompanied by the skins of the parent birds, and I am much indebted to Messrs Sclater and Salvin for having kindly identified the latter for me.

Before, however, describing these in detail, I may, in a few words, give a description of the immediate district from which they have been sent.

The Estancia de la Tala, where my correspondent resides, and in the neighbourhood of which the specimens to be described were collected, formerly formed part of an extensive property, known by the name of San Jorge, whose topography and botany have recently been described by Dr Christison, and to whose papers on these subjects, and on the meteorology of the district, I would refer.*

San Jorge is situated, as above mentioned, in the province of Durazno, and on the south of the Rio Negro of Uruguay, a little to the north of latitude 33° south, and measures about 26 miles from east to west, by 14 from north to south. The height of the district above the sea-level has recently been ascertained by Mr Hall of San Jorge to be about 400 feet. The rocks are generally of volcanic origin, and in the neighbourhood of the river Tala amygdaloidal, abounding in chalcedony, opal, etc., specimens of which have been sent me. The soil is a black stiff clay. The climate is healthy, but subject to droughts, or "secas," sometimes of several months

* Trans. and Proc. Botan. Soc. Edin., xiii., p. 242.

Proc. Royal Geograph. Soc., and Monthly Record of Geography., Nov. 1880, vol. ii., new monthly series, p. 663.

Journal Scottish Meteorol. Society, vol. v., pp. 239-335.

duration, and which are liable to occur at any season. The "seca" of spring or summer, however, is the only one dreaded, or even talked of, those of winter being comparatively harmless. Rain falls on an average 60 days in the year. Gales of wind are very common, and there are few days, except in summer, without wind sufficient to cause annoyance when riding. The temperature does not fall below freezing point above 20 days in the year, and hoar frost may occur on other 20, but ice formed on the pools during night melts in the morning. The average summer temperature is 75°.

The aspect of the country is at first somewhat monotonous, consisting as it does of extensive plains, only varied by the almost imperceptible elevations of the "cuchillas," or hills. These plains or campos are smooth, and generally well covered with herbage; occasional rocks appear here and there, especially along the ridges of the hills. The vicinity is well watered, the rivers Rio Negro, and its tributary the Carpinteria, nearly surrounding it, these again having numerous smaller affluents, with permanent water. These "arroyos," as the latter are called, expand here and there into lagunas or lakelets, forming pleasant features in the landscape.

Although otherwise well clothed with vegetation, and in their season with numerous wild flowers, the absence of native trees is a marked feature not only of San Jorge but of the whole campos of Central Uruguay, and one the reason of which it is very difficult to explain, as trees when planted seem to thrive well. The only woods are those which fringe the rivers and water-courses, which they do from near their source, increasing in breadth as the streams increase in volume, until at length, here and there, on the larger of these, they attain a width of from a mile to a mile and a half, and in some places are quite thick and dark, affording a pleasant shade, and a relief from the glare of the campo adjoining. The trees, of which the species are many, are mostly stunted and crooked, the willows being generally the tallest; there are, however, places in which they grow comparatively tall and straight. They are much valued for firewood and posts.

The dark recesses of these woods, or "montes," as they are termed, are almost impenetrable in places from the prickly climbers and underwood, and they are generally fringed with thorny plants. The manner in which these woods are confined to the borders of the rivers and streams is very remarkable. The river is frequently sunk to a depth of 15 to 20 feet below the level of the valley, as in the case of the Rio Negro, and although averaging from 100 to 200 yards wide, it seems hidden between its steep banks, covered with trees and shrubs, which, when seen from a rising ground, mark out its course with well defined precision, and give the appearance of a green river, whose shade of colour varies with the season of the year. At certain points the trees thin out, and passes are left leading to fords, by which the rivers can, at ordinary times, be passed.

The vegetation of the campos is said to have undergone great modification in recent times, owing to the introduction of grazing, having become less coarse and lofty, although, on the other hand, they have suffered from the introduction of several obnoxious foreign plants. The most prejudicial of these has been the European thistle, which has overspread vast tracts, not only of Uruguay, but of Buenos Ayres, as far even as the confines of Patagonia. Darwin describes even in his time several hundred square miles in the south-west of Uruguay, as covered by them, and impenetrable to man or beast. They are often of great height, completely shutting out the view, and hiding the landmarks. The campos consist, as above mentioned, of undulating plains broken only by the rivers and streams, by which they are watered, and by the "cuchillas," or hilly ranges, and it may be by a stray ombu tree (*Phytolacca dioica*). This latter, although a large, handsome tree, is remarkable for the curious pith-like stem, which, while sometimes reaching the height of 20 or 30 feet, "retains so much of herbaceous softness that it may be cut like an enormous carrot." Until a very recent period agriculture had made almost no way, the attention of the Estancieros being entirely devoted to grazing, but the former bids fair soon to assume an important position. The country also, a few years ago entirely

unenclosed, except at the necessary corrals or folds, is now being rapidly divided by wire fencing. The former of these changes cannot fail to affect the indigenous fauna of the country, by the increase of grain feeding species.

The Estancia de la Tala, which, as above stated, forms part of San Jorge, is situated at its western extremity, and is watered by the Tala, from which it derives its name, and which in its turn is so called from the Tala shrub (*Celtis tala*), a thorny bush resembling the hawthorn, which is numerous on its banks. It flows in a north-westerly direction into the Rio Negro about eight miles from the station. The Estancia or station lies about 170 miles nearly due north of Monte Video, and 50 miles from Durazno, to which there is now railway communication from the capital.

The garden attached to the station, and where many of the nests described were obtained, is from 6 to 8 acres in extent, planted with various trees and shrubs, such as orange, peach, pear, apple, and other trees, and is enclosed with a hedge of a prickly plant called Zina Zina (*Parkinsonia*). On the banks of the Tala, and about a mile distant from the Estancia, is one of the woods described above as fringing many of the water-courses, and which in this case is about 50 yards wide, consisting of Tala (*Celtis tala*), Laurel so called (*Oreodaphne acutifolia*), Sauce or Willow (*Salix Humboldtiana ?*), Seybo (*Erythrina Crista-galli*), and numerous creepers, and where, as after mentioned, several of the nests were obtained.

As the list of species enumerated is not a large one, its chief interest lies in its being the first hitherto published from the district described, and to which I hope to be able to add on a future occasion.

1. *Cathartes atratus* (Bartr.)—Black Vulture : native name "Cuervo."—This species is found from the Southern States of North America, down through Mexico, Central and South America, to nearly the Straits of Magellan, or according to Darwin, about 41° south latitude. It is also found in some of the West Indian islands. It is stationary in Central Uruguay. It prefers a well-watered country, and is never

found on dry plains, unless near a stream. Feeding chiefly on carrion, it never attacks a living animal. In Charlestown and Savannah, in the Southern States of North America, these birds act as scavengers, and are semi-domestic. They are often seen in hundreds at a carcase, and are generally gregarious. In stormy weather they fly high, beating their wings heavily, and not sailing as does their congener, the Turkey buzzard. Mr Layard says, that at Para in Brazil, they remain on wing at a great height, from 9 or 9.30 a.m. till 3 or 4 p.m., feeding before and after these hours respectively. In early morning they sit on the trees there, in rows, with outspread wings, presenting a strange appearance.

A clutch of two eggs, taken 2d October 1878. They were laid beside the root of a tree, on the bare ground, in a boggy place. They measure $2\frac{35}{40} \times 1\frac{37}{40}$, and $2\frac{27}{40} \times 1\frac{36}{40}$ inches, respectively.

The eggs seldom, if ever, exceed two in number, and are usually laid in a hollow tree, or on the ground. Their average weight is about a pound. They are slightly larger than those of the Turkey buzzard, although the latter is a bigger bird. The ground colour is of a yellowish white, with blotches of dark reddish brown, and smaller markings of a lilac shade. These markings are generally more numerous at the larger end. The egg is figured by D'Orbigny.

2. *Milvago chimango* (Viell.)—The Chimango is found generally distributed, from the latitude of Arica in Peru, as far south nearly as the Straits of Magellan, and also in Brazil. Like the next species, with which it much associates, it attaches itself to man, and to the neighbourhood of inhabited places. It prefers dry localities, except when resting, and is more found on plains than in mountainous parts. Its food consists of dead animals, reptiles, insects, and young chickens, for as a robber of the farm yard it is much detested. It is a very quarrelsome bird, and two cannot remain within a few yards of each other without a fight ensuing, although it does not attack other species, like the Caracara. Unlike the latter, it does not much affect the woods, but perches on a house, a rising ground, or a rock, seeking the shade, however, in the heat of the day. Its

flight is not strong enough to kill a bird on the wing. In the Argentine Republic, it performs a partial migration, flying northwards in winter. Mr Gibson mentions its great familiarity in that country, as shown by its hovering over, or alighting within a yard of the place, where an animal is being flayed. It is stationary at Tala.

A clutch of three eggs, taken 6th October 1879, from a nest placed in a clump of thick grass in the campo; nest unlined save with grass stems.

Another clutch of three eggs, taken on 10th October 1879, from a similar nest, in a like situation.

The eggs of three clutches, nine in all, average $1\frac{2}{40} \times 1\frac{14}{40}$ inch.

They usually lay three eggs, which cannot be better described than as resembling, in their different varieties, those of the kestrel, being, however, somewhat larger. They are figured by D'Orbigny.

3. *Polyborus tharus* (Molina)—the Southern Caracara Eagle: native name "Carrancha."—The Carrancha, one of the most abundant of South American raptors, though a noble looking bird, and bearing the name of eagle, is more akin to the vultures, rarely killing any animal for itself, but feeding on carrion, although, according to Azara and Audubon it will eat worms, slugs, grasshoppers, frogs, and even young alligators. Like the chimango, it steals chickens, and occasionally accompanies the sportsman, and steals the game he shoots, ere he has time to secure it. Like the secretary bird of Southern Africa, it is also fond of snakes. It is found throughout almost the whole continent of South America to the Straits of Magellan, and is replaced in the Southern States of North America, and in Mexico, by an allied species. Darwin states, that if one falls asleep in the plains of South America, he will, on awaking, find one of these birds sitting on each rising ground near, patiently watching him with an evil eye. Its flight is heavy, except in the evening, when returning to its nest, and its cry loud and disagreeable, and when uttering it, it throws its head higher and higher until the top nearly touches the back. Although feeding in company with the last species, they are far from friendly,

and the carrancha is much bullied by the chimango. It is like the latter, much given to quarrelling. It mingles also with the vultures, and at other times with gulls. Its manner is lively, and it walks with its body in a horizontal position, with the top knot or plume erect. Like the chimango, it frequents the neighbourhood of houses, feeding on the offal at the killing establishments; indeed, D'Orbigny goes so far as to describe it as a parasite, following man wherever he goes, and that otherwise it would suffer from want of food. Mr Allan Watson, late of San Jorge, informs me that it is very destructive to young lambs, and that the loss thus caused by these birds is almost incredible, killing the lambs when asleep, or when accidentally parted from their mothers. Mr Gibson also mentions an instance he once observed, of one on the back of a sickly full-grown sheep, buffeting it about the head with its wings, to get it down, well knowing that once down, it would rise no more. The latter gentleman also mentions, that it is very destructive to the young of the black-necked swan (*C. coscoroba*). Mr Durnford found several specimens of this species in Patagonia, of a very light cream colour. It is stationary at Tala, and common.

A clutch of three eggs, taken 16th October 1879, from a nest in a very high tree in Tala Wood. The nest was formed of sticks, and lined with dry grass.

Another clutch of three eggs, taken 6th November 1879, from a nest in a tree standing alone, but otherwise similar to the former.

These eggs average $2\frac{9}{10} \times 1\frac{3}{10}$ inches.

It generally breeds from September to November, but eggs are found from 20th August to 1st December. They are very bold at that season, and will attack any one going near the nest. They never lay more than three eggs, which are handsome, and of a dark reddish colour, somewhat resembling those of the peregrine. They are oblong in shape, showing more affinity with the vultures. The nests often contain all sorts of odds and ends, as fish bones, cow hide, straw, string, etc. etc. The egg is figured by D'Orbigny.

4. *Geranoaetus melanoleucus* (Viell.)—Grey Eagle: native name "Aguila." This large and handsome species is found

from the latitude of Rio, in Brazil, as far south nearly as the southern extremity of Patagonia, and is met with to a considerable height in the mountains of Chili. It is generally seen near water, and, in the northern part of its range, in plains. In Patagonia it is found near high cliffs, where in that country it breeds. D'Orbigny says, that as a rule it does not choose a wooded country, and that even in perching by a river bank it prefers a dead tree for the purpose. It feeds chiefly on carrion and small animals, as rats; but in Buenos Ayres, according to Mr Gibson, its principal food is a small cavy; and D'Orbigny says that, in Patagonia, it feeds greatly on wild pigeons, which it seizes on the wing, following the flocks as they move onward, and in pursuing these northward it performs a partial migration. It also feeds in the latter country on animals cast up by the sea, as seals. Its flight is easy, without being rapid, and when disturbed it rises in circles, but drops quickly on its prey. In stormy weather it rises high in the air, almost out of sight, and cries aloud, a sure warning of bad weather. The Indians consider the down below the wing as very beneficial, when used for stanching the blood of a wound.

A clutch of two eggs, taken October 4, 1879, from a nest situated in a high tree, in Tala wood, formed of sticks, and lined with horse hair and wool. They measure $2\frac{2}{4}\frac{6}{0} \times 2\frac{2}{4}\frac{}{0}$ and $2\frac{2}{4}\frac{2}{0} \times 2\frac{2}{4}\frac{}{0}$ inches respectively.

In Uruguay and the Argentine Republic, it builds its nest in lofty trees, but in Patagonia invariably on high cliffs. The eggs are only two in number, and are of a white colour, with brownish red spots and small blotches, and much resemble, except in size, those of the kite or common buzzard (Pl. VII., fig. 3).

5. *Pholeoptynx cunicularia* (Molina)—Southern Burrowing or Prairie Owl: native name "Lechuza."—This well-known species is found over all South America and the western part of North America. Those found in the latter, however, although specifically the same, are recognised as a geographical race or variety, being somewhat smaller in size, and of a lighter brown in colour. Its habits are well known, but I may mention that in Uruguay they are their own excavators, contrary to their habit in North America, where they frequent

the burrows of the prairie dog (*Arctomys ludovicianus*), and in the Argentine Republic, those of the Bizcacha (*Lagostomus trichodactylus*). These burrows are formed on any level spot of sandy soil. They are, at all events in Tala district, always to be found near some habitation, it being a sure sign at night of being near a dwelling if one is seen to rise. They feed morning and evening, after sunrise and before sunset, and their food consists of small animals, as mice, and also of insects and reptiles. They frequently sit on a clod or thistle whence they fly to catch insects on the wing. In the Argentine Republic their principal food is a beautiful green beetle. Although congregating in communities, each pair has its own hole, which they occupy during the whole year, and they do not migrate. They are sometimes tamed as pets.

Clutch of four eggs, taken from a burrow, 8th December 1878; nest formed of dry grass.

Other two clutches, of four eggs each, taken on 22d October and 12th November 1879, from similar nests.

These eggs average in size $1\frac{14}{40} \times 1\frac{4}{40}$ inch, the largest being $1\frac{18}{40} \times 1\frac{5}{40}$ inch, and the smallest $1\frac{13}{40} \times \frac{4}{40}$ inch, there being little difference in size.

They usually lay four or five eggs, about 5 feet from the entrance to the burrow or hole, the nest being merely a few feathers, or a little dry grass. The eggs are round and white, and of the usual owl type.

6. *Podager nacunda* (Viell.)—native name "Dormilon" (or the sleepy one), probably from its nocturnal habits.—This bird, a species of nightjar, is distributed over most of South America, being found in British Guiana, Brazil, Bolivia, and the countries lying to the south of these last. It is very common in the neighbourhood of Tala, where it is only found on stony places, on which it lies asleep all day, unless when disturbed. It is stationary.

Clutch of two eggs, taken on 16th October 1879. They were laid, without any formed nest, on a scraped place in the campo.

Other three clutches of two eggs each, taken, two on 28th October, and the other on 6th November, in the same year, all being laid in similar situations to the first.

They average $1\frac{16}{40} \times \frac{39}{40}$ inch., the largest being $1\frac{19}{40} \times 1$ inch, and the smallest $1\frac{13}{40} \times \frac{37}{40}$ inch. They are oval-shaped, and resemble much in appearance those of the nightjar, except that the markings, which are similar in character to those of the latter, are of a reddish brown or port wine colour. The breeding habits seem to be very similar to those of our bird, as it forms no nest, but lays its two eggs on a scraped place in the open. The egg is figured by D'Orbigny.

7. *Hirundo meyeni* (Cabanis)—native name "Golondrino," which is applied, however, to all the swallows. A very common species at Tala.

Clutch of four eggs, taken 22d November 1878. The nest was placed in a hole in a fence post, and was composed of feathers.

Another clutch of four eggs, taken 4th December 1879, from a similar nest.

These eggs average $\frac{33}{40} \times \frac{22}{40}$ inch, and are pyriform, of a white colour, and much resemble those of the common house martin.

8. *Furnarius rufus* (Gm.)—Oven bird: native name "Hornero."—This species, called from the shape of its nest, is found over South America, between 25° and 35° south latitude, where it is commonly distributed, and it is found up to the height of nearly 9000 feet in the Bolivian Andes. It is common at Tala. Its habits resemble those of the thrush, and its gait is like that of a large robin. Insects, chiefly coleoptera, and seeds, form its food. It perches on walls in preference to trees, and is partial to the neighbourhood of houses, placing its curious nest on churches, walls, and trees, the buttress of a bridge, or a telegraph or fence post, even on those of the corral or fold, so regardless are they of man's presence. Dr Christison mentions a nest which he saw placed in a campo santo, or cemetery, at Durazno, as follows: "a number of tall wooden crosses stood in the enclosure, and on the top of the loftiest a couple of fussy horneros, strangely out of place in so desolate a scene, were building their nest of clay, and singing their noisy duet of mingled shrieks and laughter."

Clutch of four eggs, taken on 16th October 1879, from a nest in a tree in Tala garden.

Another clutch of four eggs, taken also in Tala garden, from a similarly situated nest, on 12th November 1879.

These eggs average $1\frac{3}{40} \times \frac{33}{40}$ inch, the largest measuring $1\frac{6}{40} \times \frac{34}{40}$ inch, the smallest $1 \times \frac{34}{40}$ inch. One from Buenos Ayres, however, in my collection, only measures $\frac{37}{40} \times \frac{34}{40}$.

The nest of this bird is a large structure of a globular form, made of clay or black mud, which is found near the nest, and is worked by the bird into a thorough mortar, which is said to be probably more durable than ordinary mortar would be with the same exposure. The nest is about 8 to 10 inches in diameter, the walls being an inch thick. It is placed, as before mentioned, in the most exposed situations. The opening, invariably placed on the most sheltered side, is large, and directly in front; within the nest is a partition which reaches nearly to the roof, thereby forming a passage or antechamber to the true nest, which is lined with dry grass. It is shaped somewhat like an oven, hence the name oven bird. The eggs are usually four in number, of a pure white colour, and of a shortened pyriform shape.

9. *Tænioptera nengeta* (L.)—native name "Bruja," or witch.—This species, although nowhere very common, is found over most of South America, including Brazil, and the countries lying to the south and west of that Empire. Its habits and those of the next species somewhat resemble those of the fly-catchers. It is generally seen near houses, where there are bushes or tall herbage, perched on a high twig. They are very restless, constantly descending to the ground to seek insects, or flying off to catch them in the air before alighting, as if in play. They never hop from branch to branch, nor go into the interior of a bush. They are migratory at Tala, and not very common.

Clutch of three eggs, taken 23d October 1879, from a nest in a bush in Tala garden. The largest of these measures $1\frac{6}{40} \times \frac{32}{40}$ inch, the smallest $1\frac{3}{40} + \frac{31}{40}$ inch. They are pear-shaped, of a white colour, with large, well-defined spots or blotches, of reddish brown (Pl. VII., fig. 1). The nest is about 4 inches in diameter over all, of rather a flattish shape, and is formed of roots, lined with others of finer quality, and one or two feathers.

10. *Tænioptera irupero* (Viell.)—native name "Viudita," or little widow, so called from the conspicuous black and white plumage.—This pretty little bird is found throughout Brazil, Paraguay, Uruguay, and the Argentine Republic. At Tala it is migratory, and not plentiful. In habits it much resembles the last species. It is very familiar, perching on houses, whence it rises again and again, flaps its wings, and returns to its perch. It also perches, like its congener, on bushes and low trees, growing singly, but avoids trees growing together. A great proportion of its food consists of *coleoptera.*

Clutch of four eggs, taken 12th October 1878, from a nest in a hole in a post, lined with feathers.

These average $\frac{3}{4}\frac{6}{0} \times \frac{2}{4}\frac{5}{0}$ inch, and are pear-shaped, of a creamy white colour, with a very few minute dark reddish spots, dotted at irregular intervals over the egg. Some specimens have not more than one or two spots, and none have more than eight or ten in all (Pl. VII., fig. 2). This species sometimes appropriates the abandoned nest of the hornero, or oven bird.

11. *Mimus calandria* (Lafr. et D'Orb.)—native name "Calandria."—This species of thrush, which belongs to the same genus as the mocking bird of North America, is known by that name among the English-speaking inhabitants of Uruguay. It is found in Southern Brazil, and southwards to Patagonia. It frequents clumps of bushes, and is never found either in woods or open plains. It is, perhaps, the most familiar of the birds of the country, always making its abode near some dwelling, and once attracted to the place, seldom leaves it. In winter it visits the farmyards or courts, to pick up what it can, and occasionally it there attacks the cheeses which may be drying, or meat which may be hanging up. It never hides like the thrushes, but is always seen on the tops of the bushes, generally the most elevated. It hops actively about, and in so doing elevates and expands its tail. Darwin says its song is superior to that of any other bird of the country, and may be compared to that of the sedge warbler. This, which is borne out by residents in Uruguay, who speak of its cheering notes, is, however, only in the spring; at other times its voice is harsh. It is proficient

in imitating the notes of other birds. It derives its name from the calandra lark of Europe, from a fancied resemblance in its song to that of that species. In the Argentine Republic it is migratory, appearing there only in spring and summer, although a few individuals may remain during winter. In Uruguay it seems stationary.

Clutch of four eggs, taken 4th October 1878, from a nest placed in a bush in Tala garden.

Another clutch of four eggs, taken 18th October 1879, from a nest similarly situated, in the same place.

These eggs, and those of other clutches which I have examined—16 eggs in all—average $1\frac{1}{40} \times \frac{31}{40}$ inch, varying from $1 \times \frac{30}{40}$ inch to $1\frac{3}{40} \times \frac{31}{40}$ inch. They are shaped somewhat like those of a blackbird, and much resemble the bluish green varieties of the eggs of the fieldfare and ring ousel. They are of a pale green colour, with numerous splashes of reddish brown, chiefly towards the large end, although some varieties are nearly covered with the latter colour. The egg is figured by D'Orbigny.

The nest is generally built in a bush, and formed of small branches, and lined with hair. That sent with the last-mentioned clutch of eggs is about 4 inches in diameter across the top, and is formed of small sticks and roots of different thicknesses, and is lined with cow hair.

12. *Molothrus badius* (Viell.)—native name "Toldo."—This bird's range extends from Southern Brazil, through Uruguay, into the Argentine Republic. It is partially parasitical, although in the last-named country, Mr Hudson only found it laying in nests of its own. It goes in flocks of ten or fifteen, and the sexual attachment is not strong, sometimes the members of the flock remaining together in spring in a promiscuous manner. Mr Hudson has taken no less than fourteen eggs from one nest built by the birds themselves, and all cold, and probably more would have been laid. It is sedentary, remaining all the year, but moving much about in the cold season. Its song is low, sweet, and varied, all the flock singing together. When flying, they utter a loud and melodious note, which can be heard half a mile distant. As above mentioned, they often hatch their

own eggs, but the only eggs sent me were taken from the nest of a "viudita" (*Tœnioptera irupero*), on 3d December 1878. They were four in number, of a dirty white colour, closely freckled or marbled, with large and small spots of greyish brown of two shades, and average in size $\frac{38}{40} \times \frac{28}{40}$ inch (Pl. VII., fig. 4).

13. *Zonotrichia pileata* (Bodd.)—Sparrow or Chingolo Bunting: native name "Chingol."—The Chingolo Bunting is distributed throughout South America, from Guatemala to Patagonia, and is the most common bird in Uruguay. It is found up to a height of at least 8000 feet, in the Cordilleras. In its habits and general appearance, it resembles the English sparrow. It does not go in flocks, but several may be seen feeding together.

Clutch of three eggs, taken 20th November 1879, from a nest placed in a bush, in Tala garden.

They average $\frac{32}{40} \times \frac{24}{40}$ inch, and are of a pale green colour, with numerous spots of reddish brown.

The nest measures 4 inches across the top, over all, and $2\frac{1}{4}$ inches across the cavity. It is composed chiefly of roots, coarse herbs, and a few sticks, and is lined with fine hair. The eggs are usually three in number, but occasionally four or five are laid In Buenos Ayres they have two broods in the season.

14. *Paroaria dominicana* (L.)—native name "Cardinal," so called from its brilliant plumage.—This is a very domestic species, frequenting gardens or small woods near houses, and is frequently caged as a pet, taking well to captivity. It remains during the whole year, and does not migrate.

Clutch of three eggs, taken from a nest in a tree, in the garden at Tala, on 10th November 1879. They average, $\frac{36}{40} \times \frac{26}{40}$ inch in size. The ground colour is greenish, and closely freckled over with dark brownish-green markings (Pl. VII., fig. 5). The nest measures 3 inches across the top, and is formed of the tendrils of the wild vine, and lined with horse hair.

15. *Synallaxis hudsoni* (Sclater)—native name "Espinero," or thorn bird.—This is a common species at Tala, and is also found throughout the Argentine Republic, and as far south at least as the Welsh colony of Chuput in Patagonia, whence

Mr Durnford records it, and describes it as frequenting dry places, where it lives on the ground.

Clutch of four eggs, taken from a nest placed in a tree in Tala garden, on 18th October 1879. These average $1\frac{2}{40} \times \frac{28}{40}$ inch, are pyriform in shape, and of a white colour.

The nest is formed of thorns, and is about 18 inches long, the eggs being placed at the bottom, on a lining composed of felted wool, with a few hairs, rags, and feathers intermingled. A passage leads into the nest from the top.

16. *Pitangus bellicosus* (Viell.)—native name "Bien-te-veo" (I see you well), which it has received, from the fancied resemblance which its call bears to these words.—This species, which is typical of the great family of tyrant flycatchers, is found throughout Brazil and Bolivia, and the countries lying to the south of them. It is very common in the open country in Uruguay. In general structure it resembles the shrikes, but in its habits it resembles many birds. Its flight is undulatory, and its head appears too large for its body. Darwin says it has a habit of hovering like a kestrel over one spot, and then passing on to another at a little distance, from which it might be casually taken for a bird of prey, but its stoop is wanting in force and rapidity; at other times it frequents the water-side, remaining stationary like a kingfisher, and catching any small fish that may come near the margin. At sunset and sunrise, taking their station on a bush, they reiterate their deafening cry, erecting their crest and jerking their head about the while. Its food consists of insects, small fish, grain, vegetables, and fruit. In winter when insect life fails, it comes near houses, and then also frequently follows the vultures, to pick morsels off the carcases they feed on. It is very familiar and impertinent, although a great bully, chasing, and being chased in turn, by all other birds.

Clutch of four eggs, taken 8th November 1879, from a nest placed in a tree, in Tala garden. These average in size $1\frac{5}{40} \times \frac{31}{40}$ inch, and are of a yellowish cream colour, with small very dark reddish spots, chiefly at the large end. They are pear-shaped (Plate VIII., fig. 1).

The nest is generally placed in a fork of a low tree, but Mr

Gibson mentions having seen it among the reeds in the swamps. It is a voluminous structure, about three times the size of a sparrow. That sent with the above clutch is of a domed-shape, with an opening in the side, and formed of wool, hair, and feathers. The eggs are usually four in number, and never more than five.

17. *Serpophaga nigricans* (Viell.)—native name "Ratoncito." —This species is generally found at Tala, in thickets of willow and other trees near the river. It is resident. It approaches the titmice in habits, but generally frequents lakes, ditches, and other moist places. In the Argentine Republic it is found on the shores of the river Plate, among dense cover, where it often alights on aquatic plants, growing in the water. When seated on a twig, it is fond of expanding its tail like a fan. They move generally in parties of three or four together.

Clutch of two eggs, taken 8th November 1879, from a nest placed on the banks of the Tala River. These measure $\frac{26}{40} \times \frac{19}{40}$ inch, are pyriform, and of a yellowish white, unspotted (Pl. VIII., fig. 3).

It is said to lay only two eggs. The nest is about two inches in diameter, across the opening, is cup-shaped, and formed of moss, dry grass, and hair, felted together like that of a greenfinch, and warmly lined with feathers, chiefly those of the partridge (*N. maculosa*).

18. *Milvulus tyrannus* (L.)—Scissor Bird : native name " Tejerito."—A common species in Mexico, and throughout the whole of South America, to the Straits of Magellan. At Tala it is migratory, and not very common, nor so numerous as in the Argentine Republic, where it is also migratory, passing on to Patagonia. Its habits resemble those of the other flycatchers. It often sits solitary, on the bough of an ombu tree, whence it takes short flights after insects, returning to its perch. From the structure of the tail, it has received the above name from the natives. Like all birds so constructed, it has the power of turning short in its flight, and at the same moment opening and closing its tail, sometimes vertically and sometimes horizontally. On the wing it presents a caricature of the common swallow, with its forked tail, while its note also resembles the twittering of that bird.

Clutch of four eggs, taken 21st November 1879, from a nest situated in a tree in Tala garden. Twelve eggs average $\frac{34}{40} \times \frac{24}{40}$ inch. They are of an oblong oval shape, tapering at one end, and one of a yellowish white colour, spotted with deep and prominent markings of dark red and reddish brown, much resembling those of other American flycatchers (Pl. VIII., fig. 2).

The nest accompanying the above clutch of eggs is made of small twigs, roots, and coarse herbs, or reeds, lined with finer roots, wool, and grass seeds. It measures $2\frac{1}{2}$ inches across the top. Although having no clay in its composition, it is a very firm structure. The eggs are frequently only three in number, and are most courageously defended by the parent birds, the female even occasionally attacking the caracara.

19. *Nothura maculosa* (Tem.)—native name "Perdiz comun." —The common or lesser partridge of the South American Pampas is found throughout Brazil and the countries to the south thereof. It lives entirely among grass, maize, or other herbage, and is generally seen singly, although usually a number are present in the same locality. They are rather tame, and when numerous are easily killed in some parts of the country, by sticks or whips. The flesh is dry and tasteless. It has two distinct notes, which are heard all the year round, one of which it utters as it walks or runs along.

Clutch of four eggs, taken 22d October 1879, from a nest in the campo, or plains.

Another clutch of four eggs, taken 30th October 1879, from a nest in a similar situation.

Twelve eggs in my collection average in size $1\frac{28}{40} \times 1\frac{8}{40}$ inch. The eggs are of a dark wine purple colour, and so highly polished, as almost to seem as if cut out of some dark stone (Pl. VIII., fig. 4). The nest is merely a scrape among the grass, and contains no artificial lining. The usual number of eggs is four, and although in the Argentine Republic they are said to lay seven, and even eight or nine eggs, my correspondent at Tala considers that when so many occur in one nest—a circumstance he has frequently observed—they are the produce of more than one female bird.

20. *Rhynchotus rufescens* (Tem.)—native name "Perdiz

Grande," or larger partridge.—The range of this species is nearly co-extensive with the last mentioned, but it is not found to the south of the Rio Colorado of Buenos Ayres. It dwells entirely among the larger grasses, like the common partridge, and through which it pushes its way like a rail. It is of solitary habits, and concealing itself well, is difficult to flush. When disturbed, it flies about 300 yards, and when again raised it can only fly about 100 yards, and then seems unable to rise again. It makes a great noise when flying by the vibration of the wings. Its call is heard at all seasons, and in fine evenings the birds, which, although living solitary, are generally not very far apart, answer each other. When excited, it carries its long slender crest directly forward, like a horn. It is caught in Buenos Ayres by men and boys on horseback, who riding round them in ever narrowing circles, at length put a noose over their head from the end of a long stick. They squat when alarmed, instead of running away.

Clutch of six eggs, taken 7th December 1879, from a nest in the campo. These average $2\frac{8}{40} \times \frac{26}{40}$ inches, and are of a similar colour to those of the last species, but of a greatly lighter shade of purple (Pl. VIII., fig. 5). They have the same beautifully polished appearance. The nest also resembles that of the smaller partridge, being a mere scrape, like that of a domestic fowl. The eggs are usually from six to eight in number.

21. *Zenaida maculata* (Viell.)—native name "Paloma chica" (little dove).—This species is found in vast flocks throughout the lower part of South America, from Brazil southwards. It is familiar in its habits, and sometimes frequents the farmyard, where it is looked on as a favourite. Its food consists of thistle and other seeds, notably those of the cardoon. Mr Durnford mentions having taken upwards of 700 seeds of this plant from the crop of one bird. It is stationary at Tala, where it goes in great flocks in winter.

Clutch of two eggs, taken 7th December 1879, from a nest placed in a tree, in Tala garden.

Another egg, one of two (the other having fallen through the nest, and been broken), taken on same day, from a nest in the wood at Tala.

These average $1\frac{6}{40} \times \frac{33}{40}$ inch, and are of the usual pigeon type, oval, and of a pure white colour.

The nest is a platform of small twigs, loosely built, and was placed in a tree. Sometimes as many as two or three nests, all containing eggs, may be found on the same tree.

22. *Rhea americana* (Lath.)—native name "Avestruz" for the adult, and "Nandu" for the young birds.—The Rhea, or South American ostrich, although now much reduced in numbers, on the southern bank of the River Plate, is still pretty numerous in Uruguay, where a law was passed about two years ago for their protection. Its range extends from Bolivia, Paraguay, and Southern Brazil, at least as far as the Straits of Magellan, and Dr Cunningham (*Proc. Zool. Soc.* 1871, p. 105), says it may be regarded as certain, that a species of Rhea occurs to the south of the Strait, in the large eastern island of Tierra del Fuego, but whether it be referable to this species or not is not known. It is still found in considerable numbers in Patagonia, where an allied species, *Rhea darwinii*, is also found to the south of the Rio Negro. Towards its northern limits in Paraguay and Brazil, it is, however, somewhat rare. They frequent the open plains, where their food consists of roots, grass, seeds, and other vegetable matter, also locusts. They are particularly fond of the red berries of *Empetrum rubrum*, a common plant on these plains. They are captured in large numbers by the Indians and half-breeds, who chase them on horseback, and surround them. These are armed with the bolas, which consist of two wooden or metal balls, coupled together by a long thong of hide, and which, being skilfully swung round the head of the rider, are at length launched at the bird, and becoming entangled round their legs and body, causes it to fall an easy prey to its pursuers. They, however, run with great swiftness, and frequently manage to escape. Their feathers, although a marketable commodity, are not by any means equal in value to those of the African ostrich, bringing to their captors only from one to two dollars per pound, while those of the latter are worth to the ostrich farmers of the Cape about £5, or 25 dollars per pound weight. Doubtless, however, ostrich farming would be found profitable in

South America, and would probably be the means of preserving this interesting bird from the total extinction by which it is menaced; the slaughter of late years, for the sake of the feathers, averaging, according to Mr Harting, about 400,000 per annum, the consequence of which has been, that the species has already disappeared from nearly half of the district of the river Plate. The export of feathers from Argentine ports in 1874, was about sixty tons, of the value of £26,537. Two-thirds of these were sent to Havre. The cock bird is somewhat larger than the hen, and, curious to relate, performs the duty of hatching and tending the young, a fact which is also related of the emu. Several females lay in one nest, all of whose eggs are thus hatched. The number of the eggs in the nest varies from twenty to forty or fifty, and, according to Azara, even to seventy or eighty. He incidentally mentions the number laid by a female, in confinement, to be about seventeen. A great number of eggs are also laid, scattered over the country, deserted by the birds. These are called by the natives, who use them for food, "huachos." They are said to keep a long time, and to be very palatable. The cock bird sits very close upon the nest, and is said at times to attack those who approach it. A late traveller, Mr J. Beerbohm, mentions that, if one egg even is broken, or abstracted from the nest during the absence of the male bird, he will, on returning, at once detect the theft, and become so furious, that he will smash the remaining eggs to pieces, and dance frantically round the nest. This curious fact is confirmed by my correspondent at Tala, who informs me that, disbelieving this, only six eggs of the forty-one which it contained were taken from the nest mentioned below, and on returning the next day, the whole remaining thirty-five were found dashed to pieces by the indignant bird. The rhea is easily tamed, and stands the climate of this country, with almost no protection in winter. A gentleman of my acquaintance, in the south of Scotland, has had them alive in his possession for some years.

Six eggs, taken from a nest in the campo at Tala, on 2d December 1879. The nest contained forty-one eggs.

These six eggs average nearly 5 × 4 inches in size, and are

of a dirty yellow colour, somewhat resembling those of the African ostrich.

The nest was formed of a quantity of dry grass, scraped together, probably what had been growing on the spot, and is described by my correspondent as resembling a "horse's bed."

23. *Scolopax frenata* (Ill.)—native name "Aguatero."—This snipe is a pretty common species throughout Brazil, Paraguay, and all the southern part of South America. Its habits and appearance much resemble those of our common snipe, of which in these countries it seems to be the representative. Near Buenos Ayres it is common in every marsh, and by no means rare at Tala.

Clutch of three eggs, taken 4th October 1879, from a nest situated near the river.

Other two clutches of three eggs each, taken on 6th and 22d October 1879, respectively in similar situations.

These average $1\frac{23}{40} \times 1\frac{5}{40}$ inch. They are similar in colour and markings to those of the common snipe, but in shape are more blunt at the small end, in that respect approaching those of the dotterel. Some of the varieties are not unlike those of a tern. They only lay three eggs, and the nest is a mere scrape, and without lining of any description.

24. *Vanellus cayennensis* (Gm.)—native name "Terutero."—This plover is found generally distributed throughout South America, to the Straits of Magellan. To a certain extent resembling in its habits our lapwing, it is equally noisy at the breeding season, and pertinaciously follows the intruder on its breeding haunts, uttering the rather unpleasant cry from which it derives its name, and flying within two feet of his head in a most annoying and menacing manner. It is thus very troublesome to the sportsman, as its screams are unceasing, and disturb every other living creature. One author, however, rather extols its watchful habits, as useful to the traveller, in making known the presence of the robber, as no one can pass its haunts unchallenged, even in the night. In winter it frequents the neighbourhood of towns in large flocks. The wing of this bird is armed with a curious sharp spur, resembling that on the leg of a barndoor cock, but its use seems not understood.

Clutch of four eggs, taken 22d October 1879, from a nest in the campo of Tala.

Another clutch of four eggs, taken 23d October 1879, from a similar nest.

These average $1\frac{3}{4\,0} \times 1\frac{1}{4\,0}$ inch in size, and are identical in shape and appearance with those of the lapwing. The nest, also, exactly resembles that of the same bird, consisting merely of a shallow cavity, formed by the bird's body, and lined with a few straws. They have two, and sometimes three broods in the season.

XIV. *On the "Olfactory Tubercle" as a Specific Character in Simple Ascidians.* By W. A. Herdman, Esq., D.Sc., F.L.S., Demonstrator of Zoology in the University of Edinburgh.

(Read 20th April 1881.)

Savigny appears to have been the first writer on Ascidians who mentions the "olfactory tubercle." * In his celebrated "Mémoires sur les Animaux sans Vertèbres," he figures and describes (under the name of "tubercule antérieur") this curious organ in many different species. Since that time its structure has been investigated more or less fully, and its function discussed by nearly every writer on the Tunicata.

The organ lies at the anterior end of the branchial sac on its dorsal edge, generally in close relation to the nerve ganglion. It is posterior to the circlet of tentacles, from which it is separated by the smooth area called by Kupffer the "zona præbranchialis." This zona præbranchialis on the two sides is bounded posteriorly by the right and left peripharyngeal bands, which, as they approach the dorsal region, bend posteriorly for a short distance so as to enclose a wedge-shaped space before they unite at the anterior extremity of the dorsal lamina. This space, in which the

* Julin's recent investigations (*see* Archives de Biologie, t. ii., fasc. 1) have thrown grave doubts on the supposed sensory function of this organ. I still call it the "olfactory tubercle," as that is the name under which it is best known in this country, but do not mean thereby to express any opinion on its nature as a sense organ.

Erratum to Mr Dalgleish's *Notes on a Collection of Birds and Eggs from Central Uruguay.*

I regret to find that I have inadvertently adopted for one of the species in this paper, a name given only provisionally by Dr Sclater, who, on farther comparison and examination of additional and more adult specimens lately received, has pronounced it to belong to another species. My remarks therefore on this species, described at page 246 as *Synallaxis hudsoni* (Sclater), will apply to *Anumbius acuticaudatus* (Less.) modified as follows: *Delete* from "*Synallaxis*" on page 246 fourth line from bottom, to "ground" on second line of page 247; and *read* "*Anumbius acuticaudatus* (Less.)—native name 'Espinero,' or thorn bird.—This is a common species at Tala, and resident. It is also found in Brazil and the Argentine Republic. It lives on the ground, and unlike many of its allies frequents dry ground. It is chiefly remarkable for the size of its nest, which is very large for the size of the bird. It is much persecuted by the Toldo, who often takes possession of its nest, and sometimes for this purpose will even kill and eject the young of the rightful owner."

olfactory tubercle is placed, is often of considerable importance in specification, and consequently it is convenient to have a name for it. I intend in my descriptions to refer to it as the "peri-tubercular area."

The olfactory tubercle is always situated in the peri-tubercular area, which is an offshoot from the zona præbranchialis. The tubercle in its simplest form, as described by Kupffer,* consists of a pair of parallel ridges separated by a groove, becoming continuous with each other at their ends, and bent so as to describe a curve. In the more complex forms the essential structure remains the same—two ridges continuous at their ends, and separated by a more or less narrow groove. The curves into which this band may be twisted, and the resulting shapes of the organ, seem infinite—thus necessitating the determination of how far certain differences are specific characters, and how far merely individual variations.

Even when first described, this organ was considered a specific character, as Savigny, in his "Tableau Systématique," refers to the condition of the olfactory tubercle in the descriptions of several of his species. After Savigny's time it became customary not to discuss the condition of the branchial sac and other internal organs, but merely to describe the external appearance of the animal, and it is only of late years that systematists have recognised the necessity for an account of the internal anatomy, as well as of the external appearance, in the proper description of a species. The olfactory tubercle has again come into use as a diagnostic character, and its condition in different species is found in the descriptions of Lacaze-Duthiers, Kupffer, and Traustedt.

That certain shapes of the olfactory tubercle are characteristic of certain species is undoubted, and I believe also that it would be proper to add this organ to the list of characters given for groups of a higher rank (genera and families), as in some of these, certain general types of tubercle seem to be characteristic. In addition to these points, I wish, however, to lay special stress on the fact that, while varying

* Kupffer—II. Jahresberichte d. Komm. z. Untersuch. d. deutsch. Meere, Kiel, 1874, p. 201.

according to the family, genus, and species, the olfactory tubercle also varies, and often very greatly, according to the individual,* and that therefore great care must be exercised, in using the condition of this organ as a specific character, not to endow it with more than its proper value.

In order to test the range of variation, and determine, if possible, how far it is safe to trust to this organ as a specific character, I have taken a few of the commoner species of Simple Ascidians, of which I had a sufficient number of specimens to render my results accurate, and to justify me in drawing conclusions as to typical forms, etc., and have examined the condition of the olfactory tubercle in a considerable number of individuals of each species. The chief results of this investigation are the following:

Ascidia virginea, O. F. Müller.

In this species the olfactory tubercle is of large size, and extremely variable in form. The peri-tubercular area is small, generally not accommodating more than one-third or one-half of the tubercle; as a result of this a considerable portion of it lies in the zona præbranchialis, and in many cases it extends anteriorly to within a short distance of the tentacular circlet. The peri-pharyngeal band as a rule extends considerably higher up the tubercle on the left side than it does on the right, thus rendering the peri-tubercular area unsymmetrical.

The olfactory tubercle is elliptical or ovate in general form; the posterior end is broad and rounded, while the anterior extremity shows endless variations in shape, consequent upon the extent to which the ends or "horns" are developed, and the manner in which they are curved. I have only seen one specimen which was an exception to the rule that the posterior end should be broad and regularly rounded; this individual (Fig. 1) had the lower (posterior) band considerably thickened at the posterior end, so that this part projected into the posterior angle of the peri-tubercular area.

The simplest form of tubercle noticed in this species was one in which the two horns at the anterior end were bent slightly inwards so as to point towards each other with-

* I find that Kupffer suspected this to be the case (*loc. cit.*).

out meeting, and without being coiled. The opening was anterior and central, and the form of the tubercle perfectly symmetrical.

Fig. 1.

Fig. 2.

Fig. 3.

Several slight variations from this occur, caused by want of symmetry either in the general form or in the curve of the horns; frequently one of the latter is more strongly bent than the other, which may overlap it slightly, thus rendering the opening oblique. In other cases, still of simple form, one of the horns may be nearly or altogether straight, while the other is curved inwards; this may occur to either horn, and the straighter one may sometimes be inclined slightly outwards at the anterior end, thus leading towards a very marked variety in which the one horn is bent outwards and the other inwards (that is, both in the same direction) to such an extent that their extremities point posteriorly (as in Fig. 1).

Returning to the simple form just described, we find another marked variation (Fig. 2) caused by the horns having been bent suddenly inwards and downwards, so as to be directed towards the posterior end of the organ.

One form occurs in which the horns, after curving towards each other to such an extent as almost to obliterate the opening, suddenly bend anteriorly, and run in that direction for a short distance. This leads into those forms in which both horns bend outwards (or in opposite directions—one to the right, the other to the left); this occurs to various extents, and may be symmetrical or not, one horn being frequently longer or more coiled than the other (Fig. 3).

One form still remains to be mentioned; it is quite exceptional, and was only noticed once. The right horn is so little developed as not to extend half way up the

tubercle, and is not coiled. The left horn, on the other hand, is very long; it first curves inwards towards the right side, then turns anteriorly, and finally sweeps outwards to the left, the resulting form being an S reversed.

It is extremely difficult in this species to say which variety is characteristic, and in fact it is not possible to take any one form as typical in all its details. The description should leave a margin for variation, and the following is sufficiently general to admit of all ordinary individual variations, and at the same time characteristic enough to be of use in identifying the species:

Olfactory tubercle large; elliptical or ovate in general form. Posterior end broad and rounded, sides equally curved. Aperture anterior, central, not wide. Horns of moderate length, curved either outwards or inwards.

Ascidia aspersa, O. F. Müller.

The olfactory tubercle in this species, though of considerable size, is smaller than that of *Ascidia virginea*. The peritubercular area is generally symmetrical, and contains about one-half of the tubercle. The zona præbranchialis is narrow, and the anterior end of the tubercle comes within one-third or one-half its height of the base of the tentacular circlet.

The form of the tubercle is much more constant, and the variations are fewer, than in the case of the last species. In four varieties noticed the shape was symmetrical, the opening being anterior and central, and the horns being equal and similarly coiled. The simplest form (Fig. 4) is one in which the tubercle was of an ovate shape, the posterior end being broad and rounded, while the horns anteriorly were bent inwards slightly, so as to approach each other, but without meeting. In the next variety the tubercle was transversely elliptical, and the horns, bent inwards as in the last, were coiled so as to describe three-fourths of a circle, leaving a wide opening between them. Another variety differed only in having the broad posterior end slightly pushed up in its centre, so as to form a re-entering angle, and in the horns being less coiled,

and pointing directly posteriorly. The fourth simple variation is, like the two last, transversely elongated and symmetrical, but is of a triangular form (Fig. 5). The base or posterior end is very long, and is slightly concave posteriorly in its centre; the sides slope anteriorly towards the narrow opening where the horns are bent abruptly inwards, and then coiled outwards and upwards, so as to form a complete circle.

Fig. 4.

Fig. 5.

Fig. 6.

We now come to the commoner forms in which the tubercle is not symmetrical, and in these it is easy to notice that the prevailing type is an irregular lozenge, of which the left hand angle is directed posteriorly, and the right hand one anteriorly (Fig. 6). The posterior end of the organ forms an angle which occupies the angle of the peri-tubercular area. Both horns are bent inwards, but the left one usually passes internally to the other, and is more coiled, the right hand one being sometimes straight, and almost invariably overlapping the left horn, so as to render the opening oblique or pointing anteriorly and to the left.

In one unsymmetrical variety noticed, and which occurred only once, the opening was directed anteriorly, and to the right. This was caused by the feeble development of the right horn, which, in place of overlapping the left one, was bent inwards, and approached it so as to reduce the size of the opening and change its direction.

It is comparatively easy in this species to fix upon a characteristic form of tubercle; it is undoubtedly the lozenge-shaped unsymmetrical variety with the right horn overlapping the left one, and directing the opening obliquely anteriorly and to the left.

The following description may be considered typical for the species:

Olfactory tubercle moderately large; irregularly lozenge-

shaped. Posterior end angular, sides unequal. Aperture anterior, directed slightly to the left, not wide. Horns rather short, always bent inwards, unsymmetrically curved, the right overlapping the left.

ASCIDIA SCABRA, O. F. Müller.

The peri-tubercular area is here moderately deep, and is usually symmetrical. It accommodates from three-fourths to the whole of the tubercle, which is thus kept at a considerable distance from the base of the tentacles.

The olfactory tubercle is simple. In its usual form it is oval, with the posterior end rounded, and the horns sloping inwards towards each other, leaving an aperture of variable width between them.

Two marked variations occurred in the specimens I have examined. In the first the general shape of the tubercle was normal, but at the anterior end the extremities of the horns were both bent sharply to the right and posteriorly, so that one horn turned inwards and the other outwards. The left side of the tubercle also was slightly longer than the right, consequently the left horn occupied a position anterior to the other. This tubercle was rather larger than is usual in the species.

Fig. 7.

The other variation was caused by the left horn being greatly developed, while the right was quite rudimentary (Fig. 7). At the anterior end the two sides approach and almost meet, as in the typical form, then the left horn bends anteriorly, and takes a wide sweep outwards, describing about three-fourths of a circle. If the right side was still more rudimentary, and the left horn more developed, this variety would easily approach the sigmoid form described in *Ascidia virginea*.

There is little difficulty in this species in considering as typical the simple form, which may be described as follows:

Olfactory tubercle rather large, symmetrical, ovate. Posterior end rounded, wider than anterior; sides equally curved. Aperture anterior, moderately wide. Horns equal, sloping slightly inwards.

Ascidia plebeia, Alder.

Here the peri-tubercular area is almost entirely rudimentary. At the utmost it encloses only the extreme posterior end of the tubercle, and in many individuals there is no depression at all, so that the tubercle rests on a flat surface, and is, in its entire extent, within the zona præbranchialis.

Fig. 8.

Fig. 9.

The tubercle is small, and is very variable in form. It is very commonly U or V shaped, with the horns turned inwards. The posterior end is generally rounded and the sides parallel, one of them very frequently extending further forward than the other. In this case the shorter side, which is sometimes the right and sometimes the left, is generally quite straight, while the longer one is bent inwards. A variety occurs (Fig. 8) in which the tubercle is rather broad, and both horns are bent sharply inwards and extend down the inside of the tubercle, running parallel with the sides, almost to the posterior end. There is another form in which both horns are turned inwards, but in which the form of the tubercle is very different. It is narrow at the posterior end, and the sides slope outwards; moreover, the one side is considerably longer than the other, and the horns do not point posteriorly, being coiled.

In the V-shaped type, which occurred once or twice, the tubercle, leaving the horns out of consideration, was sym-

metrical, the posterior end was narrow, and the sides sloped outwards (Fig. 9). Both horns were turned outwards, but were generally of unequal length, leaving a wide opening between them. A variety of this occurred once in which the left horn was almost rudimentary, being very slightly turned outwards, while the right horn was of large size, curved first outwards, then turned anteriorly and inwards, so as to describe a semicircle.

There are so many slight variations in this species, that it is rather difficult to fix upon a typical form of tubercle, consequently the following description has not been made very strictly, in order to leave a margin for slight variations.

Olfactory tubercle small, oblong, usually U-shaped. Posterior end rounded or pointed, never wider than the anterior end; sides symmetrical, one sometimes longer than the other. Aperture anterior, very variable in width. Horns frequently unequal, usually turned inwards.

Corella parallelogramma, O. F. Müller.

In this species the olfactory tubercle is small, and fairly constant in form. Only a few variations were found, but one or two of these were peculiar. The peri-tubercular area varies in size, in some individuals only accommodating about one-half of the tubercle, while in others it includes the whole organ. There is usually a considerable space between the top of the tubercle and the base of the tentacles.

The olfactory tubercle is semicircular in outline, the anterior end being broad and the posterior convex. In the simplest form noticed, and the one that occurred most fre-

Fig. 10.

Fig. 11.

quently, the organ is a simple curve, a semicircle, or a crescent, with the horns directed anteriorly, diverging, not

coiled, and having a wide opening between them; frequently in this form one of the sides is longer than the other (Fig. 10).

The first complication is produced by the turning-in of the extremities of the horns. This may take place in one or in both, but has not been noticed to any great extent.

A variety which occurred several times is produced from the simple semicircular form by a thickening at the right and left extremities of the posterior part or middle of the curve, resulting in two short projections like rudiments of a pair of posteriorly directed horns.

Another variety, which was only noticed once, is a very remarkable form (Fig. 11). It resembles the last one in having the posterior projections, but here they are rather more developed. The anterior horns are somewhat irregular, the right one is bent slightly outwards and the left one inwards. The great peculiarity, however, is the presence of a third anterior horn, nearly equalling the other two in size, and springing from near the middle of the posterior part of the organ. This is the only olfactory tubercle I have noticed in which such a process running up the centre of the organ was present.

The characteristic form in this species is undoubtedly the simple curve, and may be described as follows:

Olfactory tubercle small, simple, semicircular or crescentic. Posterior end rounded, sides symmetrical. Aperture anterior, wide.

Ciona intestinalis, Linn.

In this species the olfactory tubercle is small, and is pretty constant in shape. The peri-tubercular area is small, and in many cases can hardly be said to be present; the tubercle therefore lies in the zona præbranchialis, but does not extend nearly up to the base of the tentacles.

The usual form of tubercle (Fig. 12) has its lateral extent rather greater than its antero-posterior, is perfectly symmetrical, and has both horns turned inwards. The simplest modification is when, without any change in the plan, the tubercle is rendered unsymmetrical by the greater development of one

of the horns, or by one side of the organ being more raised than the other.

Occasionally a variety is found in which one of the horns is turned outwards, so that both are coiled in the same direction. Heller, in his "Untersuchungen ueber die Tunicaten des Adriatischen Meeres," mentions having met with this form.

Fig. 12.

Fig. 13.

A third variation, which only occurred in one specimen, is caused by both horns being turned outwards, one to the right, the other to the left (Fig. 13). The former is very little developed, having merely a slight hook at its end, but the latter is of considerable length, and sweeps round in a large curve, forming nearly a complete circle. The appearance of this variety is peculiar, and very unlike the normal form.

In this species the variations occur very rarely, consequently the following description of the typical form may be used for purposes of specification:

Olfactory tubercle small, symmetrical, broadly cordate. Posterior end broad, and rounded; sides equally curved. Aperture anterior, moderately wide. Horns equal, both turned inwards.

Styela grossularia, Van Beneden.

In this species the peri-tubercular area is comparatively large, and encloses the whole of the olfactory tubercle. The zona præbranchialis is narrow, and the tubercle is only separated from the base of the tentacles by a space equal to its own length.

The tubercle is small and very variable in form. There are two marked types, each of which has several varieties. The first has no aperture; the tubercle varies in shape from nearly circular through various ellipses to a very elongated

form, but in all is completely closed. In these the greater diameter is always placed transversely.

The second type is more normal. The shape of the tubercle is still very variable, but horns and an aperture are always present, though the position and size of the latter are by no means constant. The form of the tubercle is usually lozenge shaped or rudely triangular, the posterior end is pointed, and in the commonest form the aperture is at the anterior end but directed to one side, most frequently the left; the horns are both turned in, but are unequal, the right one being generally much larger than the left, and coiled spirally. The simplest form of this type is a tubercle which forms about three-fourths of a circle, the posterior end being rounded, the horns bent towards each other, and the aperture wide and placed rather to the left of the anterior end. The first complication is caused by the horns being turned more sharply inwards, so as to diminish the size of the aperture; the shape has also varied a little, the posterior end having become more angular. This leads to the typical form in which the posterior end is pointed, the aperture at the left side of the anterior end and the horns both turned in, one, however (the right), being much larger than the other. An exact sinistral variety of this has occurred once or twice, in which the aperture was at the right side, and the left horn was the larger of the two (Fig. 14).

Fig. 14.

Fig. 15.

A very marked variation (Fig. 15) still remains to be mentioned. The shape of the tubercle was triangular, but the base was posterior and the angle anterior, while the aperture was at the left extremity of the base. The left, or, in this case, posterior horn was rudimentary, while the right or anterior one was enormously developed, turned inwards quite to the centre of the tubercle. This variety is evidently derived from the typical form by the disproportionate development of the two sides, the right horn from its enormous size occupying all the

anterior part of the tubercle and forcing the aperture down to the posterior end.

Kupffer, in his description of this species, states that the olfactory tubercle is "ringsum geschlossen." He has evidently met with the first variation which is here described. This, however, I do not consider as the typical form, and I give the following description as being that of the tubercle most commonly met with, though I think it very doubtful whether it should be considered in this case as part of the specific description :

Olfactory tubercle small, unsymmetrical, more or less triangular. Posterior end pointed, sides unequal. Aperture moderately wide, rather to the left side of the anterior end. Horns unequal, both turned inwards, the right usually much the larger and coiled spirally.

Molgula sp.*

This species shows a marked difference from all the previous ones in the relative sizes of the olfactory tubercle and the peri-tubercular area. The zona præbranchialis is narrow, but its dorsal offshoot, the peri-tubercular area, is very large. It is triangular and nearly symmetrical; the small olfactory tubercle is placed nearly at its posterior end, in the angle at the anterior extremity of the dorsal lamina (see Fig. 16).

The tubercle is very small, simple, and almost constant in shape, but varies in the direction in which it is turned.

Fig. 16.

Sometimes it is symmetrical and oval, the posterior end being rounded but rather narrow, the aperture wide and placed at the anterior end, and the horns slightly developed and turned towards each other.

* Probably an undescribed form.

The other varieties noticed differed first in shape, which was crescentic, semicircular, or U shaped; and, secondly, in position, the tubercle being turned so that the aperture was directed anteriorly, to the right side (Fig. 16), posteriorly, or in any intermediate position, but never, in any specimen I have examined, to the left side.

The olfactory tubercle in this species is very constant in shape, more so than in any other species of which I have investigated a large number of specimens.

I have no hesitation, therefore, in giving the following description as characteristic of the species:

Olfactory tubercle small, simple, usually symmetrical and crescentic in shape. Aperture very wide, usually anterior, or on the right side, rarely posterior. Horns not developed.

These eight species of Simple Ascidians, in which I have examined the form of the olfactory tubercle, represent five genera belonging to the three great families of the Ascidiidæ, the Cynthiidæ, and the Molgulidæ. I think, therefore, that I am fully warranted in considering that these species may be taken as representative of, and my results as applying to, at least the group of *Ascidiæ Simplices*.

In no one of the species examined was the form and position of the olfactory tubercle found constant, but the amount of individual variation changed greatly according to the species. The *Molgula* was the most constant species, while *Ascidia virginea*, and *Ascidia plebeia* were the most variable. The points I wish to bring out therefore are:

1. That in Simple Ascidians the form of the "olfactory tubercle" may be different in individuals of the same species.
2. That the range of this individual variation changes according to the species.

The result of this is, that the form of the olfactory tubercle may be a characteristic feature in some species and not in others, and I hold that whether it is a characteristic feature or not for any particular species can only be determined by the examination of a large number of specimens.

XV. *The Invertebrate Fauna of the Firth of Forth.* By George Leslie, Esq., M.B., C.M.; and W. A. Herdman, Esq., D.Sc., F.L.S. Part III., comprising the Porifera, Coelenterata (*pars*), Vermes, Pycnogonida, and Mollusca.

(Read 20th April 1881.)

PORIFERA.

The nomenclature of the Fibrous Sponges adopted in this article is that of Professor Oscar Schmidt, as given in his "Grundzüge einer Spongien-Fauna des Atlantischen Gebietes," Leipzig, 1870. A number of the specimens we have found in the Forth are not yet identified.

CALCAREA.

Grantia compressa (Fabr.).

Not uncommon in the littoral zone. We have obtained it at Elie, Wardie, and in other parts of the shore on both sides of the estuary.

G. ciliata (Fabr.).

Frequent on roots of *Laminaria*, in the lower littoral zone, at North Berwick, etc.

Leuconia nivea (Grant).

Under surface of sheltered rocks, Prestonpans Bay (*Flem.*).

We have obtained this species at Aberdour, and near Elie.

FIBROSA.

Chalinidæ.

Chalinula oculata (Pallas).

We have found this species on the pier at Newhaven. It is the *Chalina oculata* of Bowerbank.

Isodictya infundibuliformis (Bowerb.).

Firth of Forth (*Ed. Mus.*).

Isodictya simulans (Johnst.).

We obtained this species at Elie.

I. palmata (Johnst.).

We have dredged this species in the Firth, and have also found it on Newhaven pier.

RENIERIDÆ.

Amorphina panicea (Pallas).

Firth of Forth (*Ed. Mus.*).

The *Halichondria panicea* of Bowerbank. It is very abundant, encrusting rocks about low water mark.

A. coalita (O. F. Müll.).

Firth of Forth, very common (*Flem.*); Firth of Forth (*Ed. Mus.*).

The *Halichondria coalita* of Bowerbank. We have dredged it in the Forth on several occasions.

A. paciscens (O. Schmidt).

This species was first described from a specimen found on the beach at Portobello by the German Expedition of 1872.

SUBERITIDÆ.

Suberites domuncula (Nardo).

Firth of Forth (*Flem.*); beach, Portobello (*O. Schmidt*).

The *Hymeniacidon suberea* of Bowerbank.

Vioa celata (Grant).

The *Hymeniacidon celata* of Bowerbank. It is very common in dead shells, on the oyster bank, and elsewhere.

CTENOPHORA.

I. SACCATÆ—

CYDIPPIDÆ.

Pleurobrachia pileus (Eschsch.).

Firth of Forth (*F. E. S.*).

We have obtained this species in abundance

in the late summer and autumn months in Granton Harbour, Leith Roads, Elie, and elsewhere. It usually occurs in swarms.

II. Eurystomæ—

Beroidæ.

Idyia ovata (Less.).

Firth of Forth (*F. E. S.*).

We have obtained this form in the autumn, off Elie. It is the *Beroe ovata* of Eschscholtz.

ACALEPHA.

Aurelia aurita (Linn.).

Very common in the autumn months; often stranded on the beach.

Cyanea capillata (Eschsch.).

Common in all the lower reaches of the Firth, in the autumn.

ZOANTHARIA.

I. Actinaria—

Sagartiadæ.

Actinoloba dianthus (Ellis).

Firth of Forth, on rocks uncovered only at very low tides (*T. S. W.*); Firth of Forth (*Colds.*); Firth of Forth (*M'B.*).

Sagartia troglodytes (Johnst.).

Firth of Forth (*T. S. W.*); Firth of Forth (*M'B.*).

This species is commonly found on the shore at very low water. We have obtained it at Elie, Aberdour, and elsewhere.

The variety *S. prasina* of Gosse, found by Dr Strethill Wright in the Forth, is an inhabitant of deeper water. We have dredged a considerable number of specimens of it in the neighbourhood of Inchcolm in 10 to 18 fathoms. It is characterised by having the disc and tentacles of a bright green colour.

Sagartia ornata (Holdsworth).
Firth of Forth (*M'B.*).

ACTINIADÆ.

Actinia mesembryanthemum (Ellis and Sol.).
Leith shore (*R. J.*); Firth of Forth (*M'B.*). This is a very abundant species in the lower littoral zone, on exposed rocks and in rocky ledges of pools left by the retiring tide. A well-grown specimen was taken from the Forth in 1828, by Sir John Graham Dalyell, who kept it for twenty years. It then passed successively into the hands of Professor Fleming and of Dr M'Bain. It is now in the possession of Mr Sadler, curator of the Royal Botanic Garden, Edinburgh, and continues in vigorous health.
The variety *A. chiococca* was found near the Bass Rock by the German North Sea Expedition.

BUNODIDÆ.

Tealia crassicornis (O. F. Müll.).
Firth of Forth (*M'B.*); Firth of Forth, 30 fathoms (*F. E. S.*).
Common in the littoral and upper laminarian zones, and extending into deeper water. We have dredged it on the oyster banks and elsewhere. It sometimes attains a very large size—a specimen which we found near Aberdour measuring nearly a foot in diameter.
The *Actinia gemmacea*, Leith shore (*R. J.*), was probably this species.

ILYANTHIDÆ.

Halcampa crysanthellum (Peach).
Bass Rock, 24 fathoms (*F. E. S.*).

Halcampa fultoni (T. S. W.).
Granton pier (*T. S. W.*).

The following MEDUSOID GONOPHORES have been noticed in the Firth of Forth:

Oceania pileata (Forskal).
Firth of Forth, surface (*F. E. S.**).

Lizzia sp.
Mouth of Forth, surface (*F. E. S.*).

Eucope lucifera (Forbes).
Firth of Forth (*F. E. S.*).

Phalidium viridicans (Leuckhart).
Firth of Forth (*F. E. S.*).

Tima bairdi (Johnst.).
Burntisland Harbour, winter (*E. F.*).

Bougainvillea brittanica (Forbes).
Entrance to Firth (*E. F.*).
Taken in surface-net east of Inchkeith last summer (*nob.*).

Goodsirea mirabilis (T. S. W.).
Near Queensferry (T. S. W., in *Proc. Roy. Phys. Soc.*, vol. iii.).

Stomobrachium octocostatum (Forbes).
Near Queensferry and Granton (T. S. W., in *Proc. Roy. Phy. Soc.*, vol. iii.).

Acanthobrachia inconspicua (T. S. W.).
Granton Harbour (T. S. W., in *Proc. Roy. Phy. Soc.*, vol. iii.).

VERMES.

A very complete list of the Vermes of the eastern coast of Scotland will be found in Dr M'Intosh's "Marine Fauna of St Andrews." We have worked little at this interesting but difficult group, and the following is a very imperfect list of the forms to be found in the Forth. In its preparation we have derived much assistance from Dr M'Intosh's work, and have followed his arrangement of the group. We have

* II. Jahresb. d. Komm. z. Untersuch. d. deutsch. Meere, III., Coelenterata.

used the lists prepared by Professor Möbius, of the worms obtained in the German Expedition of 1872, and for the list of species from the Forth in the British Museum, we are indebted to Johnston's Catalogue of non-Parasitical Worms.

CHÆTOGNATHA.

Sagitta bipunctata (Quoy and Gaimard).
Off St Abb's Head, 3 fathoms (*Möb.*).

GEPHYREA.

Sipunculidæ.

Phascolosoma strombi (Mont.).
Bass Rock (*Möb.*).
P. procerum (Möb.).
Bass Rock, 24 fathoms (*Möb.*).

Priapulidæ.

Priapulus caudatus (Lam.).
Leith (*Colds.*).

DISCOPHORA.

Hirudinea.

Pontobdella muricata (Linn.).
Common as a parasite on the skate, and dredged in 12 fathoms, below Inchkeith (*nob.*).

Malacobdellea.

Malacobdella grossa (O. F. Müll.).
Off Elie (*nob.*).
M. valenciennæi (Blanchard).
In *Mya truncata*, Firth of Forth (*Johnst. Cat.*).

POLYCHÆTA.

Aphroditidæ.

Aphrodite aculeata (Linn.).
Kirkcaldy Bay, 9 fathoms; Aberlady

Bay, 5 fathoms; shore, North Berwick, Newhaven, Portobello, etc. (*nob.*).

POLYNOIDÆ.

Lepidonotus squamatus (Linn.).
Firth of Forth (*Brit. Mus.*); Portobello, 0-1 fathom, under stones (*Möb.*).
This is a very common species on the oyster banks, and in all parts of the Firth.

Polynoë cirrata (Pallas).
Portobello Sands, under stones (*Möb.*).

Halosydna gelatinosa (Sars).
Off May Island, 8 fathoms (*nob.*).

SIGALIONIDÆ.

Sigalion idunæ (Rathke).
Bass Rock, 24 fathoms (*Möb.*).

NEPHTHYDIDÆ.

Nephthys cœca (Fab.).
Bass Rock, 24 fathoms (*Möb.*); beach, Aberdour, etc. (*nob.*).

N. johnstoni (Johnst.).
Firth of Forth (*Brit. Mus.*).

PHYLLODOCIDÆ.

Phyllodoce laminosa (Sav.).
Black Rocks, Leith (*Brit. Mus.*).

Eulalia viridis (O. F. Müll.).
Off Longniddry, 14 fathoms, etc. (*nob.*).

NEREIDÆ.

Nereis pelagica (Linn.).
Abundant in all parts of the Firth.

Hediste diversicolor (O. F. Müll.).
Leith shore (*Möb.*).

Alitta virens (Sars).
Beach, near Aberdour (*nob.*).

GLYCERIDÆ.

Glycera alba (Müll.).
Bass Rock, 24 fathoms (*Möb.*).

OPHELIIDÆ.

Ammotrypane aulogaster (H. Rathke).
Bass Rock, 24 fathoms (*Möb.*).
Ophelia acuminata (Œrst.).
Firth of Forth (*Brit. Mus.*).

TELETHUSIDÆ.

Arenicola marina (Linn.).
Very abundant in sand at low water mark.
Ephesia gracilis (Rathke).
Firth of Forth (*Brit. Mus.*).
Trophonia plumosa (M. Edwards).
Firth of Forth (*Brit. Mus.*); Wardie, between tide marks, Aberlady Bay, 9 fathoms; North Channel, 18 fathoms, etc. (*nob.*).
T. glauca (Malmgren).
Off St Abb's Head, 40 fathoms (*Möb.*).

SPIONIDÆ.

Cirratulus cirratus (O. F. Müll.).
Portobello (*Möb.*).

HERMELLIDÆ.

Sabellaria anglica (Ellis).
Granton,—tubes only (*Brit. Mus.*).

AMPHICTENIDÆ.

Pectinaria belgica (Pallas).
Firth of Forth (*Brit. Mus.*).

TEREBELLIDÆ.

Lanice conchilega (Pallas).
Common in the upper laminarian zone all along the shores. Dredged in 18, 9, and 5 fathoms (*nob.*).

Thelepus circinatus (Fab.).
Firth of Forth, 30 fathoms; Bass Rock, 24 fathoms (*Möb.*).

SABELLIDÆ.

Sabella pavonina (Sav.).
Very common on the oyster bank, and in deeper water; also in sand at Aberdour at very low water.

SERPULIDÆ.

Serpula vermicularis (Linn.).
Common, off Inchkeith, 5 fathoms, etc. (*nob.*).

Spirorbis borealis (Davd.).
Very plentiful on Algæ at low water.

S. lucidus (Mont.).
On Hydroids, etc., in all parts of the estuary.

PYCNOGONIDA.

This group has been recently separated from the CRUSTACEA and ARACHNIDA, with which it was formerly associated, and arranged as an independent class of the ARTHROPODA.

NYMPHONIDÆ.

Nymphon gracile (Leach).
Not uncommon among stones and weeds between tide marks, and we have dredged it off May Island, 14 fathoms; Kirkcaldy Bay, 6 fathoms; off Inchkeith, 5 fathoms; and in many other parts of the estuary.

PHOXICHILIDÆ.

Pycnogonum litorale (O. F. Müll.).
Common between tide marks, but also found in deep water. We have dredged it in 18 fathoms. We found specimens near Inchcolm, at the end of April of this year, having large masses of ova attached to them.

MOLLUSCA.

This list comprises the true Mollusca only. Of the groups which were formerly united under the title Molluscoida, and which are now generally regarded as members of the extensive and somewhat heterogeneous type Vermes, the Polyzoa and Tunicata have already been considered; while of the third, the Brachiopoda, there are no living representatives in the Firth of Forth.

On account of the comparatively advanced state of our knowledge of Molluscan faunas, and the special share of attention which is usually given to the group by collectors, we have reason to believe that this is more nearly complete than any of our other lists.

The nomenclature and arrangement are those given in Gwyn Jeffreys' well-known work.* We have frequently, however, mentioned also synonyms used by Forbes and Hanley ("A History of the British Mollusca," 1853), and other authors, especially when these were the names under which the species had been recorded from the Forth.

Dr M'Bain's extensive catalogue† was the foundation of the present list. The Mollusca of the German Expedition of 1872, which we have already had occasion to refer to several times, were reported on by Metzger and Meyer,‡ and we are indebted to their work for the localities of several species, five of which had not previously been recorded from the Firth of Forth.

Mr F. M. Balfour, F.R.S., has kindly given us a list of a few Mollusca which he dredged in the neighbourhood of Dunbar, including one of the rarest species in our list, *Pleurophyllidia lovéni.*

We desire to express our thanks to the Rev. J. M'Murtrie, M.A., for much valuable assistance. He kindly revised our MS., and from his notes added species, localities, and remarks, which, coming from one with his wide knowledge of British shells, and experience of the conchology of the Firth of

* "British Conchology," by J. Gwyn Jeffreys, F.R.S. London, 1863.

† "The East Neuk of Fife," by the Rev. Walter Wood. Edinburgh, 1862.

‡ Jahresb.—VIII., Mollusca.

Forth, were of very great importance to us. These contributions are subscribed (*M.*) in the list. As of peculiar interest we may mention his discovery of *Lepton squamosum* in shell sand at North Berwick. This species belongs to the south and south-west coasts of England, and the only Scotch locality mentioned in Jeffreys' "British Conchology" is Oban (Barlee). Mr M'Murtrie informs us that he has found the shell at Bamborough, and this, we believe, is the only place recorded where it has been found on the east coast.

LAMELLIBRANCHIATA.

Anomiidæ.

Anomia ephippium (Linn.).

Firth of Forth (*M'B.*); the so-called variety *aculeata*, which is common, and also var. *squamula* (young), at Granton, etc.; var. *cylindrica* on tangle stems at Leith and Granton (*M.*).

This species is very common in the Firth. It occurs adhering to dead shells, etc., on the oyster bank; and is also found at low water mark attached to the roots and stems of *Laminaria*, etc.

We have taken the varieties *cylindrica*, *aculeata*, and *squamula* at Aberdour.

A. patelliformis (Linn.).

On North Berwick shore (*M.*).

We have taken this species in from 5 to 7 fathoms, off Inchkeith.

A. patelliformis, var. *striata*.

On Dunbar shore (*M.*); Firth of Forth (*M'B.*).

Both *A. patelliformis* and the variety *striata* are common on roots of tangle cast up by storms at Newhaven (*M.*).

Ostreidæ.

Ostrea edulis (Linn.).

Firth of Forth (*M'B.*, etc.).

The oyster occurs chiefly in the Firth in a few fathoms of water (5 to 10) on the bank stretching west from Inchkeith, and is dredged for the market by the fishermen from Newhaven, etc. We regret to say it is by no means plentiful.

The forms (they are scarcely varieties) *hippopus* and *deformis* occur (*M.*).

PECTINIDÆ.

Pecten pusio (Linn.).

Firth of Forth (*M'B.*).

Taken living in a tangle root, after a storm, on Craigroyston shore—attached by a byssus. Single valves are not uncommon on North Berwick shore, etc. (*M.*).

P. varius (Linn.).

Firth of Forth (*M'B.*).

P. opercularis (Linn.).

This is probably the commonest Lamellibranch in the Firth. It is abundant on the so-called "oyster bank" and other localities, and is dredged in large quantities by the Newhaven fishermen.

Specimens, with pure white shells, are brought in alive by storms somewhat plentifully at Craigroyston (*M.*).

Gwyn Jeffreys states that specimens of this species from the Firth of Forth "are much larger than usual," and that a specimen in his collection from Portobello measures $3\frac{2}{10}$ths inches long, and nearly 4 broad.

The variety *lineata*, with intermediate forms, is often taken by the Newhaven fishermen (*M.*).

P. septemradiatus ? (Müll.).

It is probably this species which is mentioned in Fleming's "British Animals"

under the name of *Pecten glaber* as being rare in the Firth of Forth.

Pecten tigrinus (Müll.).

Firth of Forth (*M'B., and Ed. Mus.*).

Taken alive in Newhaven Harbour. It had probably been thrown away by the fishermen (*M.*).

We have dredged this species in the Firth, and have found it cast ashore at Elie.

P. tigrinus, var. *costata.*

Single valves of this, and also of the species, are found on the North Berwick shore (*M.*).

P. similis (Laskey).

Fifeshire (*Flem.*); Firth of Forth (*Laskey*).

P. maximus (Linn.).

Firth of Forth (*M'B.*).

Single valves are cast up at Craigroyston, but not plentifully (*M.*).

We dredged this species last summer off the Isle of May, in 8 fathoms.

MYTILIDÆ.

Mytilus edulis (Linn.).

Firth of Forth (*M'B.*, etc.).

Extremely common between tide marks and at low water on many parts of the shore. It occurs in profusion on the muddy beach at Wardie and Newhaven, where it is collected by the fishermen.

M. edulis, var. *incurvata.*

Abundant on sloping walls between Granton and Leith, wedged in between the stones (*M.*).

M. edulis, var. *pellucida.*

Granton (*M.*).

We have taken this variety at Wardie.

M. edulis, var. *galloprovincialis.*

Cast up on Craigroyston shore (*M.*).

Mytilus modiolus (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*).

Common at North Berwick, living at very low water, and in rock pools between tides. It is also frequently cast up alive along the whole coast. Large specimens are found in Newhaven Harbour, brought in by the fishermen (*M.*).

This species is frequently met with in dredging in the Firth. We have taken it to the east of Inchkeith, in 18 fathoms; west of Inchkeith, in 5 fathoms; off Fidra, in 7 fathoms; and north-west of the Isle of May, in 26 fathoms.

M. adriaticus (Lamk.).

Firth of Forth (*E. F.*).

Modiolaria marmorata (Forb.).

Off Elie (*M'B.*); Firth of Forth (*Ed. Mus.*). Plentiful on Newhaven shore in roots of *Laminaria*, after storms (*M.*).

Imbedded in the test of *Ascidia virginea*, not uncommon in 5 to 10 fathoms, especially on the bank west of Inchkeith. We have also taken it at low water at Wardie.

M. discors (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*).

Living with *M. marmorata* in roots of *Laminaria* on Newhaven shore after storms.

We have dredged this species in the Firth, and have also collected it at Portobello.

M. nigra (Gray).

Off Dudgeon (*Thomas*); Firth of Forth (*Ed. Mus., and M'B.*).

I have a specimen from Mr Damon, Weymouth, marked "Black Rocks, Leith." I have sought for it at the lowest spring tides, without success (*M.*).

Crenella decussata (Mont.).

Firth of Forth (*J. G. J.*).

Single valves, and occasionally a perfect specimen, in drifted shell sand at North Berwick (*M.*).

ARCIDÆ.

Nucula nucleus (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*).

We have dredged this species off Largo Bay, and near Inchkeith, in 7 fathoms.

N. nitida (Sowerby).

Single valves of *Nucula* on this shore are usually of this species. I have taken perfect specimens (which, however, did not contain the animal) at very low water, Craigroyston, and at Cramond Island (*M.*). We have dredged this species off Elie, and west of Inchkeith, in 5 fathoms, and have also collected it on the beach at Largo Bay.

N. tenuis (Mont.).

Firth of Forth (*J. G. J.*).

Leda minuta (Müll.).

Firth of Forth (*M'B.*, under the name of *Leda caudata*).

Small single valves occur in the drifted shell sand at North Berwick. The posterior extension is short. They are either the var. *brevirostris*, or the young state of the species (*M.*).

Pectunculus glycimeris (Linn.).

Firth of Forth (*M'B.*).

Occasionally in Newhaven Harbour, doubtless brought in by the fishermen (*M.*).

Arca tetragona (Poli).

Firth of Forth, rare (*Flem.*, under the name of *Arca fusca*).

KELLIIDÆ.

Montacuta substriata (Mont.).

On *Spatangus purpureus*, off Inchkeith (*Com. Mar. Zool.*); off the Isle of May, on *Spatangus purpureus*, 1854 (*M'B.*).

M. bidentata (Mont.).

Single valves on Edinburgh shores. Perfect specimens not uncommon in drifted shell sand at North Berwick (*M.*).

M. ferruginosa (Mont.).

Firth of Forth (*F. and H., and M'B.*).

Single valves in drifted shell sand at North Berwick (*M.*).

Lasaea rubra (Mont.).

North Berwick shore; not a plentiful shell here (*M.*).

Kellia suborbicularis (Mont.).

In drifted shell sand at Dunbar and North Berwick. I have also taken it living at North Berwick in tangle root (*M.*).

We have dredged this species in the Firth.

Mr M'Murtrie informs us that at Alnmouth, Northumberland, he has taken both the species and the variety *lactea*, living in soft stone in rock pools at low water.

LUCINIDÆ.

Lucina borealis (Linn.).

Firth of Forth (*M'B.*).

Occasionally on the beach at Newhaven, North Berwick, etc. (*M.*); Elie (*nob.*).

Axinus flexuosus (Mont.).

Firth of Forth (*M'B.* as *Lucina flexuosa*), Cramond Island, and adjoining shore,

chiefly single valves, but sometimes a perfect specimen (*M.*).

We have collected this species at Aberdour, etc.

CARDITIDÆ.

Cyamium minutum (Fabr.).

Living among small seaweeds in rock pools, etc., at North Berwick and Dunbar. Very common at the Isle of May. A clear white form is rare at North Berwick (*M.*).

CARDIIDÆ.

Cardium echinatum (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*); Bass Rock, 24 fathoms, and St Abb's Head 40 fathoms (*Metz. and Mey.*).

Taken alive between Granton and Cramond Island. Specimens with the prickles worn smooth are not uncommon, and bear a great resemblance to *C. tuberculatum*, and have been mistaken for it. Good prickly specimens are frequent in Newhaven Harbour, brought in by the fishermen. Single valves occur along the whole coast (*M.*).

This species is not uncommon in the Firth. We have dredged it off Longniddry, in 7 fathoms; west of Inchkeith, in 12 fathoms; and have collected it on the beach at Largo and Portobello.

C. fasciatum (Mont.).

We have a specimen of this species from Elie.

C. edule (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*).

This species is common. We have taken it at Cramond, Newhaven, Elie, North Berwick, Aberdour, etc.

Cardium norvegicum (Spengler).

Firth of Forth (*M'B.*); off Inchkeith (*Com. Mar. Zool.*).

We have dredged this species off the Isle of May, in 8 fathoms, and near Portobello.

CYPRINIDÆ.

Cyprina islandica (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*); Firth of Forth, very low tides (*F. and H.*).

I have taken it alive, and apparently *in situ*, in muddy sand, between Granton and Newhaven at very low water (*M.*).

We have dredged this species east of Inchkeith, 18 fathoms; north-west of the Isle of May, 26 fathoms; and have found it frequently on the beach at Portobello, etc.

Astarte sulcata (Da Costa).

Firth of Forth (*M'B.*).

We have dredged this species in the Firth.

A. sulcata, var. *elliptica*.

Firth of Forth, dead valves (*M'B.*).

A. compressa (Mont.).

Firth of Forth, not rare on the oyster banks in 7 to 14 fathoms (*F. and H.*); Firth of Forth (*M'B.*).

A. compressa, var. *striata*.

Firth of Forth, plentiful (*J. G. J.*).

A living specimen cast up on the beach in Canty Bay. Single valves are common on the shore between Canty Bay and North Berwick (*M.*).

We have dredged this species near Inchkeith, in 7 fathoms.

A. triangularis (Mont.).

Single valves, and sometimes a perfect specimen, in drifted shell sand at North Berwick (*M.*).

VENERIDÆ.

Venus exoleta (Linn.).

Firth of Forth (*M'B.*); Firth of Forth, 7 fathoms (*F. and H.*).

Frequently cast up alive at North Berwick; common at Newhaven, brought in by fishermen (*M.*).

We have dredged it west of Inchkeith in 5 fathoms, and at Newhaven.

V. liucta (Pult.).

Firth of Forth (*M'B., and F. and H.*); Bass Rock, 24 fathoms (*Metz. and Mey.*).

Cast up alive at Leven, Fife, and on the North Berwick shore, near Fidra. It appears to be less common in this Firth than it is in St Andrew's Bay (*M.*).

We have dredged it in 7 fathoms.

V. fasciata (Da Costa).

Firth of Forth (*M'B.*).

Cast up on the shore at North Berwick (*M.*).

We have taken this species on the shore at Anstruther.

V. fasciata, var *radiata*.

Cast up on the shore at North Berwick (*M.*).

V. casina (Linn.).

Dead valves occasionally at North Berwick, especially on the east shore (*M.*).

V. ovata (Penn.).

Firth of Forth (*M'B.*).

Dead valves at Cramond Island and Canty Bay (*M.*).

V. gallina (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*); Bass Rock, 24 fathoms (*Metz. and Mey.*).

Alive on Cockenzie shore at low water, sometimes without any markings on the shell (*M.*).

We dredged this species last summer in Aberlady Bay in 9 fathoms, and have found it alive on the beach at Portobello, Aberdour, etc.

Venus gallina, var. *gibba*.

Between Granton and Cramond Island, with intermediate forms (*M.*).

Tapes virgineus (Linn.).

Firth of Forth (*Ed. Mus., and M'B.*).

Good specimens in Newhaven Harbour, sometimes milk-white (*M.*).

We have found this species at Portobello.

T. pullastra (Mont.).

Firth of Forth; plentiful at low water, especially near Newhaven and Cramond (*F. and H.*); Firth of Forth (*Ed. Mus., and M'B.*); Dalmeny, where it grows to a large size—$2\frac{1}{4}$ inches broad—occasionally pure white (*M.*); beach between Portobello and Fisherrow (*Metz. and Mey.*).

We dredged it last summer off the Isle of May, in 8 fathoms, and have collected it at Elie, Cramond, and Portobello.

A monstrosity, showing the foliaceous structure of the shell, gathered at Cockenzie, has the front margin, as it were, of three shells, but only one hinge-line (*M.*).

T. pullastra, var. *perforans*.

Living in soft rock at Wardie and North Berwick at low water. Semi-fossil at Longniddry and other places (*M.*).

T. decussatus (Linn.).

Beach between Portobello and Fisherrow (*Metz. and Mey.*).

Lucinopsis undata (Penn.).

Firth of Forth (*M'B., F. and H., and Ed. Mus.*); Bass Rock, 24 fathoms (*Metz. and Mey.*).

Cast up by storms at Portobello, Granton, etc. (*M.*).

We have dredged this species in Largo Bay.

TELLINIDÆ.

Tellina crassa (Gmelin).

Firth of Forth (*M'B., and Knapp*).

Single valves common at North Berwick, especially on the east shore near the harbour (*M.*).

T. balthica (Linn.).

Firth of Forth (*M'B.*, as *T. solidula*); Firth of Forth (*Ed. Mus.*); Common at Leith, etc., living between tide-marks (*M.*).

We have collected this species in Largo Bay, Aberdour, etc.

T. tenuis (Da Costa).

Firth of Forth (*M'B., and Ed. Mus.*).

Common at Granton, Portobello, etc., living at low water, and brought up by storms (*M.*).

We have found this species in Largo Bay.

T. fabula (Gronovius).

Firth of Forth (*M'B.*); with the preceding, common at Granton, Cramond Island, Portobello, etc. (*M.*).

We have collected it at Portobello, and in Largo Bay.

Psammobia tellinella (Lamk.).

Single valves on the beach at North Berwick and Canty Bay, but not common (*M.*).

We have collected this species in Largo Bay.

P. ferröensis (Chemn.).

Bass Rock, 24 fathoms (*Metz. and Mey.*); Firth of Forth (*M'B., F. and H., and Ed. Mus.*); on Craigroyston shore and Dirleton shore, brought up by storms (*M.*).

We have dredged it in Aberlady Bay, 9 fathoms, and off Leith.

Psammobia vespertina (Chemn.).

Firth of Forth (*M'B., and J. G. J.*).

Donax vittatus (Da Costa).

Firth of Forth (*M'B.*); Craigroyston, Aberlady, and Dirleton shores (*M.*).

We have found it at Elie and Largo.

Mactridæ.

Mactra solida (Linn.).

Beach at Fisherrow (*Metz. and Mey.*); Firth of Forth (*Ed. Mus., and M'B.*).

We have dredged it off Elie.

M. solida, var. *truncata*.

Firth of Forth (*M'B., and J. G. J.*); Firth of Forth, 7 fathoms (*F. and H.*).

Lives with the species, and with intermediate forms, on the shore from Newhaven to Cramond Island (*M.*).

We have obtained this variety on Cramond Island.

M. solida, var. *elliptica*.

Firth of Forth (*M'B., and F. and H.*).

M. subtruncata (Da Costa).

Firth of Forth (*F. and H., and M'B.*); Granton and Portobello (*M.*).

We have dredged it in the Firth.

M. subtruncata, var. *striata*.

Granton, not common (*M.*).

M. subtruncata, var. *inaequalis*.

Dead shells at South Queensferry (*M.*).

M. stultorum (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*); Portobello (*M.*).

This species is sometimes found cast up in large quantities on Portobello sands after storms.

Mactra stultorum, var. *cinerea*.
Mouth of the Almond, etc. (*M.*).

Lutraria elliptica (Lamk.).
Firth of Forth (*M'B., Ed. Mus., and F. and H.*); Portobello (*M.*).
We have collected this species at Portobello, and at Caroline Park.

Scrobicularia prismatica (Mont.).
Firth of Forth (*F. and H.*); off Elie (*M'B.*).
Occurs sparingly alive on the sands at very low water between Granton and Cramond Island, especially towards Cramond Island. Empty shells, with the valves still united, are a little commoner (*M.*).
We have found this species on the shore west from Aberdour.

S. nitida (Müller).
St Abb's Head, 40 fathoms (*Metz. and Mey.*).

S. alba (Wood).
Firth of Forth (*Ed. Mus.*); Off Elie (*M'B.*).
Frequent at Portobello, etc., living at low water, and on the beach brought up by storms (*M.*).

S. piperata (Bellon.).
Firth of Forth (*F. and H., and M'B.*); Caroline Park, shells well preserved, but not living; they are in a bed of blue clay between tides (*M.*).
We dredged this species last summer in 5 fathoms, to the south-west of Inchkeith.

Solenidæ.

Solen pellucidus (Penn.).
Firth of Forth (*M'B., and Thomas and Knapp*); brought up by the tides between Portobello and Leith, and between Granton and Cramond Island, but not plentiful (*M.*); east of Inchkeith (*J. Hunter Bar-*

ron); Bass Rock, 24 fathoms (*Metz. and Mey.*, as *Cultellus pellucidus*).

Solen ensis (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*).

We have taken *Solen ensis* frequently.

S. siliqua (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*).

We dredged it lately west of Inchkeith, in 4 fathoms.

S. siliqua, var. *arcuata*.

Newhaven shore (*M.*).

Anatinidæ.

Thracia prætenuis (Pult.).

Firth of Forth (*M'B., and F. and H.*).

T. papyracea (Poli).

Firth of Forth (*Ed. Mus., and M'B.*).

We have taken this species frequently at Portobello, Cramond, etc.

T. convexa (W. Wood).

Firth of Forth, dead shells (*M'B.*).

Single valves not unfrequent on the shore near Edinburgh, at low water, especially towards Cramond Island (*M.*).

T. distorta (Mont.).

Firth of Forth (*F. and H., and M'B.*).

Corbulidæ.

Neæra cuspidata (Olivi).

Off Portseaton and Fidra, 17 fathoms (*Thomas*); Firth of Forth (*F. and H., and M'B.*).

Corbula gibba (Olivi).

Firth of Forth (*Ed. Mus., M'B., and F. and H.*).

Single valves are frequent on the shores at North Berwick, Newhaven, Granton, and South Queensferry. I have taken a

perfect specimen (young) on the shore at Cramond Island (*M.*).

We have dredged this species frequently in the Firth — in Aberlady Bay, 9 fathoms; west of Inchkeith, 5 to 7 fathoms, etc.

Myidæ.

Mya arenaria (Linn.).

Firth of Forth (*M'B., Ed. Mus., and F. and H.*); Bass Rock, 24 fathoms (*Metz. and Mey.*); Granton, living at low water west from Leith pier (*M.*).

We have found this species in Largo Bay.

M. arenaria, var. *lata.*

Biel sands, Longniddry, and Newhaven. Rather common in west harbour, Granton, (*M.*).

We have found this variety at Aberdour.

M. truncata (Linn.).

Firth of Forth, from low water to 7 fathoms (*F. and H.*); Firth of Forth (*M'B.*). Living at Granton, Craigroyston, and Cramond Island (*M.*).

We have found this species at Portobello, and have dredged it in 4 fathoms, to the west of Inchkeith.

M. binghami (Turt.).

Firth of Forth (*F. and H., and M'B.*).

Saxicavidæ.

Saxicava rugosa (Linn.).

Firth of Forth (*M'B.*); Firth of Forth, 7 fathoms (*F. and H.*).

Taken living, and apparently at home, in pure sand, between Granton and Cramond Island (*M.*).

This species is very common from the

upper laminarian zone downwards. We have dredged it east of Inchkeith, in 18 fathoms; off Longniddry, in 14 fathoms; west of Inchkeith, in 5 fathoms; and have collected it at Aberdour, Elie, and Largo.

Saxicava rugosa, var. *minuta*.

Granton, North Berwick, and Dunbar (*M.*). We have some specimens of this variety from Largo Bay.

S. rugosa, var. *arctica*.

Firth of Forth (*M'B., and Cunningham*). On tangle roots at Granton, etc. (*M.*).

Gastrochænidæ.

Gastrochæna dubia (Penn.).

On Craigroyston beach, after a storm, I picked up a fossil coral, containing in cavities fresh but empty shells of *G. dubia* (*M.*).

Pholadidæ.

Pholas dactylus (Linn.).

Firth of Forth (*M'B.*).

P. candida (Linn.).

Firth of Forth (*F. and H., Ed. Mus., and M'B.*); Newhaven, containing the animal (*M.*).

We have found dead valves at Cramond Island, Aberdour, and in Largo Bay.

P. crispata (Linn.).

Firth of Forth (*F. and H., M'B., and Ed. Mus.*); Granton, west of harbour, alive at very low water, also North Berwick (*M.*); near Cramond (*J. Hunter Barron*).

We have found this species alive at Wardie, and at Cramond, and have found dead valves at Largo and other places.

SOLENOCONCHIA.

Dentaliidæ.

Dentalium entalis (Linn.).

Bass Rock, 24 fathoms (*Metz. and Mey.*); Firth of Forth (*Ed. Mus.*, *M'B.*, etc.).

Rare on the shore at Granton, Leith, and North Berwick (*M.*).

We have dredged this species off Inchkeith, in 9 fathoms; off Largo Bay, etc. It is often obtained by the fishermen adhering to the long lines; dead specimens are not uncommon on some parts of the shore, as Largo Bay, Elie, and Aberdour.

GASTROPODA.

I. Cyclobranchiata—

Chitonidæ.

Chiton fascicularis (Linn.).

Firth of Forth (*M'B.*, *F. M. B.*).

On tangle roots, Craigroyston shore, after a storm. At North Berwick alive on under side of stones in rock pools, at low water, but not plentiful (*M.*).

We have taken this species at low water mark, near Elie.

C. cinereus (Linn.).

Firth of Forth (*F. M. B.*, *M'B.*, under the name of *Chiton asellus*).

We have dredged this species frequently in a few fathoms.

C. marginatus (Penn.).

Firth of Forth (*M'B.*); between tide marks (*F. M. B.*); beach between Portobello and Fisherrow (*Metz. and Mey.*).

Very large at end of East Pier, Leith (near Martello Tower), at very low water. Length of dried specimens 0·9 inch; breadth, 0·55 (*M.*).

This species is common between tide marks at Wardie, Elie, and other parts of the Firth. Fleming, in his "British Animals," mentions having found a specimen at Newhaven, with only six valves.

Chiton ruber (Lowe).

Firth of Forth (*M'B.*); between tide marks (*F. M. B.*); abundant on roots and stems of *Laminaria* on North Berwick shore, after storms (*M.*).

C. marmoreus (Fabr.).

Rare on Black Rocks, Leith (*Knapp*).

We have taken this species in 5 fathoms, about half a mile to the west of Inchkeith.

II. Pectinibranchiata—

Patellidæ.

Patella vulgata (Linn.).

Extremely common between tide marks on rocky shores. Large, heavy specimens at Cramond Island.

P. vulgata, var. *picta*.

Granton and South Queensferry (*M.*).

We have taken this variety on the rocks at Joppa. Specially common at North Berwick, at low water.

P. vulgata, var. *cærulea*.

Granton and North Berwick, not rare. It shades off, through intermediate forms, into var. *picta* (*M.*).

We have obtained it at Wardie.

P. vulgata, var. *depressa*.

The *Patella athletica* of Forbes and Hanley. This well-marked variety is frequent along the whole North Berwick coast, at very low water, and in rock pools between tides. It grows in its longest diameter to 2·3 inches. It becomes rare as we go up the Firth, being evidently not an estuary

shell. I have not found it beyond Gullane shore, where I took a solitary living specimen. It is abundant at the Isle of May (*M.*).

Note.—Where a spring of fresh water rises on the shore above low water mark, a little to the east of Granton East Harbour, a thin form of *P. vulgata*, pale, and with a silky surface, takes the place of all other forms, and is plentiful. It may be due merely to the influence of fresh water; but I suspect a corroding quality in the spring. *Tectura testudinalis* in the same place is worn very thin. If this form of *P. vulgata* had permanence, its appropriate name would be var. *sericea* (*M.*).

Helcion pellucidum (Linn.).

Firth of Forth (*M'B.*).

Good specimens common on *Laminaria* all along the North Berwick coast, and at Dunbar and Cramond Island (*M.*).

We have found this species at extreme low water, at Elie, Aberdour, and North Berwick. It frequents the stems and roots of *Laminaria*.

H. pellucidum, var. *lævis*.

Common in the hollow part (or under side) of roots of *Laminaria* at North Berwick; also at Dunbar and Longniddry (*M.*).

We obtained the variety also at Elie and Aberdour, and on the beach in Largo Bay.

Tectura testudinalis (Müller).

Firth of Forth (*M'B.*); beach between Portobello and Fisherrow (*Metz. and Mey.*); Granton (*M.*).

The shell is sometimes an inch long on the Edinburgh shores. The markings vary greatly, and there is a blue form bearing

the same relation to the species as the variety *cærulea* does to *Patella vulgata* (*M.*). This species is common on the shores of the Firth. We have taken it at Aberdour, Wardie, etc.

Tectura virginea (Müller).

Firth of Forth (*M'B., Ed. Mus.*); Dunbar, at North Berwick living on the rocks at very low water (*M.*).

FISSURELLIDÆ.

Emarginula fissura (Linn.).

Firth of Forth (*Ed. Mus.*); empty shells on North Berwick beach (*M.*).

We have found this shell on the beach at Largo Bay.

CAPULIDÆ.

Capulus hungaricus (Linn.).

Alive off Inchkeith, May 1861 (*M'B.*); off Inchkeith (*Com. Mar. Zool.*); small empty shells on North Berwick beach (*M.*).

We have dredged it alive several times in the Firth,—Aberlady Bay, 9 fathoms; and east of Inchkeith, 7 fathoms. We have also found it cast ashore on Portobello beach.

TROCHIDÆ.

Trochus helicinus (Fabr.).

Not rare in shell sand at North Berwick and Dunbar (*M.*).

T. magus (Linn.).

I have found a worn shell on Craigroyston beach, but I do not suppose that this species inhabits the Firth of Forth (*M.*).

T. tumidus (Mont.).

Firth of Forth (*M'B., and Ed. Mus.*).

We have taken this species in 7 fathoms, off Inchkeith.

Trochus cinerarius (Linn.).

Firth of Forth (*M'B., and Ed. Mus.*); beach between Portobello and Fisherrow (*Metz. and Mey.*).

This is a very common species in the Firth about low water mark. It is abundant at Granton, Wardie, Aberdour, Elie, and other parts of the coast. We have also dredged it off Inchkeith in 5 fathoms.

T. zizyphinus (Linn.).

Firth of Forth (*M'B.*).

Not common here. I have found dead shells on the beach at Edinburgh and Dirleton (*M.*).

LITTORINIDÆ.

Lacuna crassior (Mont.).

Firth of Forth (*Ed. Mus., and M'B.*).

Not rare on the beach at Wardie, Granton, and North Berwick (*M.*).

L. divaricata (Fabr.).

Firth of Forth (*Ed. Mus., and M'B.*, as *L. vincta*).

Common on *Laminaria*, etc., at Granton, North Berwick, Dunbar, and other places (*M.*).

L. divaricata, var. *canalis.*

With the species at North Berwick, etc., somewhat common at Granton (*M.*).

L. divaricata, var. *quadrifasciata.*

On the beach at Leven, Fife (*M.*).

L. pallidula (Da Costa).

Firth of Forth (*Ed. Mus., J. G. J., and M'B.*).

Common on *Laminaria*, etc., at Granton, North Berwick and Dunbar (*M.*).

We found this species in Largo Bay.

Littorina obtusata (Linn.).

Firth of Forth (*Ed. Mus., and M'B.*);

Granton (*M.*); beach between Portobello and Fisherrow (*Metz. and Mey.*).
Very common in the littoral zone at Wardie, Aberdour, Elie, etc.

Littorina obtusata, var. *fabalis*.
Not uncommon at Dunbar, etc.; a doubtful variety (*M.*).

L. neritoides (Linn.).
Firth of Forth (*M'B.*).
North Berwick, on the harbour rocks, above high water mark. Abundant and well grown at the landing-place on the Isle of May (*M.*).

L. rudis (Maton).
Firth of Forth (*Ed. Mus., and M'B.*); Granton (*M.*); beach between Portobello and Fisherrow (*Metz. and Mey.*); very common at Wardie, Elie, Aberdour, etc.

L. rudis, var. *saxatilis*.
North Berwick, living with *L. neritoides*; and dead in shell sand (*M.*).

L. rudis, var. *lineata*.
Granton. Is this a variety, or a common form? (*M.*).
Common at Wardie.

L. rudis, var. *tenebrosa*.
Granton and Dunbar (*M.*).

L. littorea (Linn.).
Firth of Forth (*M'B., and Ed. Mus.*); Granton, sometimes orange-red (*M.*).
Very common on the beach at Wardie, etc.

Rissoa reticulata (Mont.).
We have found this species on the shore, near Aberdour.

R. punctura (Mont.).
Also found near Aberdour.
Common in the shell sand at North Berwick and Dunbar (*M.*).

Rissoa costata (Adams).

Common in the shell sand at North Berwick and Dunbar (*M.*).

R. parva (Da Costa).

Firth of Forth (*M'B.*).

Not so common as the variety *interrupta*. Good specimens at North Berwick and Dunbar (*M.*).

R. parva, var. *interrupta*.

Very common on seaweeds at low water at Granton, North Berwick, etc. (*M.*).

We have found this variety on the shore near Aberdour.

R. striata (Adams).

Firth of Forth (*M'B.*).

Alive among small seaweeds in rock pools at low water, North Berwick. Common in shell sand at Dunbar, North Berwick, Belhaven, Granton, etc. (*M.*).

We have found it in sand at Elie.

R. striata, var. *arctica*.

Occurs with the species, but is less common (*M.*).

R. vitrea (Mont.).

Rare in the shell sand at North Berwick (*M.*).

It has been found at Dunbar by Bingham.

R. semistriata (Mont.).

Firth of Forth, 7 fathoms (*F. and H.*). Common in the shell sand at North Berwick (*M.*).

R. cingillus (Mont.).

North Berwick, in the shell sand, but not plentiful (*M.*).

We obtained this species on the shore near Largo.

Hydrobia ulvæ (Penn.).

Alive at Pefferburnfoot, Aberlady; dead on the beach at Cramond, Newhaven, North

Berwick, etc. Living abundantly on mud flats at Bo'ness (*M.*).

White specimens of *H. ulvæ* come ashore at Newhaven. As they are dead, and may be only bleached, it would be unsafe to say that they are the var. *albida* (*M.*).

We have found this species in Largo Bay.

SKENEIDÆ.

Skenea planorbis (Fabr.).

Firth of Forth (*M'B.*).

Abundant on *Cladophora* and other sea-weeds at Dunbar, North Berwick, and Granton (*M.*); Elie (*nob.*).

Homalogyra atomus (Philippi).

In shell sand between North Berwick and Canty Bay, not plentiful (*M.*).

VERMETIDÆ.

Cæcum trachea (Mont.).

Firth of Forth (*Ed. Mus.*).

C. glabrum (Mont.).

Not rare in fine shell sand at North Berwick (*M.*).

TURRITELLIDÆ.

Turritella terebra (Linn.).

Firth of Forth (*M'B.*, as *T. communis*); Firth of Forth, 30 fathoms (*Metz. and Mey.*, as *T. ungulina*); Firth of Forth (*Ed. Mus.*).

Alive on the shore at very low water, near Cramond Island (*M.*).

This species is very common in the Firth; in some spots—*e.g.*, off the east side of Inchkeith, 12 fathoms; off Aberdour, 5 fathoms; and Kirkcaldy Bay, 9 fathoms—the dredge comes up almost full of dead shells of this species, imbedded in slimy grey mud.

Turritella terebra, var. *nivea*.
Not rare on the shore, both east and west from Edinburgh. Specially common towards Cramond Island, and on the shore east from Burntisland (*M.*).

T. terebra, var. *gracilis*.
Granton and towards Cramond Island, not common (*M.*).

PYRAMIDELLIDÆ.

Aclis unica (Mont.).
Somewhat rare in fine shell sand on North Berwick beach (*M.*).

Odostomia rissoïdes (Hanley).
In shell sand, North Berwick (*M.*).

O. rissoïdes, var. *alba*.
Shell sand, North Berwick (*M.*).

O. rissoïdes, var. *nitida*.
Shell sand, North Berwick (*M.*).

O. rissoïdes, var. *dubia*.
Shell sand, North Berwick. This species is highly variable, and forms occur which it is difficult to assign to any of these varieties (*M.*).

O. pallida (Mont.).
Not unfrequent in the shell sand at North Berwick (*M.*).

O. acuta (Jeffreys).
Occasionally in the shell sand, North Berwick (*M.*).

O. acuta, var. *umbilicata*.
Not unfrequent in the shell sand, North Berwick (*M.*).

O. unidentata (Mont.).
Somewhat common in the shell sand at North Berwick and Dunbar (*M.*).

O. decussata (Mont.).
Somewhat rare in shell sand, North Berwick (*M.*).

Odostomia indistincta (Mont.).
Not rare in shell sand, North Berwick (*M.*).

O. indistincta, var. *brevior.*
In shell sand, North Berwick (*M.*).

O. interstincta (Mont.).
Common in shell sand at North Berwick and Dunbar (*M.*).

O. spiralis (Mont.).
Common in shell sand at North Berwick and Dunbar (*M.*).

O. acicula (Philippi), var. *ventricosa.*
Rare in the shell sand at North Berwick. My specimens do not depart widely from the species, *i.e.*, the whorls are but slightly ventricose (*M.*).

EULIMIDÆ.

Eulima distorta (Deshayes).
Rare in fine shell sand, North Berwick (*M.*).

E. bilineata (Alder).
Not rare in shell sand at North Berwick and Dunbar (*M.*).

NATICIDÆ.

Natica catena (Da Costa).
Firth of Forth (*Ed. Mus., and M'B.*).
Alive on Leith Sands, at very low water; cast up at Joppa, alive; Longniddry (*M.*).

N. alderi (Forb.).
Firth of Forth (*M'B.*); Bass Rock, 24 fathoms (*Metz. and Mey.*).
Dead shells on the beach at Elie, Craigroyston (worn), and North Berwick (*M.*).
We have taken this species in Largo Bay.

N. alderi, var. *lactea.*
North Berwick (*M.*).
Along with the species in Largo Bay.

N. islandica (Gmel.).
Haddocks' stomachs, Firth of Forth (*Dr Knapp*).

VELUTINIDÆ.

Lamellaria perspicua (Linn.).

North Berwick in shell sand, small and not abundant (*M.*).

Velutina lævigata (Penn.).

Firth of Forth (*Ed. Mus.*); on the beach at Dunbar, North Berwick, Longniddry, Granton, and Cramond (*M.*).

This species is not uncommon in a few fathoms of water. We have dredged it in Kirkcaldy Bay, 9 fathoms; off Inchkeith, 5 fathoms; and in Aberlady Bay, 9 fathoms. We have also collected it dead on the beach at Largo Bay.

APORRHAIDÆ.

Aporrhais pes-pelecani (Linn.).

Firth of Forth (*M'B.*); off Inchkeith (*Com. Mar. Zool.*); Firth of Forth, 30 fathoms (*Metz. and Mey.*).

Brought in alive by the Newhaven fishermen. On the beach at North Berwick and Craigroyston (*M.*).

Not uncommon. We have dredged it in Largo Bay and off Kirkcaldy, and have also obtained it on the beach at Largo.

CERITHIIDÆ.

Cerithium reticulatum (Da Costa).

A worn fragment on the beach at North Berwick. I do not think the species lives on this coast. However I found a perfect though dead shell on the Northumbrian shore at Alnmouth (*M.*).

III. SIPHONOBRANCHIATA—

BUCCINIDÆ.

Purpura lapillus (Linn.).

Firth of Forth (*M'B.*).

This species is extremely common in the littoral zone in the Firth.

Purpura lapillus, var. *imbricata.*

Granton and Newhaven. I have not found a good specimen of this variety at North Berwick, though the species varies very much there as regards colour (*M.*); Firth of Forth (*Dr Knapp*).

This variety is common at Wardie, Aberdour, etc., between tide marks.

Buccinum undatum (Linn.).

Firth of Forth (*Ed. Mus., and M'B.*).

Forms occur which approach the varieties *littoralis* and *striata*, but they are not very well marked (*M.*).

Very common on the oyster bank and in other parts of the Firth. We have also taken it between tide marks at Wardie and Aberdour.

Muricidæ.

Murex erinaceus (Linn.).

Firth of Forth (*Ed. Mus.*).

Dead shells of *M. erinaceus* are not rare on the beach at North Berwick. I took a living specimen in a rock pool at very low water there (*M.*).

Trophon truncatus (Ström.).

Wardie, Portobello, and North Berwick (*M.*); Firth of Forth (*Ed. Mus.*).

We have dredged this species in the Firth, and have also taken it at Wardie.

Fusus antiquus (Linn.).

Firth of Forth (*Ed. Mus.*); Firth of Forth, 30 fathoms (*Metz. and Mey.*); Off the Isle of May (*M'B.*).

This species is not uncommon. We have dredged it in Kirkcaldy Bay, 9 fathoms; north-east of Inchkeith, 12 fathoms; and

between Inchkeith and the Isle of May, 18 fathoms. Often brought to Newhaven pier in the fishing boats.

Monstr. *varicosum*, with several persistent outer lips, whitish, and large ($6\frac{1}{4}$ inches long). Newhaven Harbour, brought in by the fishermen (*M.*).

Fusus gracilis (Da Costa).

Firth of Forth, 30 fathoms (*Metz. and Mey.*). We have obtained it from the fishing boats at Newhaven. Probably it is this species which is referred to by M'Bain under the name of *Fusus islandicus*.

F. propinquus (Alder).

Firth of Forth, 30 fathoms (*Metz. and Mey.*); off the Isle of May, 1854 (*M'B.*).

F. jeffreysianus (Fischer).

Firth of Forth, 30 fathoms (*Metz. and Mey.*).

NASSIDÆ.

Nassa reticulata (Linn.).

Firth of Forth (*M'B.*).

N. incrassata (Ström.).

Firth of Forth (*M'B., and Ed. Mus.*).

At Wardie it is commoner than the var. *minor* (*M.*).

This species is very common in the Firth. We have taken it in abundance at North Berwick, Wardie, Aberdour, etc.

N. incrassata, var. *minor*.

Living, and abundant, on the under side of stones and crumbling rocks at North Berwick, at very low water, and in roots of tangle. This variety is commoner than the species at North Berwick and Elie. It is merely a dwarf form, with a fully developed labial rib. Children at North Berwick pierce them with needle and thread, and call them necklace shells (*M.*).

Nassa incrassata, var. *simulans*.
Occasionally at North Berwick and Granton (*M.*).

PLEUROTOMIDÆ.

Defrancia linearis (Mont.).
Common on the beach at North Berwick and Dunbar (*M.*).

D. linearis, var. *æqualis*.
Somewhat common on the beach at North Berwick and Dunbar (*M.*).

Pleurotoma costata (Donov.).
Firth of Forth; in shell sand at Granton, Longniddry, North Berwick, and Dunbar (*M.*).
We have found this species on the beach near Aberdour.

P. septangularis (Mont.).
Firth of Forth (*M'B.*).

P. rufa (Mont.).
Wardie and North Berwick, in shell sand (*M.*).

P. turricula (Mont.).
Firth of Forth (*M'B.*); on the beach at Wardie, Longniddry, North Berwick, and Dunbar (*M.*); Bass Rock, 24 fathoms (*Metz. and Mey.*).

P. turricula, var. *rosea*.
North Berwick and Dunbar (*M.*).

P. trevelyana (Turt.).
Bass Rock, 24 fathoms (*Metz. and Mey.*); Firth of Forth (*M'Andrew*).

CYPRÆIDÆ.

Marginella lævis (Donov.).
Laskey gave Dunbar as a locality, but his specimen was a tropical species (*Dr Gwyn Jeffreys*).

I have a young shell (two-thirds grown) which I took alive from the under side of a stone in a rock pool, at very low water, opposite the Marine Hotel, North Berwick. It is thin and semi-transparent, with a sharp outer lip, the young of this species being unlike the mature form. I have gathered the shell at the same stage of growth on Herm beach, near Guernsey, where *M. laevis* is not rare (*M.*).

Cypræa europæa (Mont.).

Largo Bay, etc. (*M'B.*); Firth of Forth (*Ed. Mus.*).

Rare on the Edinburgh beach. It becomes more frequent as we go east, and at North Berwick is sometimes very abundant. At North Berwick adult specimens worn smooth, and having about two whorls of the spire laid bare, are not uncommon (*M.*). We have taken it at North Berwick, Largo Bay, Anstruther, etc.

IV. Pleurobranchiata—

Bullidæ.

Cylichna umbilicata (Mont.).

Firth of Forth (*M'B.*).

C. cylindracea (Penn.).

Bass Rock, 24 fathoms (*Metz. and Mey.*); Firth of Forth (*M'B.*); on the beach at Dirleton and North Berwick, but not plentiful (*M.*).

We have found this species in Largo Bay.

Utriculus truncatulus (Brug.).

Firth of Forth (*M'B.*); common on the beach at North Berwick and Dunbar (*M.*). We have found it on the beach west from Aberdour.

Utriculus truncatulus, var. *pellucida*.
Occasionally at North Berwick and Dunbar (*M.*).

U. obtusus (Mont.).
Firth of Forth (*M'B., and J. G. J.*); on the beach at Craigroyston (*M.*).
Along with the last species near Aberdour.

U. hyalinus (Turton).
Not rare in shell sand at Cramond Island, North Berwick, and Dunbar (*M.*).

Actæon tornatilis (Linn.).
Firth of Forth (under the name of *Tornatella fasciata*, M'B.); on the beach at Edinburgh, Portobello, and Dirleton, but not common (*M.*).
We have taken this shell at Wardie and Aberdour.

Philine catena (Mont.).
Bass Rock, 24 fathoms (*Metz. and Mcy.*).
Somewhat common in the shell sand at North Berwick and Dunbar (*M.*).

P. pruinosa (Clark).
Firth of Forth (*Flem.*).

P. aperta (Linn.).
Firth of Forth (*M'B., Ed. Mus., and Forb.*); alive at very low water at Portobello and near Cramond Island, sometimes plentiful (*M.*).
We have taken this species alive on the Silver Sands, Aberdour; and have collected the shell at Aberdour, Largo Bay, Elie, etc.

APLYSIIDÆ.

Aplysia punctata (Cuv.).
Firth of Forth (*M'B.*).

PLEUROPHYLLIDIIDÆ.

Pleurophyllidia lovéni (Bergh).
Off Dunbar, 30 fathoms, in mud (*F. M. B.*).

V. NUDIBRANCHIATA—

HERMÆIDÆ.

Hermæa bifida (Mont.).
Black Rocks, Leith (*Landsb.*).

EOLIDIDÆ.

Eolis papillosa (Linn.).
Firth of Forth (*M'B., and Ed. Mus.*); not uncommon, Firth of Forth (*F. and H.*).
We have found this species frequently at Elie between tide marks.

E. coronata (Forb.).
On *Coryne decipiens*, North Queensferry (*M'B.*).

E. drummondi (Thomp.).
On *Tubularia indivisa*, North Queensferry (*M'B.*); Firth of Forth, 30 fathoms, and off Bass Rock, 24 fathoms (*Metz. and Mey.*).

E. landsburgi (Ald. and Han.).
On *Eudendrium rameum*, North Queensferry (*M'B.*).

E. nana (Ald. and Han.).
On *Hydractinia echinata*, Morrison's Haven (*T. S. W.*).

E. angulata (Ald. and Han.).
Off the Bass Rock, 24 fathoms (*Metz. and Mey.*).

E. despecta (Johnst.).
We dredged this small species east of Inchkeith last summer.

DOTONIDÆ.

Doto coronata (Gmel.).
Off Inchkeith (*M'B.*); shallow water, Firth of Forth (*F. M. B.*).

DENDRONOTIDÆ.

Dendronotus arborescens (O. F. Müll.).
Firth of Forth (*M'B., and Dr Grant*).

We have dredged this species near Inchkeith.

TRITONIIDÆ.

Tritonia hombergi (Cuv.).

Firth of Forth (*Flem., and Ed. Mus.*); Firth of Forth, 30 fathoms (*Metz. and Mey.*).

T. plebeia (Johnst.).

Firth of Forth (*M'B.*).

We have found this species at Elie.

POLYCERIDÆ.

Ægirus punctilucens (D'Orb.).

Shallow water, Firth of Forth (*F. M. B.*).

Triopa claviger (Müller).

Shallow water, Firth of Forth (*F. M. B.*).

Polycera quadrilineata (Müller).

Firth of Forth (*M'B.*).

P. lessoni (D'Orb.).

We dredged this species on the oyster bank last summer in 5 fathoms.

Ancula cristata (Alder).

Off Seafield, March 1857 (*M'B.*); Anstruther (*H. D. S. G.*).

We have found this species frequently at Elie, Wardie, and Aberdour, and have also dredged it.

Idalia aspersa (Ald. and Han.).

Off the Bass Rock, 24 fathoms (*Metz. and Mey.*).

Goniodoris nodosa (Mont.).

Between tide marks (*F. M. B.*).

We found several specimens lately at low water mark, west of Aberdour.

DORIDIDÆ.

Doris tuberculata (Cuv.).

Firth of Forth (*M'B., and Ed. Mus.*); between tide marks (*F. M. B.*).

This species is common in the littoral zone.

We have found it at Wardie, North Berwick, Elie, Aberdour, etc.

Doris bilamellata (Linn.).

Firth of Forth (*M'B.*); abundant at low water in the Firth of Forth (*F. and H.*). Common at Aberdour, etc.

D. repanda (Ald. and Han.).

We have taken this species frequently between tide marks at Aberdour, Elie, and Wardie.

D. pilosa (Müll.).

Not uncommon on the shore at Aberdour, under stones, at low water.

We lately took a specimen of the pure black variety of this species (the *Doris nigra* of Fleming) under a stone, at low water mark, on Carcraig Rock, near Inchcolm.

VI. Pulmonobranchiata—

Carychiidæ.

Melampus bidentatus (Mont.).

Occasionally on the beach at North Berwick (*M.*).

M. myosotis (Drap.), var. *ringens.*

Rare on the beach at North Berwick (*M.*).

CEPHALOPODA.

I. Decapoda—

Teuthidæ.

Ommatostrephes todarus (Delle Chiaje).

Firth of Forth (*Forb., F. and H.*); Leith shores, common (*M'B.*); Granton and Craigroyston, cast ashore alive (*M.*).

This species is rather common in the Firth. We have found it alive at Portobello, Kinghorn, and Craigroyston, and have frequently obtained it dead, cast ashore.

Ommatostrephes sagittatus (Lamk.).
Firth of Forth (*Ed. Mus.*).

Loligo vulgaris (Lamk.).
Firth of Forth (*Dr Grant, F. and H.*): off Seafield, 1854 (*M'B.*); Craigroyston (*M.*). We have found this species frequently cast ashore at Portobello, Kinghorn, and Granton.

L. media (Linn.).
Aberlady Bay, 1857 (*M'B.*).

Rossia macrosoma (Delle Chiaje).
We obtained an adult individual of this species alive, at low water, on the Silver Sands, Aberdour, a few years ago.

Sepiola rondeleti (Leach).
Probably this is the species referred to under the name of *Loligo sepiola* by Dr Fleming, in his "British Animals," as having been found in the Firth of Forth by Dr Grant and also by himself.

II. Octopoda—

Octopidæ.

Octopus vulgaris (Lamk.).
Firth of Forth (*Grant*); not unfrequent in the Firth (*Neill*).
Probably it is this species which is recorded from the Forth by Dr Coldstream as *Octopus octopodia.*

Eledone cirrosa (Lamk.).
Kirkcaldy Bay, 1855 (*M'B.*).

APPENDIX.

Since the preceding pages have been printed we have received additional records of species from Mr Balfour, of Cambridge, and Professor Cunningham, of Belfast; these, along with others obtained by ourselves during a few days dredging in the neighbourhood of Inchcolm, and some previously omitted, are now inserted.

ALCYONARIA.

Virgularia mirabilis (Linn.).

We found this abundant in 5 to 10 fathoms, between Aberdour and Inchcolm, on a bottom of stiff blue mud.

OPHIURIDEA.

Amphiura filiformis (Müll.).

We have dredged this species on several occasions lately near Inchcolm, 18 fathoms.

HOLOTHUROIDEA.

Psolus phantapus (Linn.).

Professor R. O. Cunningham informs us that he has frequently obtained this species, taken at the entrance to the Firth, from the Prestonpans fishermen.

POLYZOA.

Bugula purpurotincta (Norman).

We have dredged this in considerable quantity on the west and north-west sides of Inchcolm, in 10 to 15 fathoms.

CIRRIPEDIA.

Balanus hameri (Ascanius).

Professor Cunningham writes, "I once obtained a magnificent mass attached to a stick, which it covered for about 2 feet."

AMPHIPODA.

Byblis gaimardi (Kröyer).

St Abb's Head, 40 fathoms (*Metz.*).

Corophium longicorne (Latr.).

Very abundant in the mud flat at Morrison's Haven (*Cunningham*).

Dexamine spinosa (Leach).

Low water, Prestonpans (*Cunningham*).

Hyperia galba (Mont.).
In the pouches of *Medusæ* (*Cunningham*).

Ligia oceanica (Linn.).
Under stones at high water mark (*Cunningham*).
We have found it at Wardie.

CUMACEA.

Leucon nassica (Kröyer).
St Abb's Head, 40 fathoms (*Metz.*).

Iphinoë gracilis (Bate).
Bass Rock, 24 fathoms (*Metz.*).

STOMAPODA.

Themisto longispinosa (H. Goods.).
Rocks, 2½ fathoms, off Broxmouth, not uncommon (*F. M. B.*).

DECAPODA.

Hippolyte varians (Leach).
Rocks off Broxmouth, near Dunbar (*F. M. B.*).

H. cranchii (Leach).
In same locality as *H. varians* (*F. M. B.*).

H. thompsoni? (Bell).
Firth of Forth (*F. M. B.*).

Pagurus cuanensis (Thompson).
In *Turritella*, Firth of Forth (*F. M. B.*).

Ebalia cranchii (Leach).
Mr Balfour dredged specimens twice in about 25 fathoms in mud about 2½ miles off Dunbar.

TUNICATA.

Pelonaia corrugata (Forb. and Goods.).
Beach at Portseaton after a gale, one specimen (*Cunningham*); not very uncommon (*F. M. B.*).

XVI. *The Glaciation of Caithness.* By B. N. Peach, Esq., F.R.S.E., F.G.S., and John Horne, Esq., F.R.S.E., F.G.S. [Of the Geological Survey of Scotland.]

(Read 20th April 1881.)

I. Introduction.

In the course of our annual leave of absence from official work, we visited Caithness in the autumn of 1880, for the purpose of continuing our investigations regarding the extension of the ice in the North Sea in the Glacial period. The results of our previous observations in Shetland and Orkney, which have appeared in the *Quarterly Journal of the Geological Society*,* point to the conclusion that during the climax of the Ice Age the Scandinavian and Scotch ice-sheets coalesced on the floor of the North Sea, and that a great portion of this ice-field moved in a north-west direction towards the Atlantic. We showed that a careful examination of the *roches moutonnées*, the striated surfaces, and more especially the dispersal of the stones in the boulder clay, compelled us to admit an ice movement from the North Sea to the Atlantic during the primary glaciation. We inferred that the Shetland group must have been overridden by the Scandinavian portion of the ice-field, as the striated surfaces clearly point in that direction; while the presence of Scotch rocks in the Orcadian boulder clay led us to the conclusion that these islands must have been overflowed by the Scotch ice-sheet. Further, we adduced evidence to prove the existence of local glaciers in Orkney and Shetland long after the great *mer de glace* had melted back from the old coast lines of these northern islands.

The glacial phenomena of Caithness have an important bearing on the general question of the extension of the ice in the North Sea, and although they have been described by many writers, we resolved to visit the county with the object of gathering evidence regarding the direction of the ice-flow and the probable physical conditions which prevailed during the accumulation of the superficial deposits. In the sequel

* Quart. Jour. Geol. Soc., vol. xxxv., p. 778; xxxvi., p. 648.

we hope to show that in many respects there is a close resemblance between the glacial phenomena of Orkney and those of the Caithness plain. We obtained evidence which shows that the local ice, shed from the hilly ground along the county boundary, moved E., N.E., and N. till it debouched on the plain, where it was compelled to veer round to the north-west in harmony with the general movement in the low ground of the county.

II. Previous Literature on the Subject.

The boulder clay of Caithness has long been celebrated for the abundance of organic remains which are present in that deposit, and its origin has consequently given rise to considerable discussion. The occurrence of marine shells in the boulder clay was first made known by Hugh Miller in the pages of *The Witness* in 1847, where he states that Mr John Cleghorn of Wick and Mr Dick of Thurso had supplied him with shells from their respective sides of the county.* The writer of the article also states that, to Mr Dick's chagrin, he had come across an old work, entitled, "Minutes of Observations Drawn Up in the Course of a Mineralogical Survey of the County of Caithness in 1802 by John Busby, Edinburgh," wherein were chronicled several instances of the occurrence of marine shells in the blue clay of Caithness. The survey was made at the instance of Sir John Sinclair.

In his rambles across the county Mr Dick brought to light many localities where this deposit yields marine shells, and blocks of fossiliferous secondary rocks along with chalk flints. He detected the ice-markings on the rocks at Thurso, and he noted the occurrence of erratics at various points which had travelled far from their parent sources.† Indeed, his long-continued examinations of the sections from the Thurso river to Freswick burn and southwards to Dunbeath, led him to the belief that the boulder clay, in some way or other, was of glacial origin.

* "Rambles of a Geologist; or, Ten Thousand Miles over the Fossiliferous Deposits of Scotland."

† See "Life of Robert Dick," by Smiles, pp. 159, 164, 169, 184, 187, 195, 223, etc.

To Mr C. W. Peach, however, geologists are indebted for most of the knowledge we possess regarding the organic remains of that deposit. His residence at Wick for many years afforded him frequent opportunities of making collections of these remains. The results of his observations have been communicated mainly to this Society, and have been published in the *Transactions*, while some reports were also presented to the Geological Section of the British Association.* He was the first to publish lists of the organic remains, and was likewise the first to recognise the resemblance between the ice-worn blocks of the secondary rocks in the boulder clay and the representatives of these rocks on the Sutherlandshire coast. In 1868 he informed Dr Croll that his researches had led him to the conclusion that the boulder clay was a genuine product of land ice, and in every respect identical with Scotch till.† He also stated that he had come to believe that the ice movement had been from the Moray Firth towards the Atlantic, and that in all likelihood it might have been produced by masses of land ice crossing the Moray Firth from the high grounds to the south-east.

In 1866 Mr T. Jamieson, in a paper on "the Glacial Phenomena of Caithness,"‡ gave an excellent account of the shelly boulder clay, referring specially to its distribution, its physical characters, and organic remains. He advocated the theory that this deposit was due to floating ice during what he terms the glacial marine period, and he suggested that the transport had been from the north-west to the south-east, across the country between Reay and Dunbeath. The main argument adduced by him in support of this movement from the north-west, is the overlapping of the dark grey shelly

* See the following papers by Mr. C. W. Peach in the Trans. of the Roy. Phys. Soc., Edin., "On the Discovery of Calcareous Zoophytes in the Boulder Clay of Caithness," vol. i., p. 18; "On the Discovery of Nullipores and Sponges in the Boulder Clay of Caithness," vol. ii., p. 98; "On the Fossils of the Boulder Clay of Caithness," vol. iii., p. 38; "Further Observations on the Boulder Clay of Caithness, with an Additional List of Fossils," vol. iii., p. 396; also Brit. Ass. Rep. for 1862, Trans. of Geol. Sec., p. 83; *Ibid.* for 1864, p. 61.

† Geol. Mag., 1870, p. 212.

‡ Quart. Jour. Geol. Soc., vol. xxii., p. 261.

drift on the grits and conglomerates towards Dunbeath and Berriedale, coupled with the overlap of a reddish-brown boulder clay on the Caithness flags at Reay. We shall point out presently, however, that these features are satisfactorily accounted for by supposing that the ice came from the south-east. We shall have occasion to point out also that this supposed movement from the north-west is at variance with some facts recently brought to light regarding the direction of the ice-markings and the dispersal of the stones in the boulder clay, while it leaves unexplained the occurrence of various secondary rocks in that deposit. Mr Jamieson inferred that the shelly boulder clay of Caithness was of more recent date than the lower boulder clay of Scotland, which is usually unfossiliferous, being led to this conclusion by the small proportion of Arctic forms in the fauna of that deposit.

In 1870, our colleague, Dr Croll, contributed an article to the *Geological Magazine*,* in which he disputed the marine origin of the Caithness boulder clay, regarding it as a product of land ice. He called attention to two points noted by previous writers on the subject: first, that with the exception of the organic remains, this deposit closely resembles the ordinary boulder clay of Scotland, which is generally ascribed to the action of land ice; and, second, that the marine shells are scattered irregularly through the deposit, and are smoothed and striated precisely like the stones in the boulder clay. He argued that the presence of these organic remains does not necessarily prove the marine origin of the till, but rather that they had been borne inland with the *moraine profonde* from the bed of the Moray Firth and the North Sea. He endeavoured to explain the origin of the shelly boulder clay by supposing that the Scotch ice which filled the basin of the Moray Firth was deflected by reason of the Scandinavian *mer de glace*, and was compelled to overflow the Caithness plain. In his volume on "Climate and Time,"† he quotes the testimony of one of the authors of this paper in proof of the gradual bending round of the Scotch land ice between

* Geol. Mag., 1870, pp. 209-271.

† "Climate and Time," p. 453.

the Ord and Dunbeath, on the east coast of this county. The evidence now referred to will be described when we come to discuss the direction of the ice-flow and the character of the boulder clay.

In 1871, a paper appeared in the *Transactions of the Geological Society of Glasgow*, by the Rev. Henry Crosskey and David Robertson, in which they give a short account of the boulder clay sections near Wick, along with a list of the Foraminifera obtained from that deposit.*

In the volume of the publications of the Palæontographical Society, published in 1874, Messrs G. S. Brady and Robertson, in their "Monograph on the Post-Tertiary Entomostraca," describe the boulder clay near Wick, and give a list of Entomostraca from the sections in Wick Bay and burn of Haster.†

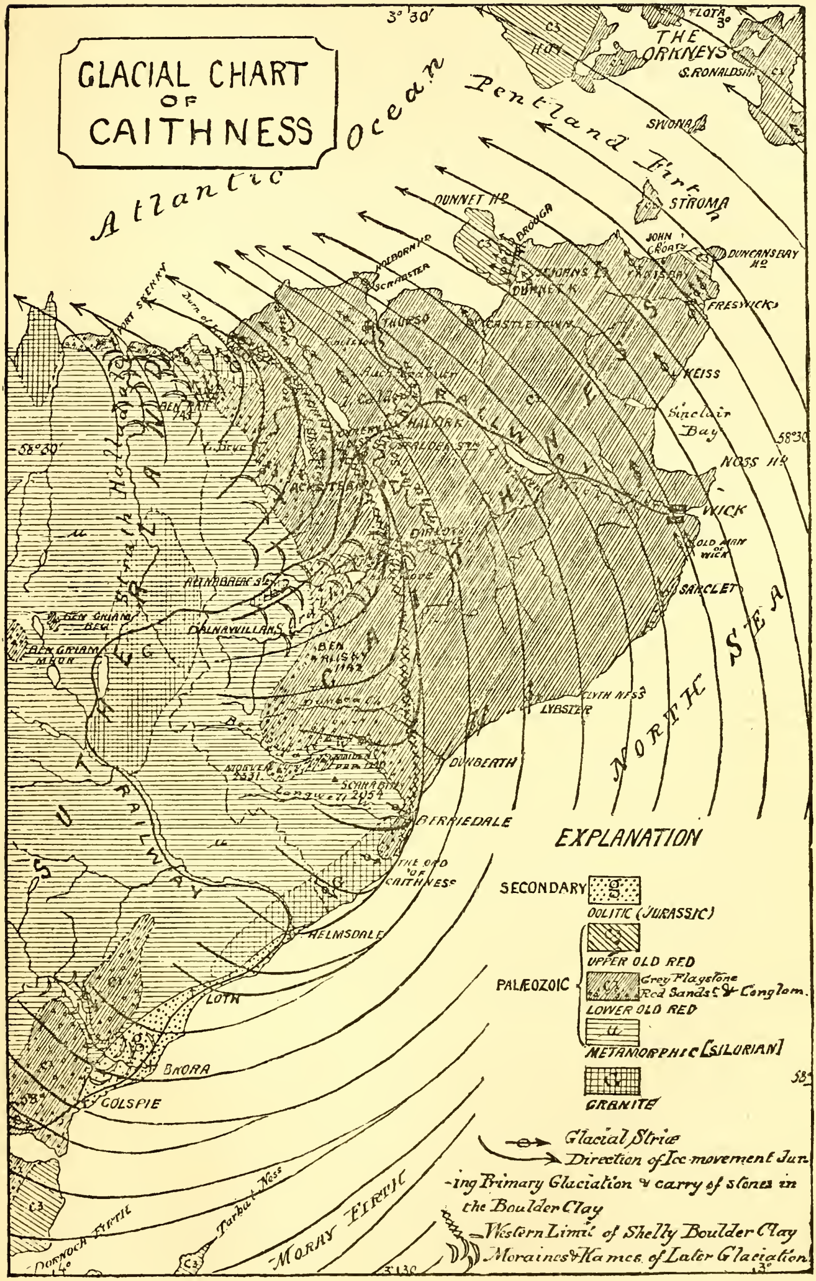
Before leaving this part of the subject, reference ought to be made to the labours of Mr Joseph Anderson, Curator of the Antiquarian Museum, Edinburgh. Though he is more widely known by his researches among "the Picts' Houses" in Caithness, yet, during his residence in Wick, he was an earnest worker at the present subject, and several observers have been indebted to him for valuable assistance. He was the first to wash the Caithness boulder clay for microscopic organisms—a process which has added greatly to the list of the fauna obtained from that deposit.

III. Glaciation.

The greater portion of the county is occupied by strata belonging to the Old Red Sandstone formation, of which the most prominent subdivision is the well-known Caithness Flagstone series. A line drawn from Ben Rha, near Reay, south-eastwards by Loch Scye, Loch More in Strathmore, to Morven and the Ord, marks the inland limit of this forma-

* "The Post-Tertiary Fossiliferous Beds of Scotland," by the Rev. H. W. Crosskey and Mr D. Robertson, Trans. of the Geol. Soc. of Glasgow, vol. iii., p. 126, 127. This paper was read in 1868.

† "Monograph of the Post-Tertiary Entomostraca," by Messrs G. S. Brady, the Rev. H. W. Crosskey, and Mr D. Robertson, Palæontographical Soc., vol. xxviii., p. 7, 1874.


GLACIAL CHART OF CAITHNESS
Atlantic Ocean
Pentland Firth
THE ORKNEYS
HOY
S. RONALDSHA
SWONA
STROMA
DUNNET HD
BROUGH
JOHN O'GROATS
DUNCANSBAY HD
FRESWICK
KEISS
Sinclair Bay
NOSS HD
WICK
OLD MAN OF WICK
SARCLET
NORTH SEA
CLYTH NESS
LYBSTER
DUNBEATH
BERRIEDALE
THE ORD OF CAITHNESS
HELMSDALE
LOTH
BRORA
GOLSPIE
DORNOCH FIRTH
Tarbat Ness
MORAY FIRTH
HOLBORN HD
SCRABSTER
THURSO
CASTLETOWN
HALKIRK
ALTNABREAC STN
DALNAWILLANS
BEN ALISKY 1142
MORVEN 2331
SCARABEN 2054
BEN GRIAM BEG
BEN GRIAM MOR
BEN RAH
58° 30'
3° 30'
3°
58°
EXPLANATION
SECONDARY
OOLITIC (JURASSIC)
UPPER OLD RED
PALÆOZOIC
Grey Flagstone
Red Sands^t & Conglom.
LOWER OLD RED
METAMORPHIC [SILURIAN]
GRANITE
Glacial Striæ
Direction of Ice-movement during Primary Glaciation & carry of stones in the Boulder Clay
Western Limit of Shelly Boulder Clay
Moraines & Kames of Later Glaciation

tion. The geological structure of this tract has been fully described by Professor Geikie in his elaborate monograph on "The Old Red Sandstone of Western Europe,"* to which reference may be made for details. Beyond the limit just indicated the strata consist of white quartzites forming the range of the Scarabens (2054 feet), orthoclase gneiss, mica schists, and occasional masses of granite; but to these we paid no special attention.

An important feature connected with the glaciation of Caithness is the complete divergence in the trend of the ice-markings, in the area occupied by the shelly boulder clay, and the district lying to the west towards the county boundary. In the former area the prevalent trend is north-west and south-east, which Mr Jamieson and Dr Croll clearly showed could not have been produced by any local radiation of the ice—a conclusion which is self-evident to any one who considers the physical features of the county. In the district lying to the west of this area towards the county boundary, the striæ point E., E.N.E., N.N.E., N., and eventually they veer round to the N.W., along the inland margin of the shelly boulder clay. We shall first describe some of the examples met with in the area occupied by the shelly drift.

In the district between Reay and Thurso we observed numerous examples on the surfaces of the flagstones. By the roadside west of the granite ridge at the burn of Isauld, striæ are seen on the grey flagstones beneath a thin covering of red boulder clay, pointing W. 40° N. These agree with the instances noted by Mr Jamieson at Reay, running N.W. and W. 35° N. At Shebster we observed ice-markings pointing W. 30° N., and at Westfield, near the Forss Water, W. 20° to 25° N.

On the surface of the blue flags in the Achscrabster quarries the trend is W. 25° N. This locality is interesting on account of the evidence which it affords of an ice movement towards the north-west. Subangular blocks have been broken off the flagstones by the ice in its passage over them, which are tilted at a gentle angle towards the north-west, while the flags themselves have been bent over in the same

* Trans. Roy. Soc., Edin., vol. xxviii., p. 406.

direction. In the Jamestown quarries, about two miles south-west of Thurso, the prevalent trend is W. 20° N., but on the same rock surface we noted a fainter set running N.E. These have been well-nigh effaced by the north-west movement, and for this reason they seem to be of older date. This was the only example we noted of a north-easterly trend away from the inland margin of the shelly drifts.

Between Thurso and Castletown, and eastwards to Brough, similar evidence is obtained of this north-west and south-east movement. On the surface of the grey flagstones in the Castletown quarries the direction is N. 20° to 23° W., and again by the roadside, south of St John's Loch, the trend is N. 10° to 15° W. Several examples were noted on the slopes between Brough and Dunnet Bays, on the surfaces of the coarse yellow sandstones of that peninsular tract. In the old quarries, on the slope to the north-west of Brough, the striæ point W. 35° N., W. 30° N., and W. 25° N. A few yards to the west of the above locality another instance was observed pointing W. 25° N. Farther to the south, by the road leading to Dunnet Church, the direction is W. 25° to 30° N., and to the west of St John's Loch W. 35° to 40° N. A careful examination of the striated surfaces on this slope convinced us that they had been produced by ice moving towards the north-west. The gradual rise on the ground to the west of Brough towards Dunnet Head (346 feet) is due to the presence of coarse massive sandstones of Upper Old Red age. On the south-east slope the sandstones are finely *moutonnée*, and the smooth faces point to the south-east, indicating the direction from which the ice came. When we come to discuss the dispersal of the stones in the boulder clay, we shall see that additional evidence is obtained in support of this conclusion.

In the undulating plain between Halkirk and Westerdale the same north-west and south-east trend is observable. In a quarry south of Achies farm-house, about three miles south of Halkirk, the direction is W. 30° N., and alongside of these is a fainter set pointing nearly west.

On the eastern seaboard, between Duncansbay Head and Dunbeath, numerous instances occur which harmonise with

the general trend now described. On the top of the cliff, near Skirsa Head, Mr Jamieson noted striæ pointing W. 25° N.; in the bed of the Freswick burn, N. 35° to 40° W.; and at Keiss, N. 35° to 40° W. Numerous examples are met with in the neighbourhood of Wick, varying from N. 15° W. to N.W. One of the best instances occurs on the cliff top opposite the Old Man of Wick, which is specially noteworthy, inasmuch as it presents certain appearances which could only have been produced by ice coming from the south-east. At this locality the flagstones dip inland (N. 30° W.) at a gentle angle, thereby forming tiny escarpments along the outcrops of the successive beds. On the dip slopes the striæ point N. 10° to 20° W., but opposite each small escarpment they are deflected, the trend being still more northerly, while in the succeeding dip slope the normal direction is resumed. The slight deflections observable in these small escarpments point to an agent moving inland from the south-east.

A more striking example, in proof of the ice having moved inland from the North Sea, is to be met with in a *goe* between Dunbeath and Latheron, close by Latheronwheel. On the north side of a narrow inlet, which is about 100 feet in depth, the face of the cliff is finely polished and striated; the striæ beginning near the water-level, and ascending the cliff obliquely. It ought to be borne in mind that there has been a large amount of denudation along that rocky coast-line since glacial times, which is greatly accelerated by the system of jointing so characteristic of the Caithness flagstones. These cliffs usually present clean-cut faces, owing to the removal of huge slices of rock along the joints by the combined action of the sea and atmospheric influences. Hence it is difficult to find instances of striated surfaces rising from underneath the water-level. Moreover, in the bays at Freswick, Wick, Lybster, Latheronwheel, and Dunbeath, the boulder clay descends to the shore, thus indicating that the streams had cut down to the present sea-level, and probably below it in pre-glacial times.

From the foregoing examples, it is evident that all over the broad flats of Caithness the general trend of the ice-

markings is north-west and south-east; but to the west of the inland limit of the shelly boulder clay the trend is widely different.

Following the shore northwards from the Ord of Caithness towards Berriedale, the striæ run in an easterly direction, as if produced by ice moving off the high ground in the south-eastern part of the county. North of Berriedale, however, towards Dunbeath, they gradually swing round and creep inland from the sea, the trend varying from N. 10° to 15° E.

Again, in the valley of Strathmore, between Loch More and Dirlot, the same curious deflection of the ice-markings is observable. By the roadside between Loch More and Strathmore Lodge, several pits have recently been opened, which have brought to light finely striated surfaces. Not far from the north-west corner of the loch, in a quarry on the north side of the road, there is a beautifully-polished surface which has been produced by ice descending the strath. The striæ occur on red sandy flags and grits, pointing E. 20° N. The smooth face of the *roche moutonnée* confronts the high grounds to the west, leaving no room for doubt as to the direction from which the ice came. On the opposite side of the road well-marked striæ are also exposed, pointing E.N.E., and the same trend is observable a short distance to the east of these localities. Again, about a quarter of a mile from the loch, in the direction of Strathmore Lodge, we noted several instances trending N. 5° E. Further down the valley, and a little way east of Strathmore Lodge, ice-markings were found, pointing N.N.E. and N.W., on the same glaciated surface, underneath a thin covering of boulder clay. We shall have occasion to point out in a subsequent paragraph that the shelly boulder clay does not extend further up the valley than Strathmore Lodge. It is apparent, therefore, that the deflection increases as we approach the margin of the shelly drift. It cannot be ascribed to any elevated mass of ground in the neighbourhood of Strathmore Lodge, because no eminences intervene which could possibly give rise to such a phenomenon. On the contrary, it points to the existence of a powerful opposing agent, which must have operated over the whole of the broad Caithness plain.

Again, on the moor between Dalnawillan Lodge and Altnabreac Station well-marked striæ were observed on granite, trending E. 10° to 15° N. This example is in harmony with the striations near Loch More. This locality is situated about four miles from the county boundary, and the markings were clearly produced by ice moving off the adjoining high grounds.

Another traverse from the hills round Loch Scye, eastwards by Loch Shurrery, Ben Dorrery, to Scotscalder, furnishes remarkable proof of the north-easterly trend of the local ice and its gradual deflection near the limit of the shelly drift. Between Achsteenalate and Loch Scye some finely glaciated surfaces have been recently exposed by the road-side. About a mile and a half to the west of Loch Shurrery well-preserved striæ are visible pointing N. 15° E. on a granitic breccia, which here forms the base of the Old Red Sandstone. To the east of this locality and about half a mile west of the same Loch, near Achsteenalate, the trend is N. 15° E., and a similar direction was noted in the bed of the stream flowing into the Loch on the west side. In these instances the *roches moutonnées* indicate a movement towards the N.N.E. Crossing the south shoulder of Ben Dorrery by the road leading to the Dorrery farm-house, several examples were noted by us pointing due N., and in one case N. 20° E. From the manner in which the south slope of this hill has been glaciated, it is evident that the ice-markings were caused by ice moving towards the north. Again, in the long railway cutting west of Scotscalder Station we found several examples pointing N. 5° W., N. 20° W., and N.W. Towards the middle of the cutting on the south side "cross hatches" were observed pointing N. and N.W., while a few yards to the west two instances point towards the N. Now, these "cross hatches," like the instance already quoted at Strathmore Lodge, occur near the inward margin of the shelly drift, and as they are situated in the midst of an undulating plain, no one can for a moment contend that such remarkable proofs of the deflection of the local ice are due to the contour of the ground.

Again, in the extreme north-west of the county similar

evidence is obtained. About two miles south-west of Reay, on the south slope of Ben Rah (795 feet), less than a mile from the county boundary, there are fine examples of glacial abrasion to be seen. The two peaks on this hill are composed of outliers of coarse granitic breccia resting on fine white sandstones, which are beautifully polished on the intervening col and on the south slope. Indeed, the striations are as fresh as if the ice had but recently passed away, and they leave no room for doubt as to the direction from which the ice came. The instances noted by us point N. 10° E., N., and N. 10° W.; and they are situated to the west of the limits of the shelly boulder clay. It is evident, therefore, that the local ice must have been powerful enough to override hills of considerable elevation near the sea-level. Descending the slope to the burn of Isauld the striæ swing round to the north-west as already indicated.

From the evidence now adduced it is clear that these two diverging systems point to the existence of two opposing streams of ice. From the hilly ground along the county. boundary and the heights in the east of Sutherlandshire the local ice flowed E.N.E. and N.N.E. towards the Caithness plain, while near the Ord and at Reay it flowed into the sea. But along the line indicated by the inland margin of the shelly drift, the local ice was compelled to veer round to the N., and eventually to the N.W. in harmony with the general movement all over the great plain. The "cross-hatching" met with along this line indicates a sustained conflict between the opposing streams, which resulted in favour of the north-westerly ice-flow. On both sides of this line the boulder clay is of two distinct types, as will be presently described. Occasionally there is a commingling of the material belonging to the rival ice-streams, but in general the features are totally different. Indeed, the phenomena now referred to are quite analogous to those met with in the central valley of Scotland, so well described by our friend and colleague Dr James Geikie. In this latter case, the great ice-streams from the Highlands and Southern Uplands coalesced in the midland valley, producing similar "cross-hatching" and the same commingling of the *moraine profonde*

Dr James Geikie reminds us that similar phenomena have been recorded by geologists in Scandinavia, "cross-hatching" having been observed many years ago by Forchammer in Denmark, and in more recent years again and again in Norway and Southern Sweden by various geologists. Quite recently they have been detected also in North Germany by Dr Penck. "The intercrossing of boulders derived from different quarters," * he continues, "has likewise been frequently noted by continental geologists in the drift deposits of various parts of Europe. Perhaps among the most remarkable examples are those described by MM. Falsan and Chantre in their magnificent work on the ancient glaciers of the basin of the Rhone. In the region lying between Bourg and Grenoble (Ain, Savoy, and Isere) the glacial deposits display again and again the most remarkable examples of erratics which have crossed each other in their journey at all angles. For example, in the neighbourhood of St Paul, a little to the west of the beautiful Lac du Bourget, the glacial deposits are charged with blocks of dolomitic limestone, which have descended from Mont du Chat—*i.e.*, in a N.N.W. direction. But in the same district occur many blocks of various rocks which have come from Upper Savoy—*i.e.*, from N.E. Here the one set of boulders has crossed the other nearly at right angles. And numerous other similar examples are pointed out by the French glacialists. Still more striking is the fact that now and again erratics have travelled in precisely opposite directions—one set having been carried *up*, while another has been brought *down*, one and the same valley. Thus, in the Val Romey (S.E. of Nantua) erratics of local origin may be traced south as far as the Lyons and Geneva Railway, while boulders derived from the Alps have travelled up the valley for a number of miles! And the same peculiar phenomena are repeated in the case of many other valleys in Dauphiny and the adjoining regions. The origin of this 'intercrossing' of erratics is very simply explained by MM. Falsan and Chantre. They point out that before the great glacier of the Rhone and the Arve had

* Extract from a letter by Dr J. Geikie, F.R.S., to one of the authors of this paper.

attained its maximum development, all the mountains of Savoy, Dauphiny, etc., had their local and independent glacier systems, some of which were very considerable. These local glaciers flowed down the valleys, as a matter of course. By-and-by, however, when the united glaciers of the Rhone, the Arve, the Isere, and the Drac, with their affluents reached their greatest extension, so as to cover all the region between Bourg, Lyons, Vienna, and Grenoble with a vast *mer de glace*, the formerly independent glacier systems of Dauphiny, etc., were overwhelmed, and their flow arrested, and in many cases actually reversed. In other words, the united *mers de glace* of the Rhone, the Arve, etc., sometimes overflowed the summit-levels from which the local glaciers had descended, while in other cases they simply dammed back the local ice and protruded long tongues of ice into the lateral valleys formerly occupied by independent glaciers. And thus alpine rocks were often carried in very different directions to the course followed by the *débris* of the local moraines. But when the great *mer de glace* declined in importance, the local glacier systems came again into existence, and rocks of local origin travelled down the valleys as before.

"German geologists have long been familiar with the fact that 'intercrossings' of erratics are not uncommon in the so-called Northern Drift; and I may refer you to 'Prehistoric Europe,' pp. 203, 564, and Plate D, where you will find some account of the general results arrived at. The 'intercrossings' of boulders in the drift deposits of Lancashire, Cheshire, etc., so ably described by Mr Macintosh, are, I do not doubt, to be explained in the same way. If those who still cling to the iceberg origin of our boulder drifts can be induced to study MM. Falsan and Chantre's work, they will pause before appealing to the distribution of boulders in the north-west of England in support of the marine theory of the drifts. To me that distribution is eloquent of the successive changes of ice-flow which took place during the gradual increase and decrease of the *mer de glace* which enveloped that part of England. Long before that *mer de glace* attained its full development, the glaciers of North Wales and the

Cumbrian Lake Country must have flowed outwards freely in many directions, which they could not afterwards follow when the united *mer de glace* came to fill up the basin of the Irish Sea and advance inland upon Cheshire, etc. At the period of maximum glaciation the path of the ice would often be at right angles to what it was before that maximum was reached, and to what it again became after the *mer de glace* was on its final decline."

Mr Jamieson states in his paper that where he observed "any indication of a *stoss-seite* it was on the north-west side."* But no instance is quoted save one about two miles south of Berriedale where some masses of conglomerate "crag" to the east, as if produced by ice moving seawards. This example is situated at the southern margin of the shelly drift, and was evidently caused by the local ice already described.

The absence of any well-marked *roches moutonnées* in the area occupied by the shelly drift may be satisfactorily accounted for by the peculiar mode of weathering of the Flagstone series. The flagstones were not capable of assuming the dome-shaped contours so characteristic of highly glaciated regions. In many instances they broke up into subangular blocks underneath the ice, a striking example of which has already been described in the Achscrabster quarries. The very same features we found to obtain in Orkney in the tracts occupied by this series. But notwithstanding this mode of weathering, we have adduced several examples which indicate a movement *towards* the north-west, and when these are viewed in connection with the remarkable deflection of the local ice-stream, it must be admitted that the evidence derived from the striated surfaces and the *roches moutonnées* is clearly in favour of this conclusion. This view receives additional support from the evidence supplied by the boulder clay.

IV. Boulder Clay.

Within the county this deposit is of two distinct types, corresponding with the two opposing streams of ice just described. We have (1.) a stiff, dark grey, shelly boulder

* Quart. Jour. Geol. Soc., vol. xxii., p. 268.

clay, containing an admixture of rocks of local origin, with a large proportion of blocks which are foreign to the district; (2.) a reddish or brown boulder clay, containing no shells, and including stones derived from the area traversed by the local ice-flow. A line drawn from Shebster midway between Reay and the Forss Water, south-eastwards by Scotscalder Station and Strathmore Lodge to Dunbeath, marks approximately the inland limit of the dark grey boulder clay charged with marine shells. The coast-line from Dunbeath to Duncansbay Head, and thence to near Reay, forms the boundary line on the east and north. Over the whole of this triangular-shaped area, measuring about 300 square miles, the shelly boulder clay is distributed in irregular sheets; and when we consider the remarkable features presented by this deposit and the extent of ground which it covers, there is little wonder that its origin has given rise to considerable discussion. Throughout the area occupied by the shelly drift, the striations have a general north-westerly trend, as already indicated; and in a subsequent paragraph we shall describe certain facts connected with the dispersal of the stones in this deposit, which indicate that the ice-flow must have been from the North Sea towards the Atlantic. The reddish or brown boulder clay, containing no marine shells, lies to the west of the line which marks the inland limit of the shelly drift. We shall first describe the *moraine profonde* produced by the local ice-flow.

On the shore, between the Ord and Berriedale, the deposit consists of a reddish-brown gritty clay, with well-striated stones composed of rocks belonging to the immediate neighbourhood. Amongst these may be mentioned pink granite, gneiss, quartzite, granitic breccia, red flags, grits, and shales, all of which occur in the vicinity. No shells were observed in this deposit, nor any of the secondary rocks which are so prevalent in the shelly drift. As already described, the striæ along this part of the coast point seawards, and the deposit has evidently been produced by ice which radiated from the adjoining high ground. But to the north of Berriedale and onwards to Dunbeath, where the striæ begin to bend inland, the boulder clay completely changes its character. The colour

becomes dark grey, blocks of the secondary rocks make their appearance, and organic remains are abundantly met with. Indeed this latter deposit occurs in great force in the Dunbeath Water, as described by Dick and Jamieson. In the Berriedale Water, however, which drains the northern slopes of Morven and the Scarabens, there are high banks of the reddish-brown ground-moraine, resembling in every respect the sections between Langwell and the Ord. Mr Jamieson states that he observed in the Berriedale Water sections some of the dark blue-grey stuff commingled with the red boulder clay, in which, after some search, he found "nine or ten small pieces of shell and a bit of a *Balanus*."* But this commingling of the separate deposits occurs near the margin of the shelly drift, where the conflicting ice-streams must have shifted their ground, according to the relative pressure, which need not necessarily have been constant. Such an admixture of the ground-moraine of the respective ice-streams is just what might be expected under these conditions.

We can now explain the overlap of the dark-grey shelly drift on the red conglomerates, grits, and flags north of Berriedale towards Dunbeath, referred to by Mr Jamieson. A similar overlap occurs at the Sarclet, five miles south of Wick, where the same conglomerates and red flags are brought to the surface by means of an anticlinal fold. It is evident that this overlap is due to the forcible invasion of that area by the ice from the North Sea, which pushed along underneath the mass the pebbly silt and sand charged with marine shells lying in its path.

Again, in Strathmore, on the banks of the Thurso river, this reddish-brown boulder clay is exposed above Strathmore Lodge. At the bend above the lodge, close by the footbridge, there is an excellent section of this deposit on the right bank of the stream. It consists of red gritty boulder clay, with well-striated stones, which have been derived from the metamorphic rocks to the west. But not far below the lodge the dark-grey shelly boulder clay makes its appearance simultaneously with the change in the trend of the ice-markings,

* Quart. Jour. Geol. Soc., vol. xxii., p. 270.

and from thence it forms a series of bluff cliffs, from 20 to 25 feet in height, as far as the rocky ravine below Dirlot Castle. In these sections we detected numerous blocks of secondary rocks, with fragments of marine shells.

In the burn of Isauld, and by the roadside leading to Shebster, sections of red boulder clay, free from shells and secondary rocks, are found resting on the grey flagstones. Associated with pieces of the grey flags are numerous striated blocks of red sandy flags and grits. A slight knowledge of the geological structure of the district satisfactorily explains the overlap of the red boulder clay on the grey flagstones east of Reay. On the hills round Ben Rah, and southwards to Loch Scye, there is a coarse granitic breccia, largely composed of fragments of orthoclase felspar. In the upper reaches of the Forss Water this granitic breccia passes underneath a great series of chocolate-coloured flags, which cover a strip of ground a mile in breadth between Achsteenalate and the east bank of Loch Shurrery, and these beds are overlaid in turn by the grey flagstones of Ben Dorrery. Now, the local ice, which streamed north-east and north from the hilly ground between Ben Rah and Ben Shurrery, must have crossed these zones at the base of the Old Red Sandstone; and hence numerous blocks of the chocolate flags would be mingled with the ground moraine, and the colour of the deposit would naturally become red. In its northward march this local ice must have invaded the area occupied by the grey flagstones between the burn of Isauld and Shebster. It is not necessary, therefore, to invoke a movement from the north-west to explain this overlap. In the light of the foregoing facts, all difficulty regarding its occurrence disappears.

To the west of Sandside Lodge, by the roadside, there is a section of similar reddish-brown boulder clay of local origin, containing blocks of grey micaceous gneiss, granite, pink felstone, grey and red flags.

To the east of the line already described, as marking the inland limit of the shelly drift, the boulder clay differs widely in character from that just described. The shelly drift is not distributed uniformly over the whole area. It reaches

its greatest depth along the stream courses and in the various bays which indent the rocky coast-line. Excellent sections are exposed in the bed of the Forss Water, the Thurso river, at Scrabster Harbour, in Wick Bay, and Dunbeath Water. In many places it reaches a depth of 40 feet, and at Scrabster Harbour its thickness is upwards of 100 feet. In the undulating dome-shaped tracts it thins out to a foot or so in thickness, and in many places it disappears altogether.

We have little to add to Mr Jamieson's accurate account of the physical characters of this deposit. Again and again we had occasion to confirm many of the observations recorded in his paper. We shall therefore have to repeat the description of some of the well-known features dwelt on by him in order to show that they cannot be satisfactorily explained by the theory of floating ice.

The shelly boulder clay is of a dark-grey slate colour when moist, but frequently, in the upper part of the sections, it assumes a brown or ferruginous tint, which may be due to oxidation. It is evident that this brown tint is a mere surface discoloration, because when the deposit is dug into for a little way the slate colour appears. Throughout it consists of an extremely stiff gritty clay, charged with stones of various sizes. In all the sections the stones are scattered irregularly through the matrix. Occasionally lenticular seams of sand occur in the midst of the deposit, but their presence does not impart a stratified arrangement to it. Indeed, all those who have carefully examined the sections agree in stating that this shelly drift has no trace of stratification, and that in physical character it resembles ordinary Scotch till. Marine shells in a more or less fragmentary form are scattered irregularly through the gritty matrix as well as the seams of sand. There is one section described by Jamieson, on the south side of Wick Harbour, which is of importance, as it shows a slight change in the character of the deposit in the upper parts of the cliff. The section is about 50 feet high, the lower part of which consists of a dark-coloured and very tough gritty clay, with very small stones and numerous remains of marine shells. Thin seams of sand are mixed with this deposit, but there is no trace of stratification. In

the upper part of the section the deposit is of a brownish tint, and less compact. A few feet from the top of the section there are some large blocks of granite, sandstone, and various metamorphic rocks, which are distinctly ice-worn. The occurrence of these blocks, however, is quite exceptional. Along the cliffs to the south of Wick the same change in colour is observable, but fragments of shells are also met with in this material, and the stuff is quite homogeneous from top to bottom.

The nature of the stones embedded in the deposit deserve special attention, as they furnish important evidence regarding the ice movement. Throughout the area the prevalent ingredients are, of course, blocks derived from the underlying Caithness flags. It is particularly observable that in the sections along the eastern seaboard there is a comparative absence of ordinary-sized blocks of this material. Indeed, with certain exceptions, the deposit is not stony, as the matrix contains only small well-rounded pebbles. When the sections are followed inland, however, the stones derived from the Flagstone series increase both in number and size. This feature is satisfactorily explained on the supposition that the shelly boulder clay of the eastern seaboard was mainly composed of the pebbly silt and sand lying on the bed of the North Sea, which was gradually mingled with materials obtained from the flagstones as the ice advanced inland towards Thurso and Reay. The presence of the large blocks of flagstone in the upper part of the sections exposed round Wick Bay may be accounted for in the same manner. It is probable that the ice took some time to remove the silt from the sea bottom, and it was not till it had done so that it was enabled to quarry the underlying rocks out of which to manufacture boulders. Dr Penck has explained similar phenomena met with in the Danish drifts in the same way. We frequently noted that the larger blocks of the flagstones lay with their long axes parallel to the direction of the ice-flow, while they are invariably striated in the same direction. This feature was observed by Jamieson in the Milton and Haster burns, and it is capitally displayed in the sections in the Thurso river, between Dirlot and Strathmore Lodge.

Here there are occasional blocks of grey and chocolate flags, upwards of 3 feet in length, arranged as described.

Owing to the remarkable uniformity in the character of the Caithness Flagstone series there is some difficulty in determing the direction of the ice-carry from the dispersal of the local rocks in the boulder clay. There is one striking instance, however, to which we paid special attention, which confirms the opinion that the ice must have come from the south-east. The peninsular tract of ground, which is situated between Brough Bay and Dunnet Bay, extending northwards to Dunnet Head, measuring about five square miles in extent, is occupied by coarse yellow and red sandstones, which are brought into conjunction with the Flagstone series by a fault. This dislocation runs from Brough Bay southwards by St John's Loch and the church of Dunnet to Dunnet Bay. Now, in the boulder clay sections to the east of the fault, no trace of these characteristic sandstones is to be seen on the shore or inland, whereas the Caithness flagstones have been carried on to the surface of these Upper Old Red Sandstone rocks. Had the ice-flow been *from* the north-west, the phenomena would have been precisely the reverse of what we have stated, as blocks of these massive sandstones would certainly have been mingled with the *moraine profonde* to the south-east of the fault.

Again, on the shore about four miles to the south of Wick, at the Sarclet, massive beds of conglomerate, attaining a thickness of nearly 300 feet, are brought to the surface by means of an anticline.* Blocks of this conglomerate can be traced inland from this locality, both in the boulder clay and on the surface in the direction of Thurso.†

But in addition to these local rocks there is a large percentage of blocks which are foreign to the Caithness plain. Amongst these may be mentioned granite, porphyritic felsite, diorite, gneiss, mica schist, quartzite, oolitic limestone, oolitic brecciated conglomerate, grey sandstone belonging to the

* Trans. Roy. Soc., Edin., vol. xxviii., p. 376.

† Dick mistook the boulders of this rock, which he found between Thurso and Dunnet, for fragments derived from the conglomerates of Port Skerry in Sutherlandshire, from which they differ considerably.

Oolite formation, septarian nodules, along with chalk and chalk-flints. Indeed, over all the tract occupied by the shelly drift chalk-flints are occasionally met with on the surface, having escaped denudation while the matrix which enclosed them has been worn away. Some pieces of jet were also obtained by Mr C. W. Peach in the sections at Wick, and several specimens of belemnites were found by him both at Wick and in the Thurso river. It ought to be borne in mind that the secondary rocks in the dark-grey clay are co-extensive with the shells, and where these blocks occur shells are common. These foreign blocks are hardly ever found in those places where the deposit is only a foot or two thick, and the same remark applies to the organic remains. In that case the blocks are almost invariably composed of the underlying rocks.

We believe that Mr C. W. Peach was the first to recognise the close resemblance between the blocks of the secondary rocks in the shelly boulder clay and their representatives on the Sutherlandshire coast. Many of the included blocks contain the same fossils as those chronicled from the latter locality. Indeed, nearly all the blocks of secondary rocks, save the chalk and chalk-flints, might quite well have been derived from the Sutherlandshire coast, or the outliers which occur in the basin of the Moray Firth. But though cretaceous rocks do not occur in place on the shores of the basin now referred to, they are believed to exist on the bed of the Firth. In addition to these, several blocks of fossil wood are met with in the shelly drift which are identical with those found by us in the Odin Bay section, in Stronsa, Orkney. Sections of this rock show distinct cell structure under the microscope, and they have been determined by Mr Kidston of this Society as specimens of *Peuce Lindleyana* of Oolitic age. The same rock is embedded in the oolitic shales in Sutherlandshire, where it is burned for lime.

The occurrence in the shelly boulder clay of these blocks of secondary rocks which are known to exist in the basin of the Moray Firth, is an additional argument in favour of the theory that the ice-flow across the Caithness plain was towards the north-west.

The distribution of the shells in this deposit seems to favour the same conclusion, for along the eastern seaboard the shells are abundant, but they are more difficult to obtain as the sections are followed inland towards Thurso and Reay. The appearances presented by these organic remains indicate glacial abrasion precisely in the same manner as the stones in the same deposit. This fact has been noticed by various observers, and has been repeatedly referred to in connection with the question of the origin of the till. They are broken, smoothed, and striated like the stones associated with them; indeed they resemble the shell fragments we found in the Orkney boulder clay, though in the latter case they are more fragmentary and not so well preserved. The most common forms met with are *Cyprina Islandica, Mactra solida, M. truncata, Turritella ungulina, Astarte elliptica, A. borealis.* But though the shells as a rule are more or less broken and in many instances striated, yet in some cases entire valves have been dislodged. Mr Jamieson found "one entire valve of *Astarte borealis,* another of *A. elliptica,* and two small ones of *A. compressa,* likewise a specimen of *Natica nitida,* and another of *N. Islandica,* both almost perfect." The striking example of the complete bivalve *Anomia,* referred to by Mr Jamieson and Dr James Geikie, was found by Mr C. W. Peach protected in the hollow of a stone. Indeed it is highly probable from the appearances presented by many of the fragile shells that they were frozen in the ground moraine, and in this way escaped complete destruction.

A glance at the accompanying list conclusively shows that the sections have yielded but a small number of forms characteristic of the littoral zone. After years of vigilant searching, Mr C. W. Peach obtained only a few species which lived along the shore, among which may be mentioned two specimens of *Purpura lapillus,* a few specimens of *Patella vulgaris, Mytilus* rarely, and *Tapes pullastra* also rarely. We shall point out presently that the scarcity of these shore forms, and the great abundance of species whose habitat lay in deeper water, have an important bearing on the question of the origin of the shelly boulder clay.

List of Organisms from the Caithness Boulder Clay.

VERTEBRATA.

Piece of fish-bone.

ANNULOSA.

Crustacea—

Portion of shell of Brachyurous Crustacean.

Cirripedia—

Balanus crenatus.
B. scoticus (*porcatus*).
Verruca stromia.

Ostracoda—

Cythere concinna.
C. Dunelmensis (Norman).
C. Finmarchia (G. O. Sars).
C. lutea (Müller).
C. mirabilis (Brady).
C. villosa (G. O. Sars).
C. viridis (Müller).
Cytheridea papillosa (Bosquet).
Cytherideis Dunedinensis.
C. subspiralis.
Cytherura undata (G. O. Sars).
Cytheropteron latissimum (Norman).
Loxoconcha impressa (Baird).
Xestoleberis depressa (G. O. Sars).

Echinodermata—

Echinus neglectus.
Spatangus spec.
Ophiocoma rosula.

Annelida—

Pectinaria ? (sandy tube of).
Serpula vermicularis.

Sipunculus Bernhardus (Forbes).
Spirorbis granulatus.

MOLLUSCA.

GASTEROPODA—

Aporrhais pes-pelecani.
Buccinum undatum.
*Capulus Hungaricus.**
Cerithiopsis costulata.
Chiton cinereus.
Crenella decussata.
Dentalium abyssorum.
D. entale.
Fusus antiquus.
Lacuna divaricata.
Littorina littorea.
L. obtusata (*L. littoralis*).
Mangelia lævigata (*M. nebula*).
M. Leufroyi.
M. pyramidalis.
M. Trevelliana.
M. truncata.
Nassa incrassata.
Natica affinis (*N. clausa*).
N. Islandica (*N. helicoides*).
N. nitida.
N. pallida (*N. Grœnlandica*).
N. sordida.
Odostomia acicula (*Eulimella acicula*).
O. albella.
Patella vulgata.
Purpura lapillus.
Rissoa parva, var. *interrupta.*
Tornatella fasciata.

* *Capulus Hungaricus* has been added to this list from a specimen obtained by C. W. Peach from Freswick, and which he inadvertently omitted from his reports.

Trochus Grœnlandicus (*T. undulatus*).
T. Vahli.
T. ziziphinus.
Trophon clathratus (*Fusus scalaformis*).
T. clathratus, var. *Gunneri.*
T. truncatus.
Turritella ungulina (*T. communis*) (*T. terebra* ?).

Pelecypoda—

Anomia ephippium, var. *squamula.*
Astarte borcalis (*A. arctica*).
A. compressa.
A. sulcata, var. *Scotica.*
A. sulcata, var. *elliptica.*
Cardium echinatum.
C. edule.
C. exiguum (*C. pygmœum*).
C. fasciatum.
C. Grœnlandicum.
C. Norvegicum.
Cyprina Islandica.
Cyrtodaria (*Glycimeris*) *siliqua.*
Donax vittatus (*D. anatinus*).
Leda minuta (*L. caudata*).
L. pernula, var. *buccata.*
L. pygmœa.
Lucina borealis.
L. spinifera.
Mactra solida.
Mya truncata.
M. truncata, var. *Udivallensis.*
Mytilus edulis.
M. modiolus (*Modiola modiolus*).
Nucula nucleus.
N. sulcata (*N. decussata*).
Ostrea edulis.
Pecten Islandicus.
P. maximus.
P. opercularis.

Saxicava Norvegica (*Panopæa Norvegica*).
S. rugosa.
Tellina calcaria (*T. proxima*).
T. Balthica (*T. solidula*).
Venus casina.
V. gallina (*V. strictula*).
V. lincta (*Artemis lincta*).
V. ovata.

BRACHIOPODA—

Rhynconella psittacea.

MOLLUSCOIDA.

Cellarea (*Salicornaria*).
Cellepora pumicosa.
Crisia denticulata.
Hyppothoa divaricata.
Lichasopora hispida (*Tubulipora hispida*).
Membranipora catenularia.
M. spec.
Mucronella Peachii (*Lepralia Peachii*).
Mucronella Peachii, var. *labiosa* (*L. Peachii*, var. *labiosa*).
Schizoporella unicornis (*Lepralia unicornis*).

PROTOZOA.

SPONGIDÆ—

Geodia —— ?.
Clionia cælata.

FORAMINIFERA—

Biloculina ringens (Linn.).
Bulimina marginata (D'Orb.).
B. pupoides (D'Orb.).
Cassidulina lævigata (D'Orb.).
Cristellaria rotulata (Lamk.).
Dentalina communis (D'Orb.).

Discorbina rosacea (D'Orb.).
Globigerina bulloides (D'Orb.).
Lagena costata.
L. globosa (Montagu).
L. Jeffreysii (Brady).
L. marginata (Montagu).
L. semi-striata (Will.).
L. squamosa (Montagu).
L. sulcata (W. and J.).
Nodosaria raphanus.
Nonionina asterizanus.
N. depressula.
Planorbulina Mediterranensis (D'Orb.).
Polymorphina compressa (D'Orb.).
P. lactea (W. and J.).
P. lactea, var.
Polystomella arctica.
P. crispa.
P. striato-punctata.
Pulvinulina Caracalla (Roemer).
Quinqueloculina seminulum.
Q. subrotunda.
Textularia difformis (D'Orb.).
Triloculina oblonga (Montagu).
Trochammina inflata (Montagu).
T. incerta.
Truncatulina lobulata.
Vaginulina legumen.
V. linearis.

PLANTÆ.

ALGÆ—

*Melobesia polymorpha.**

* This list has been prepared from the papers published by (1.) Mr C. W. Peach, (2.) Mr T. F. Jamieson, (3.) Messrs H. W. Crosskey and D. Robertson, (4.) Messrs G. S. Brady, H. W. Crosskey, and D. Robertson. The private collection belonging to Mr C. W. Peach has also been re-examined by one of the authors of this paper. For references to these papers, see Footnotes under section dealing with the previous literature of the subject.

Mr Jamieson, in his paper,* gives an analysis of the Mollusca from the Caithness boulder clay by J. Gwyn Jeffreys, F.R.S., who comes to the following conclusions:

61	per cent.	are species now living	on the west coast of Europe to the south of lat. 50°.†
80	do.	do.	on coasts of Britain.
88	do.	do.	on west coast of Europe between lat. 60° and the Arctic Circle.
84	do.	do.	within the Arctic Circle.
55	do.	do.	on the east coast of N. America.

V. Moraines and Gravels.

An interesting feature connected with the glaciation of Caithness is the development of moraines and morainic deposits in several parts of the county. Hitherto they have not been described. In Strathmore they are well developed, and they stretch far down the valley to the edge of the great plain. The most easterly limit of the moraines and gravels is at Dalemore, about a mile to the East of Dirlot Castle. This point is situated about fourteen miles from the county boundary at the head of the strath. Near Westerdale, about a mile to the north of Dirlot, the grey shelly boulder clay forms a great plain, through which the Thurso river has cut a channel, and formed an alluvial terrace. This platform of boulder clay is dotted over with conical heaps and ridges of sand and gravel, at a height of 200 feet above the sea. Sections of these heaps are exposed by the roadside on the way to Dirlot, which show that the material consists of sand and gravel, more or less stratified, with occasional blocks of conglomerate and sandstone, measuring 3 feet across. Indeed, the sections closely resemble the kame series of the midland counties of Scotland. One of these ridges is specially noteworthy on account of its length, extending from the farm-

* Quart. Jour. Geol. Soc., pp. 278-280.

† Since the analysis was published (1866) the French explorations in the Bay of Biscay will no doubt have added to the percentage of the species coming under this category.

house of Dirlot to Dalemore, a distance of nearly a mile. Its height varies from 20 to 30 feet.*

From Dirlot westwards to Strathmore Lodge conical mounds and ridges rest on the plain of grey shelly boulder clay. They are not abundant, however, occurring only at intervals, and chiefly on the left bank of the stream. From this point to Dalnawillan Lodge, which is about eight miles up the strath from Dirlot, similar heaps can be traced. Towards the latter locality they become more numerous, and on the left side of the valley at Dalnawillan they are well developed. Here the moraines form huge mounds and ridges, excellent sections of which are exposed by the roadside and in the burn courses.

It is observable that the material gradually changes its character as we ascend the valley, for while towards the eastern limit it is sandy and gravelly, with distinct stratification, it becomes more compact, and the stones are not so well rounded near the head of the strath. Indeed, it approaches the type of moraine matter which is commonly met with in upland valleys. We are inclined to believe that the kamiform ridges near Dirlot mark the easterly extension of the later glaciers, for it is highly improbable that they are of marine origin, when no trace of similar deposits has been observed between this locality and the eastern seaboard. On the other hand, the fact that the mounds can be traced at intervals from Dirlot to Dalnawillan, where the material resembles ordinary moraine matter, indicates a probable connection between the different deposits.

The evidence supplied by these later accumulations is important, because they rest both on the reddish-brown boulder clay and the grey shelly drift. They steal across the surface of the shelly drift for a distance of three miles between Strathmore Lodge and Dalemore, so that there can be no doubt that the shelly drift is of older date than the deposits under consideration. This is the only locality where we found the shelly boulder clay overlaid by gravel ridges and moraines; indeed, so far as our observations went,

* These gravel ridges were noticed by Dick in his rambles. *See* Quart. Jour. Geol. Soc., vol. xxii., p. 270.

there is a marked absence of such accumulations throughout the area occupied by this deposit, as noted by Mr Jamieson.

Between Dalnawillan Lodge and Altnabreac Station, we observed moraine heaps composed of the same material as the mounds at the former locality. Over much of the moor also there is an irregular covering of gravelly material exposed in pits, which may belong to the same series. In Strathmore we observed the same material in places where no mounds could be seen, which leads us to believe that this covering may have been deposited by flood waters from the melting ice.

Again, on the moor to the west of Loch Shurrery, moraine heaps occur, and by the roadside leading to Loch Scye pits have been dug in coarse gravelly and rubbishy material, which evidently belongs to the same formation.

In the Braxside burn, which drains the western slopes of Ben Rah, south of Reay, moraines may be seen extending across the valley, and they occur at intervals on the moor northwards to Sandside. But to the west of Reay, in the direction of the county boundary, similar deposits are irregularly distributed over the slope. They increase in number and in size on the col and along the slope towards Strath Halladale, in the county of Sutherland. Indeed, the deposits of the later glaciation in this strath are grandly developed. The bottom and sides of the valley are covered with groups of moraines, displaying at some points a marked concentric arrangement. Numerous *blocs perchés* are strewn on these mounds, composed of granite and granitic breccia. The material consists of a compact stony and rubbishy matter, gravelly in some places and clayey in others, with subangular and rounded stones, few of them being striated.

Now, it is interesting to note that while the traces of the later glaciation overlap on to the grey shelly boulder clay at Dirlot, they do not reach the outer limit of the red boulder clay at Reay. Taking Shebster as the boundary line between the two boulder clays, the later morainic deposits "tail off" about three miles from this limit. But when we think of the large tract of country between Reay and Strathmore over

which these deposits are spread, it will be readily admitted that they form an important feature in the history of the glacial phenomena of Caithness. Moreover, if we take into consideration the physical features of the north-west part of Caithness, the absence of deep valleys, and the limited elevation of the hills, we can hardly escape the conclusion that these later accumulations were deposited by a more or less continuous sheet of ice.

It is rather remarkable that, while these traces of the later glaciation are so abundant in the north-western part of the county, they should not have been observed in the large valleys in the south-east. We traversed the course of the Berriedale Water from the slopes of Maidenpap (2313 feet) to the sea, and observed no indications of moraines on the boulder clay slopes. It is possible, however, that small moraine heaps may yet be met with in the higher reaches of the Langwell, Berriedale, and Glut Waters.

Erratics.

Over the Caithness plain occasional boulders have been observed resting on the boulder clay, or partly buried in that deposit, which bear unmistakably the impress of glacial action on their smoothed and striated sides. They cannot be said to be numerous; still a few have been chronicled by Mr Dick and Mr C. W. Peach in their rambles, while we met with several examples during our traverses. The smaller boulders have been removed from the fields in the course of the reclamation of the land, and have been used for building dykes. At Greenvale a boulder of the Sarclet conglomerate was noted by us, and erratics of hornblendic granite. East of St John's Loch boulders of granite were also observed. Along the road from Greenvale to Ham various blocks of foreign rocks occur, which have been borne off the fields, amongst which may be mentioned grey and pink granite, quartzite, grey micaceous gneiss, red sandstone like the beds at Ham, and conglomerate. No boulders of the Upper Old Red Sandstones, which form the tract already referred to between Brough and Dunnet Bay, were observed to the

south-east of the fault, which is quite in keeping with the rest of the evidence in favour of an ice movement from the south-east throughout the Caithness plain.

Mr Dick noted a large granite boulder on the hill-side above East Murkle, near Castletown, a similar one at the head of Weston Loch, and two of the same material round the same loch. He has also recorded the occurrence of a conglomerate boulder near the Slater's Obelisk at Holborn Head. Mr C. W. Peach observed blocks of the Sarclet conglomerate near Weydale, south-east of Thurso.

West of Reay numerous *blocs perchés* occur on the moraine heaps, consisting of granite and granitic breccia, and at Dalnawillan, in Strathmore, blocks of metamorphic rocks also occur on the mounds.

Conclusion.

We must now consider the evidence which has been adduced in the foregoing pages with the view of determining the probable physical conditions which prevailed during the formation of the various superficial deposits in Caithness. We have endeavoured to show that across the plain there is one prevalent system of ice-markings running south-east and north-west, which, from the appearances presented by the striated surfaces near Latheronwheel, the Old Man of Wick, and Brough, seem to have been produced by ice moving from the south-east. This conclusion receives additional support from the fact that, as we proceed from the Ord to Reay along the tract lying between the county boundary and the inland limit of the shelly drift, the striæ point E., E.N.E., N.N.E., N., and eventually swing round to the N.W. The traverses we made across this tract place beyond doubt that the local ice, radiating from the hilly ground to the west, moved outwards towards the Caithness plain, but having there met a powerful opposing ice-current, it was compelled to change its course and turn round in the direction of the Atlantic.

That such was really the case is confirmed by an analysis of the evidence supplied by the boulder clay. There are two

deposits of this nature, the one comprising local rocks and produced by local ice; while the other is richly charged with marine shells, and contains blocks which are foreign to the county. The areas occupied by the two boulder clays correspond with the limits of the respective ice-streams, as indicated by the striations on the rock surfaces. Moreover, in spite of the lithological uniformity which prevails throughout the tract occupied by the Caithness flagstones, there are certain data connected with the dispersal of the stones in the shelly boulder clay which are only explicable on the supposition that the ice came *from* the south-east. Blocks of the Sarclet conglomerate can be traced inland in the boulder clay, while striated blocks of the grey flagstones occur in the *moraine profonde* west of the fault at Brough. Had the movement been *from* the north-west, then assuredly we would have found material derived from the massive yellow sandstones at Dunnet Head in the ground-moraine to the *south-east* of the fault. But this is not the case. In addition to this, there are blocks of oolitic limestone, oolitic breccia, septarian nodules, fossil wood, belemnites, chalk, chalk-flints, etc., in the shelly boulder clay, some of which are identical in lithological character and fossil contents with the representatives of these rocks in the basin of the Moray Firth and adjoining tracts. The occurrence of these foreign blocks in the grey drift is not explained by a movement *from* the north-west, while it is quite in keeping with the theory that the ice which filled the basin of the Moray Firth was deflected and forced to overflow the Caithness plain. In view of all these lines of evidence it is impossible to resist this conclusion.

When we consider the physical character of the reddish-brown boulder clay, it so completely resembles the ordinary lower till of Scotland, that no one who believes in the land-ice origin of boulder clay would hesitate to ascribe it to the action of that agent. The features presented by the shelly drift are somewhat different as we have shown, and for this reason the question of its origin has given rise to some diversity of opinion. But a careful consideration of the various phenomena connected with it shows that there is

really no valid argument against the land-ice origin of this deposit.

It might be argued that the shelly drift is a product of coast-ice driven along the shore by currents; but the evidence derived from the organic remains is quite at variance with such a hypothesis. It has already been stated that the most careful searching has only brought to light a few specimens characteristic of the littoral zone, while the great majority of the shells belong to deeper water. Moreover, such a supposition leaves quite unexplained the gradual deflection of the local ice in its eastward course, neither does it account for the actual inland limit of the grey shelly boulder clay. Another formidable objection to this hypothesis, which is also applicable to icebergs or floe-ice, is the entire absence of stratification throughout the wide area occupied by this deposit. Dr Croll long ago pointed out that if the grey shelly drift were really due to floating ice, it would undoubtedly have shown signs of stratification. We know that the finely laminated shelly brick-clays round the coast of Scotland, which occasionally contain striated blocks, point to aqueous disposition. But those who have examined the numerous sections of the grey drift in Caithness unite in saying that in physical character it is indistinguishable from ordinary boulder clay. Mr Jamieson states that it "resembles the Old Boulder Clay of the middle of Scotland in regard to its physical arrangement, but differs therefrom in the prevalence of marine organisms scattered through it." And in order to account for the occurrence of these organic remains, he imagines that "a set of marine beds containing Arctic shells were probably deposited over the low part of Caithness; and much drifting ice seems to have passed over the district from the north-west, which crushed and destroyed these marine beds, broke the shells, and mixed them up with the superficial *débris* into that mass of rough pebbly mud which now overspreads the surface."

Now, there is nothing improbable in the supposition that such marine beds were deposited in pre-glacial or inter-glacial times on the low ground of Caithness, though none has been chronicled by Mr C. W. Peach, Mr Jamieson, nor

by ourselves. The only record of stratified beds underneath the boulder clay rests on the authority of Mr Dick.* He describes a section seen in a small stream running into Gill's Bay, which has cut a channel down to the solid rock through a deposit of grey boulder clay, containing chalk, chalk-flints, and oolitic rocks, and yielding remains of *Mactra, Cyprina, Turritella,* and *Dentalium.* Below the boulder clay he observed a bed of gravel with broken shells resting on red sandstone. Again, on the south side of the Moray Firth, one of us found, in the summer of 1880, while prosecuting the geological survey of Banffshire, a series of stratified sands, with marine shells, which are covered in part with boulder clay. These shelly sands indicate a marine depression to the extent of 500 feet in inter-glacial times. It would seem, then, that there is evidence in favour of the existence of stratified beds with Arctic shells below the boulder clay in the north of Scotland. But even admitting the existence of such deposits, it is difficult to see how floating ice could so act on them as to produce the phenomena presented by the shelly drift. In such a case there would have been signs of stratification in the deeper sections, as, for instance, in the Scrabster Harbour, where the deposit is upwards of 100 feet thick. Nay, more, such a theory does not account for the greater abundance of marine shells along the eastern seaboard, and the gradual increase of blocks derived from the Caithness flagstones as we move inland from the east coast. Neither does it explain the deflection of the local ice.

It is perfectly evident, therefore, that the phenomena of the grey shelly boulder clay cannot be satisfactorily explained on the hypothesis of floating ice, and we are therefore forced to accept the only remaining solution, that it is really a product of land ice. Indeed, when we view the evidence supplied by the striated surfaces and the boulder clay in the light of our previous work in Orkney and Shetland, it will readily be admitted that the glacial phenomena of these widely separated areas have a close relation to each other. They point to the union of the Scotch and Scandinavian ice-sheets on the floor of the North Sea. The ice which flowed

* Life of Robert Dick, by Smiles, p. 228.

into the basin of the Moray Firth, as well as the local ice which streamed outwards in the direction of the Caithness plain, was deflected towards the north-west by reason of the greater force of the Scandinavian *mer de glace.* The pebbly mud and marine shells would be borne inland from the bed of the North Sea across the low-lying part of Caithness, where they would be commingled with the *débris* of the flagstones, and any marine deposits which might have been deposited in pre-glacial or inter-glacial times. Blocks of the various secondary formations derived from the areas crossed by the Scotch ice would also be mingled with the ground moraine.

It is no doubt true, as Mr Jamieson pointed out, that the mollusca are of a less Arctic type than those obtained from the stratified shelly clays of Elie, Errol, and other localities. But this may quite well be explained by supposing that they belong to a pre-glacial or mild inter-glacial period. The evidence in favour of alternations of climate in glacial times is steadily accumulating, during which there were constant migrations of northern and southern fauna. It does not follow, therefore, that because the fauna of the Caithness boulder clay is of a less Arctic type that the deposit does not belong to the boulder clay period. There can be little doubt, from the evidence we have adduced, that the reddish-brown boulder clay of local origin is of the same age as the grey shelly drift.

The widespread traces of moraines and gravels prove that long after the Scandinavian *mer de glace* had retreated, and the climatic conditions had become less severe, local glaciers moved outwards from the hilly ground to the west, depositing their materials alike on the red and the shelly boulder clay.

XVII. *On the Preparation and Preservation of Frozen Anatomical Sections.* By J. SYMINGTON, Esq., M.B., F.R.C.S.E., Lecturer on Anatomy, School of Medicine, Edinburgh.

(Read 16th February 1881.)

The method of anatomical investigation by means of frozen sections offers many advantages over the ordinary methods of dissecting, in the determination of the exact position and relations of the viscera and other structures.

By the researches, in this manner, of Pirogoff Braune, Luschka, Henle, Legendre, Rüdenger, etc., our knowledge of the topographical anatomy of the human body has been rendered more exact, and many erroneous ideas have been dispelled. As the plan admits of being applied to the investigation of many undetermined points in comparative anatomy, and as only vague directions are given in the various works on topographical anatomy regarding the mode of preparing, examining, and preserving frozen anatomical sections, I thought it might be useful to bring before this Society a more detailed account of the various points which my own experience leads me to consider as of special importance.

The animal or part which is to be frozen, unless very small, should be first injected with preserving fluid and the arteries filled with lard coloured with vermilion. As a preserving fluid an arsenical solution acts admirably, but care should be taken not to inject or previously immerse the animal in methylated spirit, as this would interfere with the freezing process.

If the sections are to be made in relation to any bony prominences, these should be marked on the skin previous to freezing, as when frozen they will not be distinguishable by the feeling from the soft parts. The animal should then be fixed in a watertight case, and great care must be taken that the body is not distorted in any way by pressure. For animals of moderate size, such as a cat or small dog, an ordinary fish kettle with a well-fitting lid answers admirably; for those of a larger size a tin case, as near the size of the animal as pos-

sible, must be made. The tin case is then placed in a perforated wooden box containing the freezing mixture. The freezing mixture should entirely surround the case in which the animal is placed, and means should be adopted to allow of the escape of the water formed in the freezing mixture.

Snow and salt (2 to 1) make by far the best freezing mixture for this purpose. If snow cannot be obtained ordinary canal ice, well-pounded, should be used. Snow is much more convenient than ice, considerable difficulty and waste attending the pounding of the ice sufficient fine. A considerable mass of freezing mixture should be used, and, if kept in a cool place, it will not be required to be renewed oftener than once every twelve hours. A lower temperature is obtained if the mixture be well stirred up every two or three hours.

The temperature of the mixture should be taken occasionally by inserting into it a thermometer protected by a metal tube. A temperature of 10° Fahr. can easily be obtained in this way, and with a considerable mass of snow and salt I have repeatedly found it about 0° Fahr., although the mixture had not been renewed or stirred up for twelve to fifteen hours previously.

Care must be taken that the brine does not come in contact with the animal, as parts saturated with it are extremely difficult to freeze. A small animal, such as a rat, can be frozen in a few hours, but an animal as large as a man takes four or five days. With large animals one is apt to be deceived by the hardness of the superficial parts, as the integument may be very hard while the viscera in the centre of the trunk are still unfrozen.

The sections are best made with a saw. I use a tenon-saw with a movable back, unless the animal is very large, when I employ a saw with two handles, its teeth arranged so as to cut both ways. The cut surface of the sections are to be washed with warm water to remove the saw dust, and the surface carefully dried as a layer of ice tends to form rapidly upon it.

As soon as the surface of the section has been cleaned, a tracing should be taken of it. This can best be done by

painting on glass with ordinary dry colours mixed with boiled oil and a little turpentine. Ordinary tracing paper cannot be placed directly upon the surface as it gets wet. If a thin sheet of glass be placed between the section and the tracing paper the outline of the different parts cannot be seen with sufficient distinctness. Ribemont ("*Recherches sur l'Anatomie Topographique du Fœtus*," Paris, 1878) recommends that the tracing paper be covered on one side with varnish and the other placed against the glass. This makes the tracing paper more transparent, but in my hands not sufficiently so. The tracing paper is rendered still more transparent by smearing it with boiled linseed oil, but tracing paper treated in this way does not keep well. Painting on glass, although a slower method than pencilling on tracing paper, is the best plan I am aware of.

The sections should be kept frozen until they have been thoroughly examined, although the surface may be slightly thawed to facilitate its examination.

If it is desired to ascertain the position of any particular part in the substance of the section, it can be thawed by means of a hot iron, while the rest of the section is kept frozen.

The surface of a frozen section when well washed forms an exceedingly beautiful preparation, and one not unnaturally wishes that they could be preserved in that condition; but if allowed to thaw the softening of the tissues and their unequal contraction causes the previously smooth surface to become rough and irregular, and the relative position of the parts is disturbed.

If it is desired to keep the sections they should be made as thin as possible, and carefully embedded close up to the cut surface in Plaster of Paris while still frozen, and allowed to thaw under methylated spirit.

In a series of transverse sections of such parts as a limb, it is generally recommended to make them about one and a half or two inches in thickness, but sections half an inch will keep much better.

If the section passes through any cavities containing water,

blood, fæces, etc., these should be cleared out by means of a hot iron, and the cavity filled with gelatine or Plaster of Paris before the part is allowed to thaw.

If it is advisable to keep thick sections such as one-half of a mesial section of a trunk, the displacement of the viscera upon thawing can to a considerable extent be prevented by passing long needles into the tissues in different directions. By the plans above mentioned I have succeeded in preserving a large number of frozen sections with very little displacement of the parts.

The tissues do not all freeze equally well. Muscular tissue is the best; fat never freezes so hard and firm. The nervous centres can easily be frozen, but on thawing it cracks apparently by spicules of ice. This, as is well known, rendered the freezing method useless in the microscopic examination of the brain and spinal cord; but Dr D. J. Hamilton has shown that by steeping the nervous tissue in a solution of syrup this is prevented, probably by causing the particles of ice to assume a granular instead of a spicular form.

XVIII. *Notes of a Journey to Mexico in* 1879-80.

By Patrick Geddes, Esq., F.R.S.E., Lecturer on Zoology in the School of Medicine, and Demonstrator of Botany in the University of Edinburgh.

(Read 19th January 1881.)

In this paper an account (which has been published in the last Report of the British Association) was given of the geology of the Valley of Mexico, of the author's palæontological excavations, and of his zoological and botanical collection.*

* (1.) "Report of Committee, consisting of Dr Gamgee, Prof. Schâfer, Prof. Allman, and Mr Geddes, for conducting Palæontological and Zoological Researches in Mexico" (Report Brit. Ass., 1880).

(2.) "Notice of Crustaceans collected by P. Geddes, Esq., at Vera Cruz," by E. J. Miers, F.L.S. (Journ. Linn. Soc. Zool., vol. xv., 1880).

XIX. *On the Morphology of the Cell.* By Patrick Geddes, Esq., F.R.S.E., Lecturer on Zoology in the School of Medicine, and Demonstrator of Botany in the University of Edinburgh.

(Read 16th March 1881.)

Abstract.

In this paper (which will be published in full in the Society's *Proceedings* immediately after the reading of the concluding portion early in the Session 1881-82) it is attempted to review the present position of the cell-theory, and to summarise and discuss the leading recent contributions to our knowledge of the subject, with special reference to the author's researches—(*a.*) on the relation of the ciliated to the amœboid state; * (*b.*) on the plasmodia formed by the clotting of invertebrate corpusculate fluids; † (*c.*) on the free cell-formation of the coloured blood corpuscles in *Echinus*; ‡ (*d.*) on interlaminar gemmation in *Enteromorpha*; § (*e.*) on the mode of formation of the vegetable cell-wall; ‖ (*f.*) on a new sub-class of Infusoria,¶ etc.

* "Observations sur le Fluide Périviscéral des Oursins" (Archives de Zool. Exp., 1880).

† "On the Coalescence of Amœboid Cells into Plasmodia," etc. (Proc. Roy. Soc., Lond., 1880).

‡ "Observations sur le Fluide Périviscéral des Oursins" (Archives de Zool. Exp., 1880).

§ "On the Phenomena of Variegation and Cell-Multiplication in a Species of *Enteromorpha*" (Trans. Roy. Soc., Edin., 1881).

‖ "Notes on *Chlamydomyxa labyrinthuloides*" (Quart. Journ. Micro. Sci., 1882).

¶ "Sur une nouvelle sous-classe d'infusoires" (Comptes Rendns, 1881).

JOURNAL OF PROCEEDINGS.

SESSION CX.

Wednesday, 17th November 1880.—Professor DUNS, D.D., President, in the Chair.

The following gentlemen were elected as Ordinary Fellows of the Society: William Erskine; George Bird.

An Opening Address was delivered by Professor DUNS, the retiring President, on "The Early History of Scottish Natural Science."

Wednesday, 15th December 1880.—Professor ARCH. GEIKIE, F.R.S., President, in the Chair.

The following Office-Bearers were elected:

Presidents—ROBT. ETHERIDGE, Jun., F.G.S.; Professor ARCH. GEIKIE, F.R.S.; Professor H. ALLEYNE NICHOLSON, F.R.S.E.

Secretary—ROBERT GRAY. *Assistant-Secretary*—JOHN GIBSON.

Treasurer—CHARLES PRENTICE, C.A. *Librarian*—R. H. TRAQUAIR, M.D.

Councillors—William Ferguson; Andrew Taylor; Principal Williams; J. F. King; Alex. Galletly; George Leslie; A. B. Herbert; John Sadler; B. N. Peach; D. J. Surenne; John Walcot; Professor Duns.

The following gentlemen were elected Ordinary Fellows of the Society: J. M. Anderson, S.S.C.; Patrick Geddes; Frederick Pearcey; John Glover, S.S.C.; R. Sidney Marsden, D.Sc.; Frank E. Beddard, B.A.; Ferdinand F. Begg.

The following communications were read:

1. "On the Affinities of the Liassic Genera, *Oxygnathus*, *Cosmolepis Thrysonotus*, and *Centrolepis*." By Dr R. H. TRAQUAIR, F.R.S.
2. "Additional Notes on the Invertebrate Fauna of Lamlash Bay." By Dr W. A. HERDMAN.
3. Dr TRAQUAIR exhibited, with remarks, a specimen of the Red-Legged Hobby (*Falco rufipes*), shot in Fifeshire on 20th September 1880.
4. "Early Chapters in the History of the Squirrel. Part II.—Mythological, Heraldic, and Historical Evidence in Scotland." By J. A. HARVIE-BROWN, F.Z.S.
5. Mr GRAY exhibited, with remarks, several birds from various localities in Scotland. These included an Albino Sea Eagle, shot in Shetland on 10th September; Great Grey Shrike, a young male showing vermicular markings on the under surface, shot on 28th October near Kirkcudbright; Rough-Legged Buzzard, shot at West Salton on 16th November; and a Great Crested Grebe, shot at Hopetoun on 24th November, this last bird having the stomach distended with a mass of its own feathers.

Wednesday, 19th January 1881.—Professor H. A. NICHOLSON, President, in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society: Charles Cook, W.S.

The following communications were read:

1. "Note of a Journey to Mexico in 1879-80." By PATRICK GEDDES.
2. "A List of the Invertebrata of the Firth of Forth, Part I., comprising the *Hydroida, Alcyonaria, Echinodermata.*" By GEORGE LESLIE, and W. A. HERDMAN, D.Sc.
3. "On the Structure of *Lepidodendron selaginoides.*" By ROBERT KIDSTON.
4. "Note on the Occurrence of the Desert Wheatear (*Saxicola deserti*, Rüpp.) near Alloa" (specimen exhibited). By JOHN J. DALGLEISH.
5. "Additional Notes on the Algæ of the Firth of Forth, with exhibition of new British species." By GEORGE W. TRAILL. Communicated by Professor DUNS.

Wednesday, 16th February 1881.—Professor DUNS, President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: John White; Allan Ewen Grant; John Methven; John Cooper Pottage; Wm. Christie, Jun.; Thos. Burn Murdoch, M.B., C.M.; Wm. Lang Todd, Advocate; Robert Humphrey.

The following Motion, notice of which was given at last Meeting by Mr WALCOT, was discussed in terms of the Society's Constitution, and was declared carried, viz.: "That Ex-Presidents, by virtue of the official position they have held, shall be Honorary Members of the Council, and be entitled to take part in its deliberations." It was accordingly remitted to the Council to make the necessary alteration in Rule VII., consequent on the passing of this resolution.

The following communications was read:

1. "Late Chapters in the History of the Squirrel in Scotland—Restoration and Spread of the Species." By J. A. HARVIE-BROWN, F.R.S.E.
2. "Notes on the Post-Tertiary Deposits of Elie and Largo Bay, Fifeshire." By ROBERT ETHERIDGE, Jun.
3. "On some Spiders from Newfoundland, with Description of a new Species." By Rev. O. P. CAMBRIDGE. Communicated by the SECRETARY.
4. "On the Preparation and Preservation of Frozen Anatomical Sections." By JOHNSON SYMINGTON, M.B., C.M.
5. "On a Peculiarity in the Dentition of the Bandicoot Rat of India (*Mus giganteus*)." By ANDREW WILSON, L.D.S.
7. The SECRETARY exhibited, with remarks, the following Birds:
   (1.) Hybrid Pheasant, between the Common and Golden Pheasant, shot at Birkhill on 15th January by Captain Wedderburn.
   (2.) Another Hybrid, between the Common and Lady Amherst's Pheasant, shot in December last near Alloa.
   (3.) A Red-necked Grebe, captured on the Lammermoors during a severe snow-storm on 1st February. (The last-mentioned bird showed naked traces of the breeding plumage.)

Wednesday, 16*th March* 1881.—Professor H. A. Nicholson, President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Jasper J. Capper; R. J. Shaw Simpson, M.A.; A. P. Laurie; Frank W. Young; Robert Hamilton; D. W. Kemp.

The Council reported that in accordance with the powers given them at the Society's last meeting, they had resolved that Rule VII., referring to the management of the Society, should be altered as follows: "The management of the Society shall be vested in a Council consisting of three Presidents, a Treasurer, Secretary, Assistant Secretary, Librarian, and twelve other Fellows, whose election and duties are hereinafter prescribed. Such gentlemen as have filled the office of President shall also be Members of Council."

The following communications were read:

1. "The Migration of Mammals." By Professor J. Duns.
2. "On the Presence of the Scattered Skeletal Remains of Holothuroidea in the Carboniferous Limestone Series of Scotland." By R. Etheridge, Jun.
3. "On the Morphology of the Cell." By Patrick Geddes.

Wednesday, 20*th April* 1881.—Professor Arch. Geikie, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Hugh Miller; Ernest V. Annandale; Thomas Richardson; John Gibson, Ph.D., Henry Mowbray Cadell.

The following communications were read:

1. "On the Olfactory Tubercle as a Specific Character in Ascidians." By W. A. Herdman, D.Sc.
2. "The Glaciation of Caithness." By B. N. Peach, F.R.S.E., and John Horne, F.R.S.E.
3. "The Invertebrate Fauna of the Firth of Forth, Part II., comprising *Protozoa*, *Polyzoa*, *Crustacea*, and *Tunicata;* Part III., comprising the *Porifera*, *Cœlenterata* (pars), *Vermes*, *Pycnogonida*, *Mollusca*." By George Leslie, and W. A. Herdman, D.Sc.
4. "On a Collection of Birds and Eggs from Central Uruguay," with exhibition of Specimens. By John J. Dalgleish.
5. Dr Traquair exhibited, with remarks, a specimen of the King Duck (*Somateria spectabilis*), shot in Fifeshire.
6. "On the Habits of *Parus major* and *Parus cœruleus* in Confinement." By Wm. Evans.

DONATIONS AND ADDITIONS

TO

LIBRARY OF THE ROYAL PHYSICAL SOCIETY

DURING SESSIONS 1880-81.

Proceedings of the Royal Society [of London], Vol. 30, Nos. 202, 203; Vol. 31, Nos. 207-210. *From the Society.*

Transactions of the Manchester Geological Society, Vol. 15, Parts 12, 13; Vol. 16, Parts 1, 2. *From the Society.*

Proceedings of the Geologists' Association [of London], Vol. 6, Nos. 5-9. *From the Association.*

(*a.*) Transactions of the Zoological Society of London, Vol. 10, Part 13; Vol. 11, Part 2; (*b.*) Proceedings for 1879, Part 4; and for 1880, Parts 1-3; (*c.*) List of Vertebrate Animals in the Gardens in 1879; (*d.*) Catalogue of the Library of the Zoological Society, 1880. *From the Society.*

Proceedings of the Academy of Sciences of Philadelphia for 1879. *From the Academy.*

Annales de l'Observatoire de Moscou, Tome 6, Livraison 2. *From the Imperial Academy of Sciences, St Petersburg.*

Videnskabelige Meddelser fra Naturhistorisk Forening i Kjöbenhavn, 1879-80. 2, 3, Hefte. *From the Society.*

Kais.-könig. Zoologisch-Botanische Gesellschaft in Wien. Band 29 (Jahrgang 1879). *From the Society.*

Boletin del Ministerio de Fomento de la República Mexicana, Tomo 5. *From the Ministry of the Interior, Mexico.*

Die Naturgesetze und ihr Zusammenhang mit den Prinzipien der abstrakten Wissenschaften; Dritter Theil, drei Lieferungen. *From the Author.*

Proceedings of the Berwickshire Naturalists' Club, Vol. 9, No. 1. *From the Club.*

Annual Report of the Regents of the Smithsonian Institution for 1878. *From the Institution.*

J. A. Allen's History of the North American Pinnipeds; a Monograph of the walruses, sea-lions, and seals of North America. *From the Department of the Interior, U.S. Government.*

Annales de l'Observatoire de Moscou, Tome 7, Livraison 1. *From the Imperial Academy of Sciences, St Petersburg.*

Proceedings of the Manchester Literary and Philosophical Society, Vols. 16-19, 1877-80. *From the Society.*

Memoirs of the Manchester Literary and Philosophical Society, Vol. 6, 3d series, 1879. *From the Society.*

Abhandlungen des Naturwissenschaftlichen Vereins zu Bremen, Bd. 7, Heft 1, 1880. *From the Society.*

Jahresbericht des Vereins für Erkunde zu Dresden, 1879-80. *From the Society.*

Bulletin of the U.S. Geological and Geographical Survey, Vol. 5, No. 4. *From the Department of the Interior.*

List of Occurrences of North American Birds in Europe. By J. J. DALGLEISH. *From the Author.*

The Cobham Journals, 1825-50. Edited by E. A. ORMEROD. *From the Editor.*

Science for All, Vol. 3. Edited by ROBERT BROWN, M.A., Ph.D. *From the Editor.*

Early Discoveries of the Hawaiian Islands: Evidence of Visits by Spanish Navigators during the Sixteenth Century. By HENRY A. PIERCE. Ethnologically considered by CHARLES WALCOTT BROOKS. *Presented by Mr Brooks.*

Boletin de la Sociedad de Ingenieros de Jalisco, Vol. 1, Nos. 4-6. *From the Society.*

A Monograph of the Silurian Fossils of the Girvan district in Ayrshire, with special reference to those contained in the "Gray Collection." By Professor H. ALLEYNE NICHOLSON and ROBERT ETHERIDGE, Jun., F.G.S., etc. Fasciculus I. (*Rhizopoda, Actinozoa, Trilobita*), and Fasciculus II. (*Trilobita, Phyllopoda, Cirripedia,* and *Ostracoda*). *From the Authors.*

A Monograph of the British Copepoda. By Dr G. STEWARTSON BRADY, Ray Society. Vols. 2, 3, 1878-80. *Purchased.*

Transactions and Proceedings of the Botanical Society of Edinburgh, Vol. 14, Part 1, 1881. *From the Society.*

Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger, 1880, No. 2. *From the Society.*

Proceedings of the Royal Society of London, Vol. 31, No. 208, 1880.

Proceedings of the Philosophical Society of Glasgow, Vol. 12, No. 1. *From the Society.*

Journal and Proceedings of the Royal Society of New South Wales, Vol. 13, 1879. *From the Society.*

Annual Reports of the Department of Mines, New South Wales, for the years 1878 and 1879. *From the Royal Society of New South Wales.*

Maps to accompany the above Report for 1879. *From the Royal Society of New South Wales.*

Journal of the Linnean Society—Zoology, Vol. 15, No. 85. *From the Society.*

Report on Temperatures during the Winter of 1879-80 at the Royal Botanic Garden, Edinburgh. By the late JOHN SADLER, Esq., Curator of the Garden. *From the Author.*

INDEX.

M'Farlane & Erskine, Printers, Edinburgh.

Fig. 1.

Fig. 2.

Fig. 3.

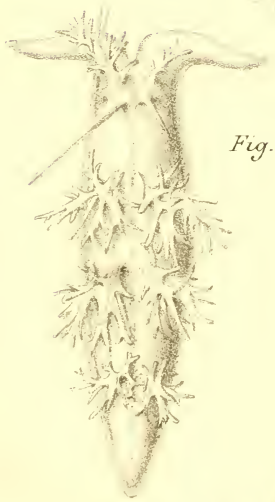


Fig. 4.

Fig. 6.

Fig. 5.

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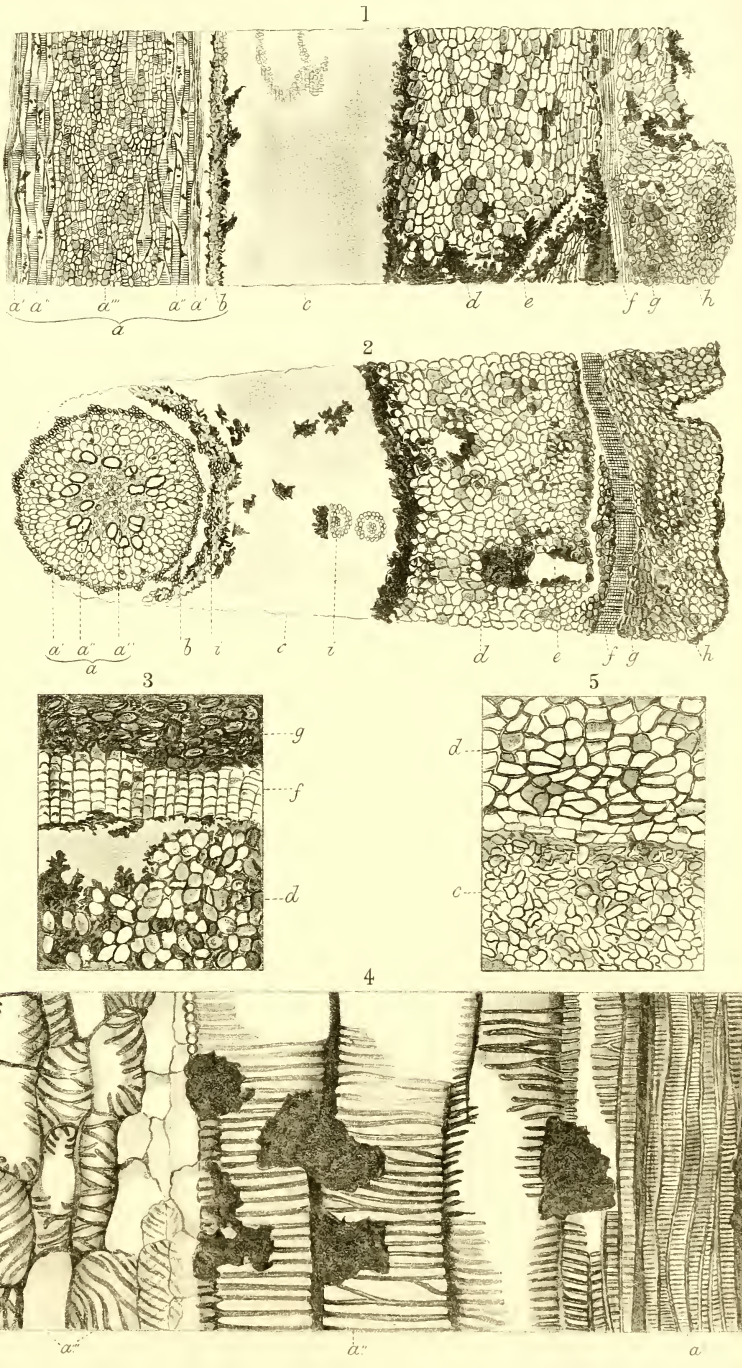
Fig^s 1-3. EOLIS MOLIOS, n. sp. Fig^s 4-6. HERO FORMOSA, Lovén.



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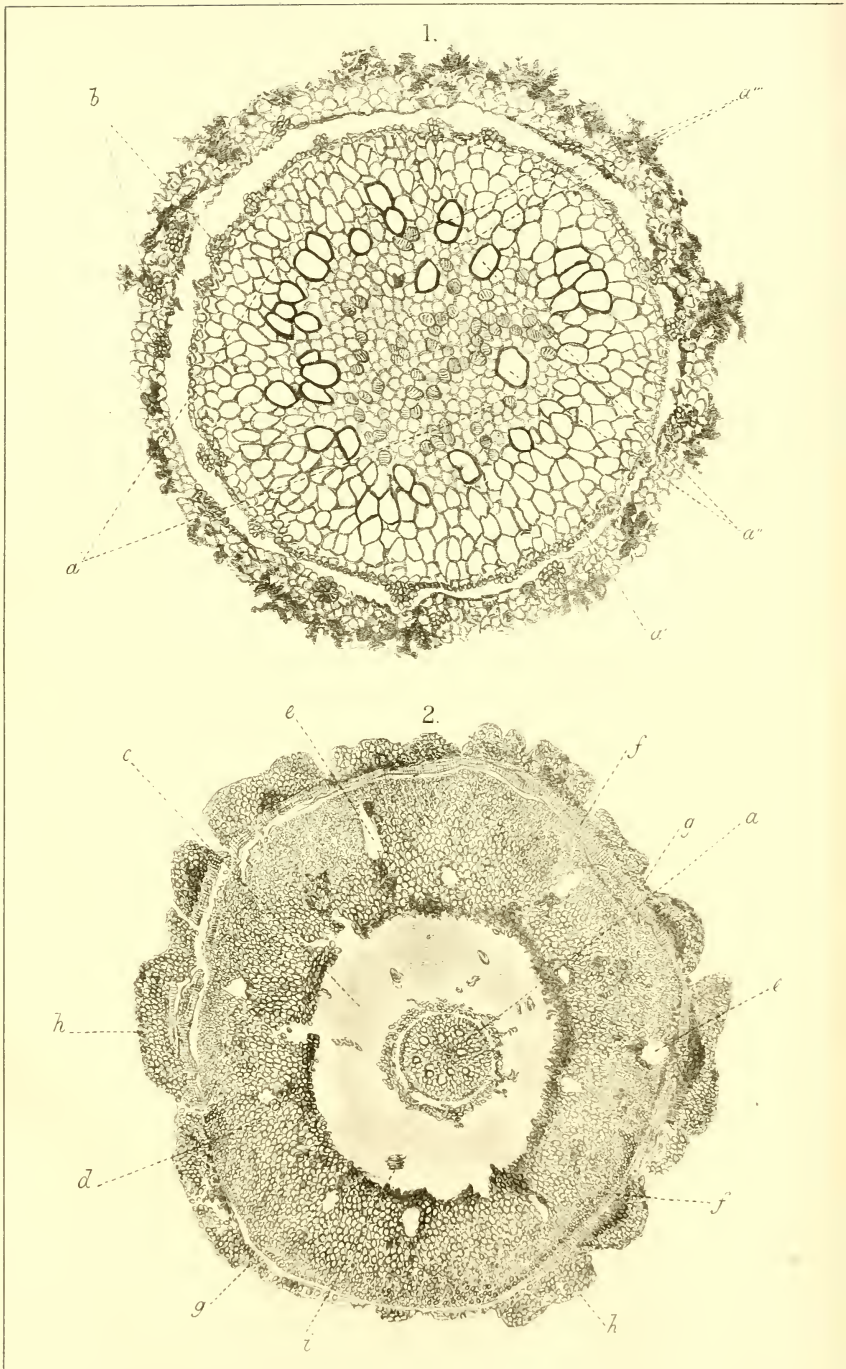

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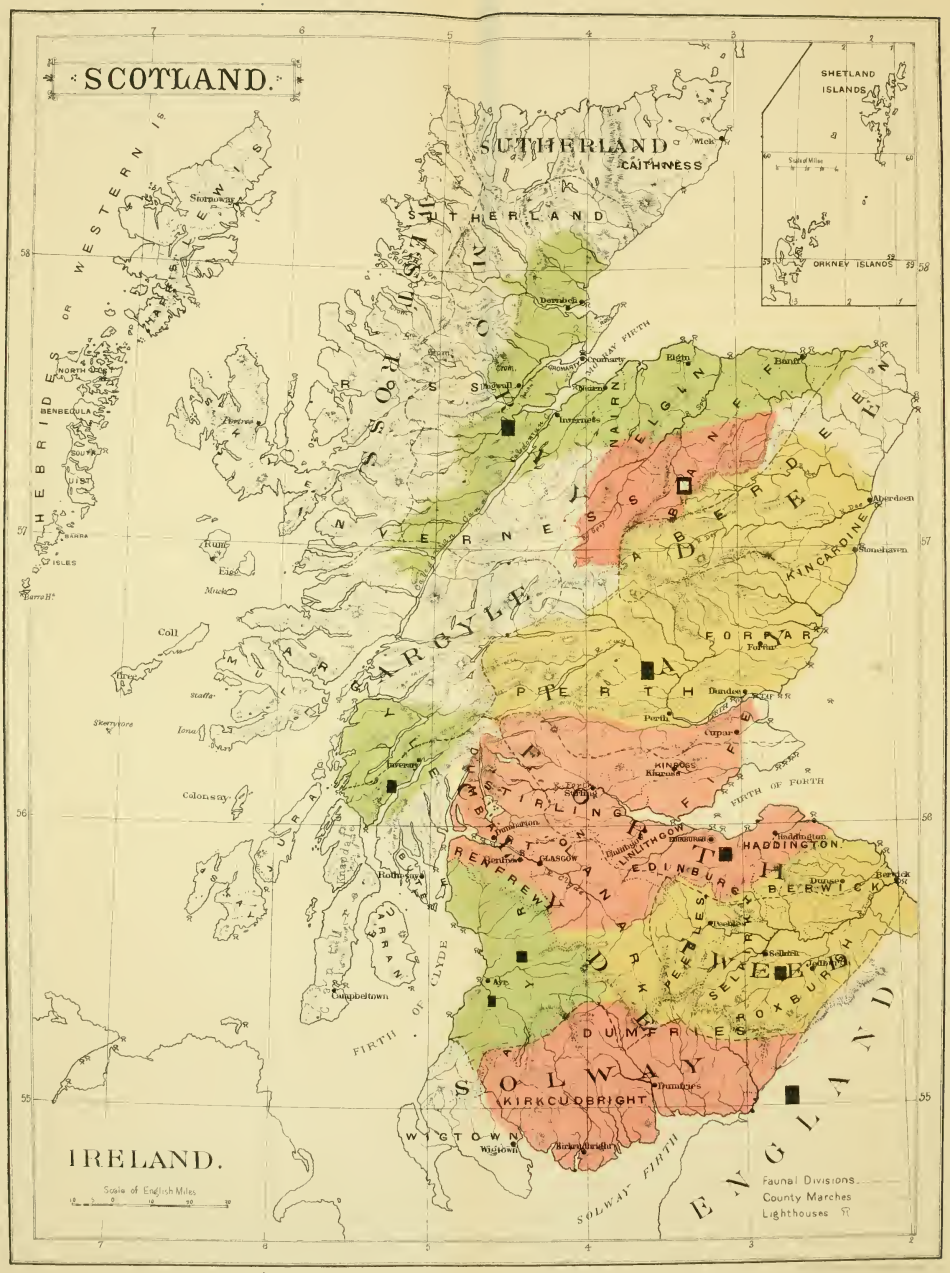
LEPIDODENDRON SELAGINOIDES.

Nat. length

O. P. C. del.

M^cFarlane & Erskine Lith^rs Edin^r

EPEIRA HILARIS. Sp. n.
Newfoundland.


SCOTLAND.
SHETLAND ISLANDS
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ROSS
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NAIRN
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BANFF
ABERDEEN
KINCARDINE
FORFAR
PERTH
ARGYLE
BUTE
DUMBARTON
STIRLING
LINLITHGOW
HADDINGTON
EDINBURGH
BERWICK
RENFREW
AYR
PEEBLES
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Faunal Divisions
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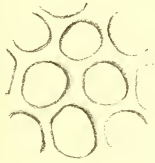
Lighthouses



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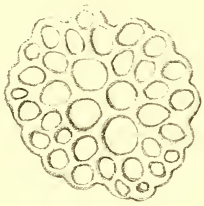

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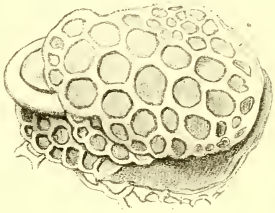

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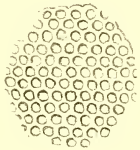

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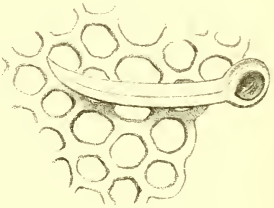

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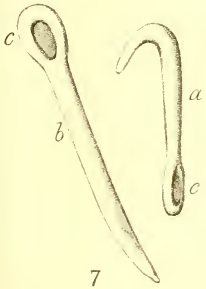

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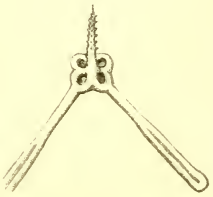

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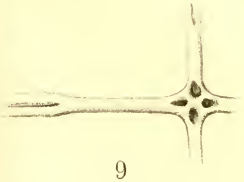

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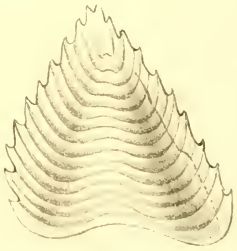

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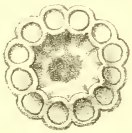

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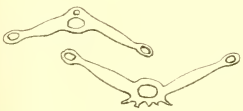

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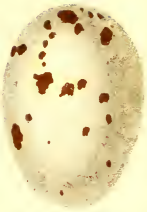

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M'Farlane & Erskine Lith.

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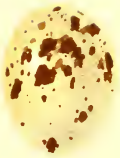

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McFarlane & Erskine Lith^rs Edin^r

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