THE

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EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

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Remarks on the Recent Eruption of Vesuvius in December 1861. By Charles Daubeny, F.R.S., &c., Professor of Botany, Oxford.*

The eruption to which I wish to direct the attention of this Section has already been described by several eye-witnesses, two of whom, namely, Professor Palmieri and M. Pierre de Tchihatscheff, of London, have communicated to the Geological Society brief reports of the most striking physical phenomena attending it, such as the outburst of springs of acidulous and hot water, and the upheaval of the ground at Torre del Greco, to the height of 1.12 metre above the level of the Mediterranean.

M. Claire Deville, also, a French savant who has made the gases evolved from volcanos his particular study, was summoned from Paris immediately upon the commencement of the eruption, and arrived in time, if not to witness the outbreak, at least to collect and examine the emanations which were its immediate consequences.

All, therefore, I shall attempt to do in this brief communication, is to point out to you the facts of the greatest novelty which others have anticipated me in recording, and to consider the bearing which they may have on the general theory of Volcanos.

Vesuvius, within the last few years, has entered apparently upon a new phase of volcanic operations. At former periods

* Read at a Meeting of the British Association for the Advancement of Science, Friday, October 3d, 1862.

its eruptions occurred at distant intervals apart, but were distinguished by their violence and magnitude.

Thus, only 9 eruptions are recorded as having taken place between the commencement of the Christian era and the beginning of the seventeenth century; in the course of the latter, viz., from 1631 to 1694, there occurred 4; in the eighteenth century 22; and in the first half of the nineteenth, viz., from 1802 to 1850, no less than 17.

Thus, even allowing for the greater imperfection of records during the Middle Ages, which might have prevented a few of the earlier eruptions from having been handed down to us, there seems to be sufficient evidence of a gradually increasing frequency in the volcanic outbreaks, as we approach the present time.

As to the greater violence of the earlier eruptions, there seems sufficient proof of it in the accounts given us by ancient writers of the fearful outbreak of A.D. 79, by which Pompeii and Herculaneum were overwhelmed; of that of 204, described by Dion Cassius and Galen, in which the noises produced by the ejection of matters from the crater were loud enough to be heard at Capua; of the third, in 472, which is said by Procopius to have spread alarm even at Constantinople; and of that great one in 1631, which, after a pause of one hundred and thirty-one years, during which the crater had been covered with shrubs and rich verdure, overspread with lava the greater part of the villages lying at its foot on the side of the Bay of Naples, and occasioned the death of 4000 persons. But it is further remarkable, that the greater number of these eruptions took place either from the crater, or at least at a high level. One only, that of 1760, broke out at a considerable distance from the summit, namely, on its southern flank, about one mile above the Convent of Camandule.

Within the last few years these conditions appear in a great degree reversed. In the year 1858, an aperture was formed along the south-west flank of the mountain, from which, after a succession of detonations and earthquake-shocks had taken place from its neighbourhood, a torrent of lava suddenly gushed out; and this was followed, a few days afterwards, by the issuing forth of several other vents along the line of the fissure, which also vomited forth streams of molten matter.

This flow of lava continued from various points, all placed nearly upon one transversal line to the axis of the mountain, for more than a year, so that in May 1859, when I took my leave of Naples, it was still going on.

Thus the lava stream travelled slowly down the sides of the mountain, in the direction of Resina, and was finally arrested about half a mile above that village.

The exact period of its cessation I have not ascertained, but I believe it was not long antecedent to the outbreak of December in last year, which took place above the town of Torre del Greco, and has been described by Palmieri, Guiscardi, and other local geologists. Here, it must be observed, the vents or fissures from which the lava issued occurred at even a lower level than on the former occasion, namely, not more than half a mile at the most from the level of the sea, and at a height of only a few hundred feet above it. If, therefore, I may be allowed to judge from these two latest outbursts of volcanic energy, it would seem as if the sides of the mountain had become so much weakened by the continued emission of ignigenous matter during so many centuries, that its walls were no longer able to sustain, as before, the pressure of a column of lava equal to the height of the mountain itself, but gave way at a considerably lower level.

The first remarkable feature in this eruption was the sudden upheaval of the coast, for a distance of several miles on either side of Torre del Greco, to the height of 3 feet 7 inches at that locality, gradually diminishing, both to the right and left, until it ceased altogether.

Thus, the Balani, Patellæ, Ostreæ, and other marine shells that live adhering to the rocks just at the margin of the sea-water, were found to be raised 3 feet 7 inches above it, affording a parallel instance to the famous one of the columns belonging to the Temple of Serapis at Pozzuoli, on the opposite shore. We have here, perhaps, the first well-authenticated instance that can be cited of an elevation of land near Naples caused by, or coincident with, a volcanic outbreak; for the well-known case at Pozzuoli seems rather to prove an oscillation in the level of the land, than a permanently elevatory movement, as the ground had first sunk, then had risen, and is now apparently sinking again below the level at which it stood at the time of the erection of the temple.

Several cases, indeed, of apparently permanent upheaval are pointed out on the neighbouring coast, but these cannot, like the present case, be referred to any particular volcanic outbreak, and it will therefore be the more interesting to observe, whether the present elevation of the land near Torre del Greco is maintained, or whether the latter again shall subside, after a few years, to its former level.

It has struck me, that the reason why the lava-stream which issued from the fissures on the morning of the 8th of last December was so soon arrested in its downward progress, may have been its flowing into the hollow occasioned by the heaving up of the land along the coast, which took place during the great earthquake, that ushered in the eruption, and produced so much damage and alarm in the town of Torre del Greco.

This last eruption has also been characterised by the evolution of certain volatile matters, not hitherto observed, I believe, amongst the products of Vesuvius.

Upon approaching the town of Torre del Greco, nearly a month after the eruption had taken place, I perceived a very powerful and offensive smell of naphtha, which pervaded the whole place, especially in the vicinity of the sea. Its occurrence reminded me of the asphalt met with in the volcanic tuff at Pont du Chateau, near Clermont, in the midst of the genuine volcanic rocks of Auvergne, and probably as a product of similar operations in the Dead Sea; but the most abundant examples of the same phenomenon are to be found amongst pseudo-volcanic rocks, as at Trinidad, and in Sicily, at Macaluba, and at Leonforte.

Another product, now for the first time detected amongst the emanations of Vesuvius, and perhaps having a similar origin, was light carburetted hydrogen or marsh gas, which M. Deville found bearing in the proportion of from 3 to 4 per cent. to the carbonic acid evolved from the fumeroles near the town. In order in some degree to appreciate what this proportion of the gas would amount to, we must recollect that the quantity of carbonic acid disengaged from the earth during, and subsequently to, such an eruption as the one I am describing, is something so enormous, that the mind can hardly grasp its proportions.

On the day I visited Torre del Greco, which was on the 10th of January, and therefore thirty-three days after the eruption had taken place, the atmosphere throughout the town of Torre del Greco, and over a considerable area on either side of it, was so impregnated with carbonic acid gas, that my respiration was sensibly impeded, especially as I approached the level of the Mediterranean. There, indeed, even in the open air, the oppression on the lungs caused by the presence of this gas was so great, that I was glad to make a hasty retreat to a higher part of the town, in order to breathe a purer air. The gas was bubbling up in various places in the sea like a great caldron, and a copious spring, fully charged with carbonic acid, had appeared in a new place, and was gushing down into the sea close to the hot mineral waters of Torre. No wonder, therefore, that in confined situations, as in cellars, the accumulation of noxious gas was at this time such, as to render the atmosphere utterly unrespirable, and that many of the dwellings of the town had been in consequence deserted.

Curious to obtain some rough estimate of the proportion of carbonic acid which pervaded the air of the town and its vicinity, I prevailed upon M. Deville to analyse the latter in different positions, and obtained from him the following report respecting it:—

1*st.* In the first street, on entering the town from the side of Naples, and at a height of about 30 feet above the sea's level, at a little distance from a fissure from which mephitic gas was issuing, having a temperature of 40 Cent., the carbonic acid bore as high a proportion as 6·5 per cent. to the remaining air. There the houses were uninhabited, but men were working in the open air, within a few yards of the spot from which the air had been taken.

2*d.* In a street which runs at right angles to the former, and at a height of about 5 feet above the ground, where there was a free circulation of air, the percentage of carbonic acid amounted to 3·1.

3d. On the road to Resina, outside of the town of Torre, on the slope of the hill upon which it is built, 5 feet from the ground, under a shed standing in front of a cook-shop, the percentage was 2·6.*

I think it might be possible, by applying the formulæ contained in Bunsen's Gasometry to the data thus afforded, to approximate to the quantity of carbonic acid emitted from the ground in a given time, assuming the atmosphere to be impregnated to this amount to the height of 20 feet from the ground, over an area of a mile, embracing Torre del Greco as its centre, and this state of things to continue for at least thirty-three days from the date of the eruption; but without entering into such calculations, the amount emitted will be seen to be something prodigious, if we estimate the rapidity with which a gas spreads itself through the atmosphere, when no natural obstructions occur to prevent its diffusion. In setting down, therefore, the proportion of marsh gas to that of carbonic acid at 3 or 4 per cent., we in reality represent it as constituting no insignificant product of the volcanic operations going on in this locality.

But how are we to account for the presence of this new gas, and of the naphtha which accompanied it, amongst the emanations of the volcano? Are we to suppose the volcanic processes themselves to have undergone a change, or are we to account for it by their having been set up in connection with certain new materials?

The former of these explanations would probably be preferred, if we adopted the views of M. Deville, and recognised with him two classes of volcanos,—the one those of the common kind—the other such phenomena as are exhibited at the Lago Naftia, and at Macaluba in Sicily, as well as in the peninsula of Taman, and in some other localities, and which are the results of what persons imbued with this hypothesis have designated by the name of mud-volcanos.

* In the most densely crowded apartments, the percentage of carbonic acid has seldom been found to range higher than about 1 per cent.

These latter are broadly distinguished from the former, by the absence both of lava and of scoriform masses, as well as by the ejection of semiliquid mud, consisting of a kind of unctuous clay mixed up with water, having crystals of pyrites disseminated, and a saline effervescence on its surface. And whilst the erupted masses of an ordinary volcano reveal a temperature sufficient, in some instances, to fuse cast-iron and copper, the outburst of a mud volcano is attended with comparatively little heat; for the ejected mud of Taman is stated by Pallas to have issued quite cold, and the gases of Macaluba were found by Deville to exceed only by 3° Cent. the temperature of the surrounding air.

Moreover, whilst the gases evolved from volcanos in general, during their active condition, are muriatic and sulphurous acids, those which accompany the outbursts of what are called mud volcanos seem to be confined to carbonic acid, light carburetted hydrogen, and nitrogen. This composition, which I determined at Macaluba so long ago as the year 1825,* has been also assigned to them by M. Deville, in one of his letters to M. Dumas, as the result of his recent examination of this locality.

There seems, therefore, nothing in common, between the gaseous products of ordinary volcanos and those of which Macaluba and Taman are the types, except it be carbonic acid, which is emitted in enormous quantities both by the one and the other.

If, then, we were to adopt the hypothesis above suggested, it must be imagined that Vesuvius is at present in a kind of transition state, passing, as it were, from its ordinary phase of operations into one which approximates more nearly to those of mud volcanos; carburetted hydrogen, naphtha, carbonic acid, and azote, taking the place of hydrochloric and of sulphurous acids.

But another mode of explanation suggests itself to my mind, which seems less encumbered with difficulties, and which, whilst it places the pseudo-volcanic phenomena of Macaluba and the like under an entirely different category from those of

* See my "Sketch of the Geology of Sicily" in the Edinburgh Philosophical Journal for 1826.

genuine volcanos, will enable us to account for the occasional occurrence of such products as have exhibited themselves for the first time at Vesuvius, without supposing any essential change in the character of the operations of that volcano. On looking at the table suspended in the room,* which states on the authority of Deville, Bunsen, and Boussingault, the nature of the gases disengaged from those volcanos which have been most accurately explored, it will be observed, that some, such as hydrochloric and sulphurous acids, together with, in certain instances, an inflammable gas—which, as it gives rise to flames, probably contains, as one at least of its constituents, hydrogen—occur during a period of intense activity; others, such as carbonic and sulphuretted hydrogen, and sometimes atmospheric air, with less than its normal proportion of oxygen, are disengaged, where the action is more languid. Now, I would regard the former as the primary and essential concomitants of volcanic action, the latter as the secondary and accidental ones.

The former gases originate from the chemical actions, which either originate, or are inseparably connected with, the internal processes or workings of the volcano.

To my mind they suggest, that the access of sea-water to the seat of the internal action is the prime mover of the processes going on, and at the same time indicate the existence of a heat sufficient to disengage from the chlorides contained in the sea-water their electro-negative principle, leaving the bases free to combine with silicic acid or other earths, and thus to form silicates, aluminates, &c.

They also indicate the existence in the interior of the earth, near and about the seat of the volcanic action, of a deoxidizing as well as of an oxidizing process; the former causing the water present to be decomposed into its elements, and its hydrogen eliminated; the latter causing the sulphur to be converted into sulphurous acid gas, and perhaps other elements, existing in the interior of the earth, either in a free state, or in combination with sulphur, also to undergo oxidation.

That these two antagonistic processes should be going on at

* This Table is given at the end of the Memoir.

the same place and time, cannot indeed be supposed; but if we grant the existence in the interior of the earth of materials capable of decomposing water, it is quite conceivable that the heat produced by this reaction should occasion the volatilization of the sulphur present, and its consequent escape into a region where it could combine with oxygen, and thus be converted into sulphurous acid gas.

But as there are doubtless many who may prefer to imitate the caution of M. Deville, and to abstain from theorising on the subject, I would only ask my hearers to admit with me the essential connection of the above gaseous products with volcanic action, as evinced by their frequent, if not their constant co-existence, apart from any hypothesis as to the cause of their being so associated.

It is different, however, with some of the other gases which will be seen enumerated in the table alluded to.*

Carbonic acid, though, as we have seen, disengaged in enormous quantities from the earth in the vicinity of the volcanic outbreak, is not in general emitted from the crater itself during the period of an eruption, nor is sulphuretted hydrogen usually detected, except at the foot of the mountain, or during the more languid phases of its action.

The same remark would seem to apply likewise to the petroleum or naphtha, which was so abundantly disengaged after the late eruption, as well as to the carburetted hydrogen now for the first time detected. With the exception, therefore, of the sulphuretted hydrogen, which will be afterwards considered, I am tempted to regard the latter products as due merely to the action of the volcanic heat upon certain materials, upon which it was brought to operate in the neighbourhood of the volcano.

Let us, for example, suppose the Apennine limestone, which we know to occur in immense masses in the immediate neighbourhood of Vesuvius, to contain imbedded in it beds of bituminous shale, or even to be impregnated, as our own carboniferous limestones frequently are, with the same ingredients, and we can then readily understand, that there should be a disengagement, not only of enormous volumes of carbonic acid,

* Page 13.

due to the heating of the limestone itself, but also of naphtha and carburetted hydrogen, arising from the slow distillation of the bituminous matters imbedded or contained within it.

As for the sulphuretted hydrogen indeed, so abundantly given off in the precincts of most volcanos, it appears to have a different origin. Its absence from the immediate focus of volcanic heat may be accounted for, as both its constituents would at such a temperature take fire so soon as they came into contact with oxygen; but the sulphur disengaged from the volcano, whether alone or in combination with hydrogen, would form sulphurets with the earthy materials which it met with. Wherever the absence of oxygen admitted of this reaction taking place, it is quite easy to understand that the mere approach of water to these sulphurets should give rise to the evolution of sulphuretted hydrogen.

It is even possible, that the sulphuretted hydrogen found in the immediate neighbourhood of volcanos may in some instances be derived directly from the volcano, having escaped to the surface through channels in which oxygen was not present in sufficient abundance to cause its combustion to take place. By adopting this hypothesis, we get rid of the necessity, both of imagining Vesuvius to be passing into the condition of a Macaluba, and also of admitting any connection or analogy between this volcano and those others to which the name of mud-volcanos has been applied. The latter probably originate in the accumulation of vast beds of earthy and metallic sulphurets, together with bituminous materials, in the interior of the earth, often brought together, no doubt, through the instrumentality of antecedent volcanic operations; but the immediate cause of their eruptions must be sought in the access of water to such materials,* by which a heat would be produced sufficient to cause the extrication of carburetted hydrogen, as well as of carbonic acid, from the incandescent mass. Hence would arise a heaving up of the semi-fluid mud, the ejection of stones, and even at times the emission of flames. Large as the scale may be on which these operations are going on in the neighbourhood of the Sea of Azof, there is nothing in the nature of the phenomena themselves there

* See Bischof, Chemical Geology, p. 325.

exhibited, which should justify us in identifying them with ordinary volcanic processes.

The volcanos of Central Tartary, of which we have heard so much, but know so little, may probably turn out to be due to operations of the same nature as those of Macaluba, or of the peninsula of Taman. The most recent and authentic accounts transmitted to us certainly tend to dispel the notion that any true volcanos exist in that quarter,* so as to establish a real exception to the general rule that all such operations are dependent upon the near proximity of the sea.

On the other hand, it is difficult altogether to reject the testimony of so many Oriental writers, who speak of burning mountains, and of sal-ammoniac and other volcanic products, as common in these regions.

Is it not more probable—as being more consistent with analogy—that phenomena like those which, on a small scale, were presented in the neighbourhood of Lulworth some years ago, and which, in this enlightened age and country, were dignified by the name of volcanic,—phenomena which, on a scale of greater magnitude, have even produced certain not unimportant physical changes upon the condition of the neighbouring country (as in the peninsula of Taman),—may also have taken place in parts of Central Tartary, and have given rise to the accounts that have come down to us. Such an explanation does not preclude the idea that real volcanos may have existed there at some former period, when, perhaps, a great Mediterranean Sea connected the Caspian with the Lakes of Aral and Baikal; and hence may have arisen the volcanic appearances, of which Erman speaks, in the neighbourhood of the latter; whilst, if this be the case, we should have an adequate cause assigned for that accumulation of sulphurets, which, in conjunction with bituminous or carbonaceous matter, would be competent, at any subsequent time, to give rise to the phenomena of the so-called mud-volcanos.

I offer these remarks with the diffidence due to their specu-

* See Meyer's Translation of a journey made by Schrenk, a Russian traveller, in 1840, into the Eastern Kirghisian Steppes, the statements in which narrative were confirmed by the same explorer in 1841.

lative and hypothetical character; but what I consider of much greater importance, and should wish to see undertaken, if possible, in every locality where volcanos exist, is an accurate examination of the gaseous and other emanations proceeding from them in their various phases of activity. Possibly, indeed, I may somewhat over-estimate the value of this investigation, from having taken some part in it myself, and by finding the results of my somewhat coarse methods of analysis confirmed by the greatly more precise and extended researches subsequently carried out by Bunsen and Deville. But at any rate, I am quite sure, that no theory of volcanos can be considered worth attending to, in which an accurate account is not taken of the gases evolved, and in which their occurrence at the time and place at which they manifest themselves is not fully accounted for.

When this Association, some years ago, wished to become better acquainted with the processes going on in the interior of our iron furnaces, in spots unapproachable from their excessive heat, we commissioned Professors Playfair and Bunsen to examine the gases that escape from the upper orifices of their chimneys. And in like manner, I conceive, we can in no other way become acquainted with what is going on at the focus of a volcano, in spots inaccessible, from their depth, to man, than by collecting the products of the chemical processes there enacted from the fumaroles by which they communicate with the surface.

Perhaps, indeed, I may take the liberty of suggesting to geologists, that in their eager haste to class volcanic movements amongst the consequences of some of those great cosmical changes which are supposed to be going on, they have been sometimes too apt to ignore the chemical phenomena which accompany these great outbreaks, and are not sufficiently alive to the fact, that where chemical operations constitute so large a part of the problem, the aid of the chemist must be invoked, in order to arrive at an adequate and satisfactory solution. Should this be the case, the above remarks, even if they should fail of their direct object, will not be thrown away, since they may tend to direct the attention of those geologists who make volcanos their study, to the real nature of the investigation, and to the methods of research which must be resorted to with a view to its successful prosecution.

TABULAR VIEW OF VOLCANIC EMANATIONS.

No. I.

Volcanic Emanations, classified according to their position with reference to the Volcano in which they occur.

Locality.	Composition.		
	Water.	*O*	*Other Constituents.*
Vesuvius (D)			
Its Crater	absent	norm.	HCL SO_2
— Base	present	def.	CO_2 SH a trace
— Lavas	absent	norm.	CO_2 SH with or without NH_3
Ditto	present	def.	HCL SO_2
Phlegrean Fields			
Solfatara	present	def.	CO_2 SH ; CO_2; or SO_2
Lago d'Agnano	present	norm., or slightly def.	CO_2
Lipari Group (D.)			
Island of Volcano			
Crater	present	def.	Flames, SO_2; BO_3; SO_2
North Flank.		def.	SO_2
Base	present	abs.	Co_2
Boiling Springs		abs.	SH
Etna (D.)			
Crater		norm.	HCL and SO_2
Base, from Springs		abs.	SO_2
Iceland (B.)			
Hecla, Crater	absent	def.	
Krisiwik, Solfatara		abs.	CO_2 SH ; sometimes H
Equinoctial America (Bouss.)	present		
Fumaroles, various	present	norm.	CO_2 SH

No. II.

Volcanic Emanations, classified according to the successive periods of their appearance.

First stage of activity,

From the fissure of the eruption.

No water, atmospheric air, with or without salts containing Cl.

Second stage of activity,

From the lava stream, when just cooled upon the surface, but chiefly from its lower portions.

Water, sal ammoniac, and other chlorides, with atmospheric air.

Third stage of activity,

From the crater above the point whence the lava had issued.

Chiefly atmospheric air, O rather deficient; sometimes with Water, HCL, SO_2.

Fourth stage of activity,

From another spot in the crater, above the point aforesaid.

Water, with a bare trace of SH and of S.

Fifth stage of activity,

Found about Etna, but not at Vesuvius.

Water alone.

Sixth stage,

Only appearing towards the close of an eruption, but continuing afterwards during all the subsequent stages of languid volcanic action, the gases being evolved, not from the lava, but from the interior of the earth.

Water, O deficient or wanting, sometimes CO_2, with or without SH. sometimes SO_2, with or without BO_3.

N.B.—To this latter class belong thermal waters, mofettes, and other obscure results of volcanic action. It is a significant fact, with reference to the theory of volcanos, that whenever water is disengaged from them, the atmospheric air that accompanies it is either wholly, or in part, deprived of its normal proportion of oxygen. This is the result of the examination made both by Deville and Bunsen, neither of whom certainly were biassed by any theory to which such a fact might lend support.

Abbreviations.—N. Nitrogen; O. Oxygen; O. Norm., Proportion of oxygen the same as in common air; O. def., Proportion of oxygen less than in common air. HCL. Muriatic acid; SO_2. Sulphurous; CO_2. Carbonic; BO_3. Boracic; SH. Sulphuretted hydrogen; NH_3. Ammonia; NaO. Soda; KO. Potass; (D.) St Claire Deville; (B.) Bunsen; (Bouss.) Boussingault.

The Buried Church in the Sands of Gwithian in Cornwall.

By R. Edmonds, Esq., Plymouth.

The ancient British church discovered about thirty-five years since in the sands of Gwithian, on the north-west coast of West Cornwall, is probably coeval with that found in the sands of Perranzabuloe, on the north-east coast of West Cornwall; which latter I visited in September 1835, soon after its discovery; and the then present condition of it, as well as its description given by Wm. Michell, Esq., in the Cornish newspapers, immediately before I saw it, I have recorded in the "Literary Gazette."

Had Gwithian been within the Land's End district, I should have noticed its ancient church in my lately published work on that district.

It stands three or four furlongs from the sea, in the eastern part of St Ives' Bay, and about the same distance northward of the present church, near the eastern side of the road leading to Godrevy, and close to a small tributary stream running parallel with the road.

Its roofless walls were, up to the time of their discovery, completely buried beneath the turf-clad sand; and this tumulus had nothing externally to distinguish it from the hundred other green mounds in its neighbourhood. The walls may still be seen, although externally the sand is level with their tops. They are very rudely built, without cement or plaster, and consist of small unhewn stones of slate, quartz, and sandstone,—all very abundant in that neighbourhood. The two or three old beams resting on them are, I grieve to say, the remains of a roof placed thereon many years since, when the building was used for a cattle-shed, by the farmer who owns it.

The chancel and nave, lying east and west, are very distinguishable from each other,—the former being narrower than the latter. The length of the building externally is fifty-three feet, nineteen of which are occupied by the chancel. The breadth of the chancel externally is sixteen feet; that of the nave, nineteen. The height of the walls from the ground, on the inside, varies from six to eight feet. The doorway is in the middle of the south wall of the nave; and midway between it and the chancel-pier was apparently the place of a window. There are vestiges also of a small doorway, now built up with stone, in the northern end of the eastern wall. The dilapidated stone altar, and the stone seats all around the chancel, are now covered with sand about a foot deep.

The farmer who discovered this ruin found several skeletons near it, as he stated to the Rev. Frederick Hockin, the rector of the adjoining parish of Phillack, whose church is the mother church of that of Gwithian. Mr Hockin, to whom I am indebted for the above description, saw it a few years after its discovery, when less dilapidated than at present.

There is a great similarity between the two old churches of St Gwithian and St Piran* in the sands. Both were found without roofs, the worshippers having, in all probability, carefully removed their consecrated materials in order to use them again for sacred edifices less exposed to the drifting sands. Both were completely covered with calcareous sand, the Gwithian church having also a covering of turf,—the two coverings being striking emblems of death and resurrection. Both had cemeteries adjoining them. Each had an altar within, and a small rivulet or overflowing well close by it, testifying to the two sacraments; whilst the chancel and nave, distinguishable from one another, yet forming one church, represented the clergy and laity performing different offices as different members of the one body. The relative positions of the priests' door and the door of the congregation are the same in each church: in the Gwithian church, however, the stone seats are along the walls of the chancel only; in the other church they are also around the walls of the nave. The Gwithian altar, too, is against the middle of the eastern wall, while the Perran altar is midway between the priests' door and the south end of the eastern wall.

As Mr Trelawny considers the Perranzabuloe British church, and would, no doubt, also have considered the Gwithian British church, "to have been built in the sixth century," although I am disposed to assign them a much earlier date,† I may remark in conclusion, that to that century I have referred the monument found in 1843, three miles from the latter church, at Hayle, a creek of St Ives' Bay. This monument, with its inscription, is represented in the "Archæologia Cambrensis" for 1857, and my work already referred to.

* The name of this Saint is always spelt *Piran*; but the name of the parish (to which *St* is never prefixed) was *Perran in sabulo*, now corrupted into *Perranzabuloe*.

† See "The Land's End District," p. 59.

The Minute Anatomy and Physiology of the Nervous System in the Lobster (Astacus marinus). By T. S CLOUSTON, M.D., Assistant Physician, Royal Edinburgh Asylum. (Plates I and II.)

(*The following paper formed a part of the Graduation Thesis presented by the author to the University of Edinburgh, entitled "Contributions to the Minute Anatomy and Physiology of the Nervous System, as illustrated in the Invertebrata," for which he received one of the Gold Medals awarded by the Medical Faculty.*)

Believing that the simpler the structure and motions of an animal are, the less complex will be the nervous mechanism by which those motions are stimulated, I have selected the lobster (*Astacus marinus*) as the subject of the following observations. It approaches more nearly the simple articulated type in the length of the body and the distinctness and equality of its segments than any other animal of its class sufficiently large and sufficiently procurable in this country. Its nervous ganglia, therefore, combine the three elements, of large size, firm consistency, and distinct separation from each other. These advantages have not been overlooked by previous investigators, for Newport examined most carefully the structure of the nervous system of the lobster, and greatly advanced our knowledge of the subject.* He demonstrated the course of the nerve fibres as they enter the ganglia from the peripheral nerves; and if he was mistaken in his idea that there were two columns in the central part of the nervous system, a motor and a sensory, and came to wrong conclusions about the structure and functions of the ganglia,† it is more to be attributed to the backward state of physiology and histology at the time than to any want of acuteness on his part. Valentin adopted a different plan from Newport, and arrived at more correct conclusions.‡ He experimented on the river crayfish (*Astacus fluviatilis*) by vivisection; but to infer its structure from the phenomena observed after sections and

* Philosophical Transactions, 1834.

† See Dr Carpenter's "Inaugural Dissertation on the Physiological Inferences to be deduced from the Structure of the Nervous System in the Invertebrated Classes of Animals," and his Comparative Anatomy.

‡ Valentin, De Functionibus Nervorum, p. 8.

mutilations of the nervous system, is neither so satisfactory nor so sure as to demonstrate that structure under the microscope. The inferences can only extend to generalities, and in many instances the effects of a section may admit of more than one explanation. Dr Ernst Hæckel, in an inaugural dissertation on the tissues of the river crayfish, devotes a chapter to the minute anatomy of the nervous system, describing both the cells, and fibres, and neurilemma,* but did not attempt to describe the arrangement of these in the ganglia.

Different methods of hardening and preparing the nervous system have been recommended and employed by different observers. The central chain of ganglia must be carefully dissected out first, and the nerves springing from them left pretty long, so that the ganglia may be held steady while sections are being made. As much of the surrounding tissue must be removed as possible, and it is well to select a live lobster, as the nerve tissue is the first to soften after death. I tried numerous methods of hardening the tissue. That recommended by Van der Kolk, of first hardening it in spirit of wine, and then applying chloride of calcium to the sections, I did not find to be successful. The tissue was made too transparent, so that the fibres could scarcely be distinguished from each other, and the nerve-cells could not be made out at all. The method of hardening the ganglia in a weak solution of chromic acid (4 grs. to the ounce of water), and then making the sections transparent by applying a strong solution of chloride of calcium, I found to be by far the best. They must not be allowed to remain in the acid solution for more than eight or ten days or they will get friable, and generally they are sufficiently hardened to be cut into thin sections after four or five days' immersion. After the ganglia have been taken out of the chromic acid, they ought to be put into a weak solution of bichromate of potash ($\frac{1}{100}$ or $\frac{1}{200}$ to 1 part of water). After the sections are made they must be allowed to steep in water on the slide, to get rid of the chemical reagent that has permeated and hardened them. If this is not done, crystals form after the addition of the chloride of calcium, and obscure the section. This obvi-

* Müller's Archives, 1857. Dr E. Hæckel,—"Ueber die Gewebe des Flusskrebses."

ates the objections urged against this method by Van der Kolk. I found it most convenient first to dry up the water round the section after having placed it in the middle of the slide, then put on the covering glass, and place a drop of the solution of chloride of calcium at the edge of the cover, which soon finds its way to the section, making it very transparent, without destroying the distinctness of the outline of a single cell or fibre. There is still enough of the brown colour produced by the chromic acid left to give definition and sharpness to them. The residue of the chloride of calcium solution may then be wiped away by blotting paper, and the cover luted by applying two or three successive layers of asphalt in solution.

The sections may be coloured by being placed in a watch-glass containing a weak solution of carmine; and if they are then placed on the slide and treated with chloride of calcium, as I have described, the cells and fibres, and the relation of these to each other, may be seen very beautifully. The advantage of thus colouring them is not great, however, as regards the definition of structure, as compared with the simple method.

I also tried to put up sections, both coloured and uncoloured, in Canada balsam, as recommended by Lockart Clarke,* but they generally became too transparent; and even when this was not the case, the advantages of this method over the other did not appear to me at all to compensate for its greater difficulty. I am willing to admit, however, that this may have been the result of my own inability to apply this method properly. Certainly it appears to have a great advantage in the case of vertebrate nervous tissue.

Even with the best of these methods great care is required, both in making the section, and after it is made, not to injure it. The ganglionic matter is much more lacerable than the fibrous; and even when as hard as chemical re-agents can make it, plenty of spirit must be poured on the upper surface of the razor, so as to float the section as it is being made; and after having been transferred to the slide, if water be added too suddenly to the spirit, the section whirls about and is frequently broken up. A considerable number of mishaps

* Phil. Trans., 1859. Part I., p. 458.

will occur to what appear to be good sections, even in the most careful and practised hands.

The Investment of the Nervous System.—In the lobster the immediate investment of the ganglia and inter-ganglionic cords consists of a membrane somewhat like the corresponding structure in the peripheral nerves of the vertebrata. Taking the invertebrata generally, the density and thickness of this structure is in proportion to the amount of support given to the body of the animal by its external investiture. In the lobster, with its hard shell, it is comparatively thin; in the talitrus, with its horny plates, it is fortified with an additional cellular layer outside the fibrous one; in the leech, with no protecting material except a tough skin, there is a special dense covering of at least twice the thickness of the tissue it protects; and in the limax, the neurilemma contains a cretaceous deposit. In the fresh state, like the nervous system of the lobster itself, this membrane is semi-transparent; but after being hardened in chromic acid, I found it to be composed of two distinct layers of fibres,—the external running longitudinally, and the internal running transversely round. Each fibre is very distinct, and there are a few nuclei among them. In a very thin cross-section of a ganglion, the sheath presents an appearance like that represented in Plate I. fig. 1. The outer layer is then seen like a bundle of rods cut across *a*, and the limit between them and the transverse fibres is very well defined. This sheath sends in septa through the ganglia, as well as among the fibres in the inter-ganglionic cords.

Investing the two cords that connect the first thoracic to the cephalic ganglion, there is, in addition to the sheath I have described, a cellular layer. The cells have very thin walls, are pressed into hexagonal forms, and remind one of the cells in the loose pith of some plants. At the root of the pneumogastric this substance is of unusual thickness, forming an investment much thicker than the nerve substance proper. Its existence is accounted for by the fact, that the cords at that part pass through what corresponds to the pleural cavity, and require a special investment to make up for the want of support on either side.

The Nerve-Fibres.—Hæckel describes and figures the nerve-fibres of the river crab as simple tubes of different sizes, having diffluent contents, frequently dividing, and having nuclei in their walls The nerve-fibres are very large, but irregular in size, in most of the nerves of the lobster, and present a double outline,—not of the same character as the double outline of a mammalian nerve-fibre, but two equally distinct lines very close to each other, indicating that they are tubular. Some of the smaller ones, where the wall of the tube is very thin, do not show the double outline. Their average size is about $\frac{1}{600}$ of an inch in diameter, but there are many large fibres $\frac{1}{200}$ of an inch in diameter.* These large fibres were observed by Ehrenberg, and fully described by Remak in other allied species of the Crustacea. In fresh specimens they resemble blood-vessels, for which at first, indeed, I took them. Leydig made a similar mistake, but at length came to the conclusion that they were really nerve-fibres.† He figures these fibres, along with others minutely fibrillar, from the river crayfish.‡ I have repeatedly seen the same appearance in the lobster, and have one section of a cord connecting the first thoracic to the cephalic ganglion, which might almost have been the original from which Leydig's drawing was made, so similar is it, but this section happens to be cut very thin at one end, so that the fibres can all be individualised as they are traced towards this end of the section (Plate I. fig. 2 *a*). Any one examining it in this way can satisfy himself that the fibrillar appearance is only apparent, being produced by the close apposition of a number of the smaller fibres, whose outlines, seen all together, give the appearance in question. At the thin end of the section, where there is only one layer of fibres, there is no fibrillar appearance, and none of the fibres are striated longitudinally as Leydig describes them. Every stage of gradation can be traced between the dense longitudinal streaking and the unstriated fibres. This may account for Leydig's statement, that in the crab he has seen

* Hæckel gives the diameter of the fibres in the river crab as from $\frac{1}{188}$ to $\frac{1}{5000}$ of an inch. I measured them after they had been hardened in the chromic acid.

† Leydig, Lehrbuch der Histologie der Menschen und der Thiere.

‡ *Op. Citat.* p. 60.

fibres in an intermediate condition between the striated and the large tube-like ones. After the nerve-fibres of the lobster have been hardened in chromic acid, especially if they have lain long in the solution, they may be split up into fibrils by being tapped smartly between the cover and the slide (Plate I. fig. 2 *b*). Leydig says it is only the originally striated ones that can be broken up in this way; but any one may convince himself that all the nerve-fibres will split up in this way when hardened. The inter-ganglionic cords and peripheral nerves are entirely made up of tubes such as I have described, but in the optic nerves the fibres are much more delicate and smaller (Plate II. fig. 6 *a*), and the peduncles of the "hemispherical ganglia" seem to me to be composed of mere fibrillæ, and resemble much the fibrillation produced by breaking up the ordinary fibres. It is a curious and most interesting question, which I have not been able to solve, whether those minute filaments which we find in the cerebral ganglia do not, by their aggregation with similar filaments from other ganglionic centres in the brain, form the ordinary nerve-fibres. The latter would thus be compound structures, and might, at their peripheral terminations, again distribute their elements amongst the tissues. All the fibres contain oval nuclei scattered over them at regular distances. The nuclei bulge inwards towards the interior of the tubes. A few fresh nerve-fibres of the lobster, coloured with carmine, and then made transparent with acetic acid, form a very beautiful object under the microscope, from the nuclei taking up the colour. I have never been able to satisfy myself of the division of the nerve-fibres described by Hæckel.

When a nerve is cut across in such a thin section as to show the structure of the fibres, as in Plate I. fig. 4, they are seen to be tubular. This section also shows well the relative sizes of the tubes. The large ones at *a* appear as a series of open spaces, and it may be thought that they are merely the areola of cellular tissue left after the nerve fibres have been squeezed out in the manipulation; such, however, is not the case. From cross sections, in this way, too, it may be seen that there is no central solid band in any of the fibres. Cross sections of the fibres, as they leave nerve-cells, show in many cases granular contents, doubtless the granular contents of the cells prolonged into them. The appearance of a fibre as it leaves a cell, is frequently very different from that I have described and figured. It is smaller, and has not the same tubular aspect, and the nuclei are not present. It is very difficult to account for the existence of those large fibres, except by supposing that they are the result of the junction of smaller ones. The nerve-cells differ enormously in size; but as the fibres leave the cells, no such very marked difference in size is observable.

The Nerve-Cells.—Ehrenberg was the first to describe nerve-cells in the invertebrata, but he did not appreciate their importance. Since his time they have been particularly described in almost every division of the sub-kingdom, by Helmholtz, Hannover, Will, Kölliker, Wagner, Bidder, &c. Newport described them in the lobster; but so far from estimating their real value as the most essential parts of the nervous system, he thought they were for the nutrition of the fibres. It would be idle here to mention the disputes that have taken place as to whether the cells are apolar, bipolar, or multipolar. It is sufficient to say, that as micro-neurology has advanced, the belief has become strengthened and confirmed, that all the cells are at least unipolar, and most of them multipolar. Hæckel described and figured the nerve-cells of the river cray-fish as large, nucleated, and either unipolar, bipolar, or tripolar.

If a portion of one of the ganglia of the lobster be torn asunder by needles and examined under the microscope, nerve-cells of various sizes will be seen, but they will all seem apolar. In the sections of hardened ganglia, however, they appear very different. They vary in form and character enormously. In size they range from $\frac{1}{50}$th to $\frac{1}{2000}$th of an inch in diameter.* They are filled with granular matter, which, as was mentioned before, is prolonged into the tubes they give off. After hardening in chromic acid this granular matter shrinks up round the nucleus, assuming a brown colour, more dense near the nucleus. The quantity of this granular matter in different cells varies much. In some, after hardening in chromic acid, the brown granular matter fills up

* In the river crab, Hæckel says they are from $\frac{1}{100}$ to $\frac{1}{500}$th of an inch in diameter.

the cell, whilst in others it is entirely absent, and the nucleus is uncovered. As a general rule, however, it fills at least half the space contained within the cell wall. It shrivels irregularly, and is connected to the cell wall by prolongations in all directions. This is so well marked in some cases, when the cell is large, and the nucleus is in the centre, that the granular mass seems a stellate cell giving off prolongations to a circle which surrounds it (Plate I. fig. 2 *d*). Those cells have generally more than one process given off from them as nerve-fibres. In many cases a large number of cells may all appear unipolar in one section, whilst if the section is made in a different direction they are seen to be multipolar. This is very well seen in the group of cells lying in front of the optic commissure in the cerebral ganglion (Plate II. fig. 4 *i*). The large nerve-cells generally give off larger processes than the smaller ones, but this rule is not invariable. It is a curious fact, however, that so far as one can judge, the number of large *cells* in the ganglia is in about the same *proportion* to the small ones, as that of the large *fibres* to the small ones in the inter-ganglionic cords.

All the cells are nucleated. The nuclei are always darker than the shrivelled granular contents of the cell, and correspond in size to the size of the cell. The varying quantity of the granular matter in the cells affords ground for curious speculation as to the causes why it should be so. May it not be that the cell's power or irritability is in proportion to the amount of its solid contents? They may in that way indicate the state of nutrition of the cell at the time the animal died; so that if this happened after the muscles of any part had been powerfully exerted for a long time, the cells in the nerve-centre supplying these muscles would be devoid of granular contents, and *vice versa*.

In addition to the connection of the nerve-cells to the fibres, they have also connections with each other, of which little or nothing has been said by any one (Plate I. fig. 2 *c*). Processes can be distinctly traced from one cell to another. Generally there is a stellate projection where such a process comes off from a cell.

There are other cells existing in large numbers in the cephalic ganglion at the roots of the cephalic nerves, which are much more uniform in size and shape (see Plate I. fig. 3 *a*, and Plate II. fig. 6 *b*), being all small, round, and with stellate nuclei, which appear to send their processes to other cells, and to the roots of the nerves and to the hemispherical ganglia. These cells are the smallest in the nervous system of the lobster, requiring a very high power of the microscope to discover their appearance. They are all about $\frac{1}{2000}$th of an inch in diameter.

In the cephalic ganglion also there are granular nuclei surrounded by a maze of minute fibres, which I shall afterwards describe more particularly. (Plate I. fig. 3 *b*).

The arrangement of the cells into groups is so constant that I must here make a few observations on the subject. It is not the result of natural boundaries, for two or more groups are constantly seen lying in contact, as in Plate II. fig. 1 *d*, *f*. The cells composing each group are of various sizes, and have more connections to each other than those of different groups, giving them a more intimate relationship than mere apposition. Each cell has generally one principal process, which runs in the same direction as the processes of the other cells of the same group; and this is what gives this grouping its importance and interest. The approximated processes of the cells form a kind of pedicle to the group, like the stalk of a bunch of grapes. All the processes of the cells of a group do not take the same course, but some of them may join the cells in another group (Plate I. fig. 6 *c*), or pass towards the cephalic ganglion. If the section is made in any other direction than that in which the pedicle goes, the cells may seem to be mostly apolar, or merely with processes to each other. I have frequently seen two bundles of nerve-fibres proceeding in different directions from what appeared to be but one group of cells.

Van der Kolk has described a similar arrangement in vertebrata.*

Before proceeding farther, it may be well to give a sketch of the anatomy of the nervous system in the lobster, as seen by the naked eye.† It consists of a series of ganglia, usually described as fourteen in number, but I think they ought to

* Van der Kolk on the Spinal Cord. Sydenham Society's Translation.

† I would here refer to a very correct representation of the nervous system of the lobster given by Newport in the Philosophical Transactions for 1834.

be stated as fifteen, the enlargement at the foot of the pneumogastric nerve (Plate II. fig. 3 *a*) being in structure and function like any of the other ganglia, as will be seen from its minute anatomy. One of these is cephalic; one æsophageal; seven thoracic; and six abdominal. The cephalic ganglion is supported by a strong fibrous membrane, attached to each side and behind it, and has a large fleshy mass nearly the size of the ganglion itself placed above it. Its form is oblong, flattened from above downwards, so that a section across it appears oval (Plate II. fig. 5). The two optic nerves are given off from the anterior angles, and the two cords from the first thoracic ganglion enter the upper surface at the opposite angles. From the sides and under surface four other pairs of nerves are given off to the antennæ, the organ of hearing, and the integuments about the head. The ganglion bulges into two prominences on the under surface behind the roots of the optic nerves, where it has also a more opaque appearance than elsewhere.

The two cords that connect the cephalic to the first thoracic ganglion are separated by the æsophagus which passes through between them. Each gives off a nerve to the æsophagus and stomach, which is sometimes divided into two (Plate II. fig. 3). There is always a ganglionic enlargement here, and a cross nerve connects the two cords after the æsophagus has passed through between them. These two enlargements, together with the cross cord, constitute, in my opinion, a true ganglion, as was conjectured by H. Milne-Edwards.*

The thoracic and abdominal ganglia have been carefully described by Newport.† His description, however, which is generally accepted, is biassed by his theory as to the existence of motor and sensory tracts. In the thoracic region, the longitudinal cords uniting the ganglia are double; in the abdomen, there is merely a single cord. Each thoracic ganglion consists of two little roundish masses of friable ganglionic substance, united by a ridge on the under surface. This ridge consists chiefly of transverse fibres from the lateral nerves of one side to those of the other. The nerves spring much more

* See Art. "Crustacea," in Todd's Cyclop. of Anat. and Phys.

† Philosophical Transactions, 1834, p. 408.

from the abdominal than the dorsal aspect of the ganglia. Newport was certainly mistaken when he described distinct abdominal and dorsal tracts in the cords. He even figures the division between them, and says they can be dissected* away from each other after the cords have been hardened. I have carefully examined the nervous system in more than a dozen lobsters, after hardening some in spirit and some in chromic acid, and I never could see any trace of those two tracts; and in thin cross sections of the cord and ganglia (as in Plate I. fig. 4) it is demonstrated that they do not exist. In the abdominal region, the inter-ganglionic cord is described as single; but cross sections reveal a septum prolonged from the sheath antero-posteriorly, dividing the cord into two not very symmetrical halves (Plate I. fig. 4). The septum bulges to one side, but the number of fibres on the one side is much the same as on the other. Where the septum joins the sheath on the upper surface, *d*, it is thickened, appearing as a triangular mass of fibrous matter. So distinct is this appearance, that I was at first disposed to consider it a tract of smaller nerve fibres. In the section represented, one of the posterior motor nerves, *e*, is seen cut across, as it lies in contact with the dorsal surface of the cord on one side. The fibres of those nerves are supposed to run upwards directly to the cephalic ganglion. The septum is present in each of the ganglia, but is not so distinct as in the cord.

The abdominal ganglia are slight elliptical swellings on the under surface of the cord. The lateral nerves in this region are very much smaller than in the thorax.

The anterior lateral nerves of the thoracic ganglion are much smaller than the posterior; and this is also the case, but not so much so, in the abdomen. Their distribution is thus described in "Todd's Cyclopædia:"† "The posterior and larger sends branches to the basilar articulations of the extremities; the anterior, again, distributes twigs to the muscles of the flanks; the two soon anastomose, and form a single trunk before penetrating into the extremity itself, which then traverses the whole limb, sending a branch to the muscles of each arti-

* Philosophical Transactions, 1834. Plate xvii. fig. 42.

† Vol. i. p. 765.

culation." The true distribution of those nerves is very easily made out by a simple experiment. I first performed it accidentally when dissecting out the nervous system in a lobster which was scarcely dead. As the anterior and smaller nerve of the large claw was being divided, the whole claw was strongly drawn towards the abdomen, and the nippers convulsively opened, while section of the posterior large one produced exactly the opposite effect,—viz., strong extension of the whole extremity, and convulsive closing of the nippers. This I have frequently since repeated, with the same result in both the large and small claws. The anterior is therefore the extensor, and the posterior the flexor nerve of the claw. The size of the nerves is seen to be in exact proportion to the force of opening and closing the pincers in the large claws, and in the others the two nerves are much more uniform in size.

The first thoracic ganglion gives off ten pairs of nerves to the mandibles and foot-jaws. The caudal ganglion is triangular in form, with a large bulging on the under surface. It gives off ten nerves—two to each of the five segments of the tail, one for the outward, and the other for the inward motion. This may easily be demonstrated by experiment.

Microscopic Anatomy.—The minute structure of one of these ganglia can only be studied by making thin sections through it in different directions, to show, 1*st*, The distribution of the ganglionic matter; 2*d*, The course of the fibres given off by the nerve-cells; and 3*d*, The course of the fibres of the peripheral nerves when they enter the ganglia. The second is the most difficult part of the investigation. I selected about fifty from the sections I made and put up permanently as microscopic preparations; and after a careful examination of these, I have drawn the accompanying plan (Plate I. fig. 7), which embodies in one view all the facts observed in reference to the cells and fibres in a ganglion. Many of the sections merely show the distribution of a single group of cells; but it seemed to me that no clear or truthful idea of a ganglion could be got except by arranging together, in an ideal ganglion, all the isolated facts observed. The interlacement of fibres is such, that it requires many sections to be made across, and longitudinally, and in an oblique direction, to demonstrate all the anatomy.

A ganglion in the thoracic region is the most typical, being bilateral, and one of those I shall therefore describe first. There are a number of fibres which enter into and pass out of each ganglion without being connected to cells at all. These have been well described by Newport, and I merely had the opportunity of confirming the accuracy of his observations. He describes four sets of fibres :—1. Those which arise in the cephalic ganglion, and pass downwards on the dorsal surface of the cords, not entering farther into the formation of each ganglion (Plate I. fig. 7 *a*). 2. Those which are given off from the longitudinal cord, and enter into the formation of the lateral nerves directly *c*. These fibres bend round, and emerge from the ganglion at a right angle to their entrance. 3. Those which pass transversely across the ganglion from one lateral nerve to the one of the opposite side, and at right angles to the first set of fibres *b*. At least one half, or, in some of the nerves, (*e. g.* those in third thoracic ganglion), two-thirds of the fibres pass across in this way. They bend round the longitudinal cord on the under surface, only a few of them interlacing with the longitudinal fibres. Their curvature in this direction renders it impossible to make sections in the longitudinal direction, showing the fibres running from one side to the other. If the section is made in the course of the fibres of the lateral nerve of one side, they are cut across in the middle line. Cross sections of the ganglia through the roots of the nerves are not much more successful, as the nerves have a very slight direction forwards, so that they meet at an angle in the middle line in this direction as in the other. A few cross fibres may often be seen in this way, however. 4. The remaining set of fibres, like the last, have no connection with the head. They cannot be traced in the lobster from one ganglion to another. Newport describes them in the Myriapoda, where the ganglia are closer together, and indistinct bands of fibres can be traced from the one to the other. They seem in each ganglion to be part of the second set of fibres, but instead of going to the head, they run a certain distance along the cords, and then join the lateral nerves of other ganglia on the same side of the body. In some sections a band of fibres is seen to bend outwards and join the lateral nerves, corresponding to those at *e* in the diagram. Those evidently connect the parts of the body posterior to this ganglion, with the segment of the body which it supplies. It is probable that these are both fibres of reinforcement, and comprise also fibres from the cells of the ganglia, posterior to the one from which this section was made (those at *f* in Plate I. fig. 5). Some of them run from one ganglion to the next, whilst others extend to ganglia farther away, thus keeping up a direct connection between all the lateral nerves of the same side. I have myself demonstrated the existence of such fibres in the leech, connecting the two lateral nerves of the same side in the same ganglion. In that animal, some of the fibres of one lateral nerve bend round, and, without entering farther into the composition of the ganglion, emerge among the fibres of the adjacent nerve. Newport calls them "fibres of reinforcement," because they keep up the bulk of the longitudinal cord to the last ganglion.

The ganglionic matter is disposed in five places in each ganglion,—viz., in the four angles formed by the lateral nerves and longitudinal cords, and in the space between the two longitudinal cords. Those aggregations of ganglionic matter are not really distinct from each other, for that in each angle is connected with that in the other angle of the same side by a bridge, that passes round the entering lateral nerve, encircling it in a collar. It is this that partly forms the bulging on the under surface, that gives the character to the ganglion.

When a longitudinal section is made in the course of the nerve-roots as they enter the ganglion, and if the section be near the abdominal surface, the following appearance presents itself (Plate I. fig. 5). The longitudinal and transverse fibres are seen crossing each other, *c*, and a bundle of nerve-fibres from the lateral nerve are seen to change their course, and become continuous with the longitudinal cords, *d*. In many of the sections I made, this is seen much more distinctly than in the one represented. In the angle of meeting of the lateral nerve and cord, the nerve-cells are seen; and in this case they lie in two groups *f* and *g*. The cells of each group seem to be, for the most part, unipolar, but this results from many of them being superposed. They are of very different sizes, two very large ones being seen at *h* and *i*, but most of the others are small. In all of them, the granular contents are condensed round the nucleus by the chromic acid used in hardening the specimen. Each cell gives off one principal fibre, and all the fibres of the cells of each group collect together into a bundle. The main group sends its fibres to become continuous with the fibres of the longitudinal cord. These correspond to the group at *f* in Plate I. fig. 7. In this section, many of the fibres from the cells thus seem to join the longitudinal cords; but in by far the majority of the sections I made, the fibres from the principal groups of cells join the lateral nerves. The largest cell *i*, in the other group, has two processes going from it in the same direction,—viz., to the lateral nerves of the opposite side, and corresponds to those at *g*, in the diagram. This section also shows a few of the cells in the centre of the ganglion, between the two longitudinal cords, *k*, whose processes evidently go in an oblique direction to the other lateral nerve of the same side. They are a few of the cells seen in Plate II. fig. 1. On the other side of the nerve at *l*, between it and its fellow of the same side, there are a number of detached cells belonging to the ganglionic collar which invests each lateral nerve as it joins the ganglion. Most of these processes pass towards the opposite side, but many of the cells are seen to be bipolar, each pole taking a different direction. They correspond to a part of those at *i* in the ideal section. Of the other processes of the cells, some pass into the lateral nerve of the same side, and others upwards among the longitudinal fibres. The cut fibres at *m* are a bundle of longitudinal ones cut across as they pass over those of the lateral nerves.

If we now examine a section made in the same direction, somewhat more towards the dorsal part of the ganglion, as is represented in Plate I. fig. 6, a somewhat different appearance is presented. That at fig. 6 is a section of the same ganglion as that at fig. 5. In it the longitudinal fibres are cut somewhat obliquely. In fig. 6 *a*, many of the cells are seen to be connected with each other by processes; and not only are those of the same group connected in this way, but also those of the two groups seen at *c* and *d*. The cells next the longitudinal cord, *c*, send the greater portion of their fibres at first transversely, but they soon change their direction, and reinforce the longitudinal cord. This group corresponds to that at *k* in fig. 7. In this section those fibres cannot be traced, so far as to show that they do not change their course and join the lateral nerves, but I have other sections which demonstrate this point. The fibres from the other group, *d*, join the lateral nerve of the opposite side. They are not so distinctly seen as those from group *c*, for they are on a lower level, and covered by the longitudinal fibres. They correspond to *g* in fig. 7, and are representative of a larger number of fibres in the ganglia than any other group. This can only be ascertained by examining a large number of sections; and after doing so, and ascertaining the comparative frequency of the groups represented in fig. 7, I find that those at *g* and *k* are by far the most frequently met with, thus establishing the tendency of groups of cells in the ganglia to send most of their fibres to the opposite side. The groups of cells which send their fibres to the lateral nerve being more numerous than those which send them to the longitudinal cord, it follows that the group at *g* is representative of a larger number of nerve-cells in the ganglia than any of the others. In connection with the group at *c*, fig. 6, there are a few fibres, whose processes, *f*, pass in an altogether opposite direction to the main body of the fibres of the group, and are represented by the upward fibre seen at *g*, in fig. 7.

I selected those two sections, not because they present the most typical cells, for their cells seem many of them unipolar, and with fewer than ordinary observable connections to each other, but because they are of the same ganglion, and show the principal bundles of fibres from the groups of cells running in a great many different directions, illustrating, more or less fully, nearly all the ideal section in fig. 7. A section in my possession shows, in addition to the fibres of reinforcement, two groups of cells, whose processes pass to the lateral nerve of the opposite side, and backwards to join the cord. The latter are represented in Plate I. fig. 6 *c*.

The ganglionic substance, situated between the two cords, is best seen in cross sections of the ganglia through the roots of the nerves, like that represented in Plate II. fig. 1. The space between the cords, especially towards the abdominal aspect, we then see to be filled up by cells, which arrange themselves into four principal groups, two on each side of the middle line. Those groups are indicated in the section, more from the bundles of fibres proceeding from them, than anything else. At *d* we see a group of pretty uniform cells, sending its chief bundle of fibres across the middle line to join the lateral nerve of the opposite side. It corresponds to the group at *m* in Plate I. fig. 7. At *f* there are a number of large cells, most of which send their processes to the lateral nerve of the same side. The nerve processes from opposite sides (*e* and *d*) cross in the middle line. Those at *f* correspond to the fibres at *h* in Plate I. fig. 7. The groups of cells situated nearest the middle line are thus seen to send their processes to join the lateral nerves of the same side, while those situated more externally send theirs to the lateral nerves of the opposite side. The group at *g* is one whose pedicle has been cut off, and the cells appear apolar. In another cross section in my possession, a crossing of the fibres at the root of the nerve is seen, some of those lying above, passing downwards to the abdominal surface of the nerve, and *vice versa*. The object of this is not apparent.

The structure of an abdominal ganglion is very much the same as I have described. The ganglionic substance is less in quantity, and forms an oval bulging on the abdominal surface of the cord. The separate aggregations of ganglionic substance which I have described in the thoracic region are here fused into one, the cells situated between the cords being pushed downwards by their union. There are more cells anterior to the lateral nerves than posterior to them. The grouping of the cells is still seen. The arrangement is best seen in a longitudinal section made from the dorsal to the abdominal surface. Such a section is represented in Plate II. fig. 2. Numerous groups of cells are seen whose processes all run towards the dorsal surfaces. The most anterior group, and the one next it, *c*, send their processes far up among the longitudinal fibres, and at *d* they may be seen to change their course and join the longitudinal fibres towards the cephalic ganglion. The processes of the next group, *e*, run towards the fibres of the lateral nerves, seen cut across at *b*, some of them apparently joining them, whilst others run upwards among the longitudinal fibres. All the other cells *f*, send their processes towards the lateral nerves, showing a tendency to encircle them, so that we can have little doubt they reinforce them. By far the larger number of fibres from the cells in this way cannot be traced any further than the lateral nerves A cross section of an abdominal ganglion opposite a nerve displays three principal aggregations of cells ; one on either side, and one in the middle. The mediate septum is more distinct than in the thoracic ganglia. The middle group of these cells correspond to those between the cords in the thorax (Plate II. fig. 1). Some of the fibres from the two outer groups of cells pass into the lateral nerves of the same side, whilst others cross to those of the opposite side. The fibres from the middle group run upwards along the septum at first, some of them going to the same side, and others to the opposite side. Many of the cells of the latter group show processes cut across which take a different direction from the main body of the fibres, and which probably give them a connection to the longitudinal cord.

Some comparative anatomists, such as Newport and Bruch, have described ganglionic cells in the roots of the lateral nerves in the invertebrata analogous to the ganglia on the posterior spinal nerves. Bruch figures them in the leech.* I have made the most careful sections of the roots of many of the thoracic nerves, and have not been able to detect their presence in the lobster. Indeed, I am satisfied that they do not exist, for I sliced the roots of several of the nerves in the longitudinal direction, and examined all the sections under the microscope without being able to discover a single cell. In some cases, the collar of ganglionic substance, which I have described as encircling the lateral nerves as they join the ganglia, extends a little outwards, but this is in no degree analogous to a ganglion.

The Pneumogastric Ganglion.—The slight swelling at the root of each pneumogastric nerve (Plate II. fig. 3), is found on examination to consist of ganglionic matter. When a thin longitudinal section is made of it, groups of cells are seen to

* Even in the leech I have not been able to confirm Bruch's observation.

surround the roots of the nerve, whose processes pass, some of them upwards along the cord towards the cephalic ganglion, some of them along the nerve, but the greater number of them downwards towards the first thoracic ganglion. If we dissect off the fibrous covering from one of the cords, and also from a small portion of the cross nerve (Plate II. fig. 3 *c*), and trace its fibres under a microscope of low power, they may be seen to run as a distinct bundle, and aid in the ganglionic swelling (*a*). Many of them pass directly into the pneumogastric. Each cord is thicker at the part between the cross nerve and the root of the pneumogastric than at any other place. Those two swellings, therefore, are the two halves of a ganglion, and the cross cord is the commissural fibres. It is a ganglion dissected by Nature to let the æsophagus pass through between the two longitudinal cords at that part. This view is taken by H. Milne-Edwards in the article "Crustacea," in Todd's Cyclop. of Anat. and Phys., but I am not aware that he had any grounds for this opinion from dissection.

The Cephalic Ganglion.—Like the other ganglia of the body, the structure of this can only be ascertained by making sections through it at different parts and in different directions. A thin longitudinal section of the whole ganglion near its upper surface, and through the longitudinal cords at their junction, and the roots of the optic nerves, presents the appearance seen in Plate II. fig. 4. But before describing this, it may be well to describe a thin section of the roots of the longitudinal cords alone. The fibres from each spread themselves out; a number of the inner ones passing across the middle line, and forming a true decussation with those of the opposite side. Some of the fibres of each that lie most external, cross over the inner fibres, and become continuous with corresponding fibres from the other cord (Plate II. fig. 4 *k*.) In this way there is as direct a communication between the two longitudinal cords of the body as between the lateral nerves of opposite sides of a ganglion. The same section includes a part of the roots of the second cephalic nerve, a bundle of the fibres of which turns downwards and joins with the fibres of the longitudinal cord of the same side. Scattered amongst these fibres, there may be seen a few groups of ganglionic cells with no apparent connection to the fibres; but this probably results from the way the section is made. The majority of the fibres of the longitudinal cord do not decussate.

If we now examine the section to which I have referred, which is made in the same direction as the last, but deeper, we see the arrangement of the deeper fibres of the longitudinal cords and of the optic nerves (Plate II. fig. 4). Most of the decussating fibres of the cords become continuous with the roots of the optic nerves of the opposite side *c*. A number of the fibres, which do not cross, are also seen to reinforce the optics *d*. Passing from one optic nerve to the other, there is a large bundle of fibres forming a commissure *e*, as in the vertebrata. Indeed, it will be seen that the roots of the optics take the same course as in the vertebrata. There are commissural fibres, fibres crossing to the other side of the middle line, and fibres remaining on the same side.

In the middle of the thoracic cords there is an oval space *f*, where the fibres are cut across. This is not seen in a more superficial section, and is a large bundle of fibres that join the cords at this part from the large ganglionic mass to be presently described. They join the fibres of the cords at an acute angle, and are bending down to take the direction of the latter, where they are cut across in this section. At three points ganglionic cells are seen *i*, *h*, and *g*. They are all towards the periphery of the ganglion, and the processes from the cells take an inward direction. The largest group fills up the crescentic space in front of the optic commissure. These processes seem all to pass backwards, crossing the commissural fibres in bundles. In a section in which they can be traced, they are seen to join the longitudinal cords of the same side. The cells seem to be all unipolar in this section, but in a vertical one it is seen that there are other processes from the same cells which take a different direction, passing downwards on the under surface of the ganglion towards the roots of the cephalic nerves. The two other groups of cells in this section are packed as it were into the triangular space formed by the meeting of the optic nerves and longitudinal cords with the fibrous sheath to the outside. These fibres go downwards and backwards to reinforce the cords also.

A section still deeper, in the same direction, brings into view a part of the granular masses to which I have referred, exterior to the cells at *g*, in Plate II. fig. 4.

The structure of the deeper parts of the ganglion is best shown by cross and vertical sections through it. But in order to dispose of the anatomy of the optic nerve, I shall first describe a section diagonally through the ganglion (Plate II. fig. 6). This displays the course of the deep fibres of the optic nerves, which are seen to radiate on entering the ganglion, the upper ones passing over the hemispherical ganglia *e*, and following the course I have already pointed out; the deeper ones passing out first backwards, and then being reflected at an acute angle over the granular masses, leaving a space *b*, which is filled up with cells of the kind figured in Plate I. fig. 3 *a*. Many of the fibres of the optic nerve seem to lose themselves amongst those cells, some of them evidently being connected with them.

A cross section of the whole ganglion, near the centre, or slightly anterior to it, shows well its anatomy. Such a section is represented in Plate II. fig. 5. Only at one part can such a view be obtained, the slightest variation to either end of the ganglion obscuring its most important points. The ganglion is seen to be bilateral. On either side, and situated somewhat more towards the upper than the lower surface, are two large granular bodies *a*, of a somewhat circular form, well defined all round, except inferiorly, where a large bundle of fibres, which we may call the "peduncle," emerges. Each mass has apparently little connection with the surrounding parts, except by means of this peduncle. Externally it comes in contact with the fibrous sheath of the ganglion, and internally it is in contact with the longitudinal cord, seen cut across at *c*. Each has seven or eight concentric rows of nuclei imbedded in it. The periphery, in which are the two outer rows of nuclei, is less densely granular than the interior, and the nuclei are less distinct. Towards the centre the granular matter assumes a fibrillar appearance, the striæ being in the direction of the peduncle; and they gradually, when traced further, assume the fibrous form, as seen in the peduncles. The peduncle is narrower at the part where it leaves the mass than at any other part of its course. It passes at first downwards, then turns sharply at a right angle inwards, and finally bends to join the longitudinal cord of the same side. In one section in my possession, a few cross-fibres may be seen, as if they connected the two peduncles together.* Such is the appearance presented by a section of these structures, which I shall call the "Hemispherical Ganglia," when examined by a power of seventy-five diameters. Their general form can only be seen by sections in other ways as well. They are egg-shaped in a section of the ganglion antero-posteriorly, the long diameter running from before backwards. With their peduncles they form between a half and a third of the whole cephalic ganglion. In a cross section they do not seem so large, but their true size appears in a longitudinal section. Each has a hilus, from which the peduncle emerges. If a section be made above or below this hilus, the concentric circles of nuclei are complete, and there is a whorl of converging fibres in the centre. The slight connection each hemispherical ganglion has to the surrounding parts is well seen in the great difficulty of preserving it from being detached in very thin sections, that do not include the peduncle. In a very well hardened cephalic ganglion, the two oval masses may be dissected out.

Again to refer to the section—immediately behind each hemispherical ganglion, there is an irregularly elliptical mass of granular matter *d*, with lighter striations from behind forwards. These striations, when examined with a higher power, are seen to be fibrous. They appear to reinforce the peduncles of the hemispherical ganglia below; for as succes-

* Since the above was first written, Professor Goodsir, to whom I am under great obligations for his kindness in revising this paper, has pointed out to me, that M. F. Dujardin (Annales des Sciences Naturelles, 3d serie, tome xiv.), has described the external appearance of similar structures in the bee. In that animal they are quite distinct, with their peduncles, without any dissection of the cephalic ganglion. In fact, the cephalic ganglion of the bee would closely resemble that of the lobster, if, in the latter animal, those structures were cleared of their surrounding tissue, and left hanging by their peduncles. Dujardin calls them in the bee "les corps pédonculés," which in their interior present "une disposition stratifiée." He endeavours to make out, that in insects the bulk of the *corps pédonculés* is in proportion to the intelligence of the animals.

sive sections are made from above downwards, the fibrous matter increases in quantity, until at the very lowest part there is merely an aggregation of fibres, twisting about in a very inexplicable manner.* In the spaces included by the ganglia and their peduncles *e*, there is a group of those cells seen in Plate I. fig. 3 *a*. Most of their processes appear to pass upwards, and are lost where the hemispherical ganglion comes in contact with the longitudinal cord. This is the group of cells in which a part of the fibres of the second cephalic nerve ends, as is shown in a section I made through the root of this nerve. In the middle line there is a large group of ordinary ganglionic cells, such as are seen in the other ganglia *f*. They send most of their processes upwards, a few of them joining the opposite cord, but most of them going to that of the same side. On each side of this group, and below the peduncles, there is another aggregation of cells similar to those at the root of the optic and second cephalic nerves *g*. These processes chiefly pass outwards, and they doubtless form a nucleus for the roots of some of the other cephalic nerves.

The only other part of the ganglion undescribed is the posterior and under part, into which the other cephalic nerves enter. On account of the different directions of these fibres, it is very difficult to trace each to its termination. All the nerves send a part of their fibres to join the longitudinal cords directly, and another part to enter into the groups of ganglionic cells which abound there. Most of these cells are of the same kind as those in the thoracic and abdominal ganglia.

The minute structure of the hemispherical ganglia can only be seen in very thin sections and with a very high power. If they have been coloured with carmine, it is still better seen. The matter, which appears granular when viewed with a power of 70 diameters, is seen to be only partly granular when viewed with a power of 600 diameters. It is then seen to be chiefly composed of small fibres, very tortuous, bending and twisting at acute angles, and in all directions, amongst each other, each fibre being only capable of being followed for a very short

* I may mention, that in the cephalic ganglion of the crab (*Cancer Pagurus*) the structure of the hemispherical ganglia is the same as that of the masses here described.

distance. It is more like what we might suppose a fishing-net crushed up to be, than anything else to which I can compare it. Among those extremely minute fibres there are a number of granules scattered. The nuclei-like bodies that lie in concentric rows, are not really nuclei, or rather they are more than nuclei, for the greater part of each of them is composed of those fibres I have just described, packed more closely than in the surrounding tissue. In the centre of each there is a nucleus like that of an ordinary nerve-cell, only a little more irregular in its outline (Plate I. fig. 3 *b*). This can only be seen in the thinnest section, for it is surrounded by a dense brush-like areolus of the small fibres which seem to be implanted on the nucleus—growing from it, as it were, and giving it its irregular outline. Each nucleus has either one or two nucleoli. In a very thin section, also, there is seen round each of those bodies a lighter areolus, where the fibres and granules are not so densely packed (Plate I. fig. 3 *b*). It is curious to trace the origin of the fibres of which the peduncle is composed. A little striation is at first seen, the tortuosity of the fibres diminishing gradually till they become straight, and lie parallel to each other. The granules which are scattered among the fibres, when examined by a power of 900 diameters, seem to be, many of them, thickenings of the fibres, and others the centres from which two or three small fibres proceed in a stellate manner. The fibrillæ, of which the peduncle is at first composed, very much resemble the appearance of the large fibres after they have been split up by concussion. The large fibres of the nerves and longitudinal cords would therefore seem to be composed of these minute fibrillæ which arrange themselves so as to form tubes very much as a cask is made up of staves. In the perfectly formed tubes of the peripheral nerves, no trace of striation is to be seen in a cross or longitudinal section, even when examined by a power of 900 diameters. I think it is very probable, however, that at their peripheral extremities where they come into intimate relationship with the tissues to which they convey the nerve-force, that they may again split up.*

* In the crab, the minute anatomy of the cephalic ganglion is very similar

Lying in contact with the outside of the hemispherical ganglia, there is a kind of fibrous covering very like a vascular coat. The fibres composing it are larger, and interspersed among them are small arteries, sending branches at regular intervals into the ganglia (Plate II. fig. 6). Along with the arteries and fibres there are also many caudate and stellate ganglion cells, whose fibres interlace and enter the ganglion. At certain parts, groups of cells like those seen at Plate I. fig. 3 *a*, lie in contact with the hemispherical ganglia, and give off processes into them.*

I cannot help thinking that the "punctiform mass" described by Leydig† as occurring in the Arthropoda and in spiders, and by Leuchart in the Acalepha, must be of the same nature as the hemispherical ganglia I have just described. In those animals, the ganglia are so small, that sections of them cannot be made, and without this, their true anatomy cannot be ascertained. The idea put forward by Leydig, that the granular matter is for the support and preservation from injury of the delicate cells, is not consistent with what is observed in the nervous system of any other class of animals, whose nerve-cells are as delicate, and require protection quite as much as do those of the animals to which he refers. Leydig, indeed, mentions somewhat vaguely, that "there are often forms of such a nature, that clear nuclei, with nucleoli, are surrounded by part of the punctiform substance, merely in the form of an areola, and perhaps no essential distinction can be made between such extra cellular punctiform substance and that enclosed within the ganglionic bodies, since in many animals, no ganglionic bodies are present, but the homogeneous punctiform substance fills up equally the ramifications of the nervous tubes."

Physiological Inferences from the foregoing Data.—The physiology of the nervous system of the invertebrata was

The nuclei are not distributed in concentric rows, and striation, like that seen where the peduncle takes its origin, is more general.

* In the crab, this investment is much better seen. Distinct bundles of fibres run inwards from it to join the fibres of the peduncle without being in any way connected with the nuclei. The cells that surround the hemispherical ganglia in this animal are both of the large and small kinds.

† *Op. cit.*, p. 60.

greatly advanced by means of experiments on the living animals, before much of its anatomy was known. Valentin seems to have been the first to perform a series of experiments, and he selected the *Astacus fluviatilis*, a species closely allied to the subject of the present paper. He came to many correct conclusions on the subject.* He shows a decided tendency to compare the abdominal ganglia in this animal to the sympathetic ganglia of the vertebrata, and he had not the theory of reflex action to explain many of his difficulties. It is unnecessary for me to detail fully his experiments, nor those of Mr Newport, performed on the Iulus. I have repeated those of Valentin on the lobster, with the same results as he obtained. I have also performed one or two others, viz., cutting one of the cords connecting the cephalic to the first thoracic ganglion, and then observing whether a stimulus to that side of the head on which the section was made, was followed by reflex action on both sides of the body. I found that the animal, after such a mutilation, although it had lost all voluntary power over the muscles of the extremities of that side, yet displayed reflex action on both sides alike, in response to impressions made on the eye or antennæ of the injured side. This is important, as indicating cross action, both in the brain, in order that the impression should pass down the uncut cord—and in the ganglia, to produce motion on both sides of the body.

The influence of the cephalic ganglion is at once explained by the cords that proceed from it to distribute their fibres to the lateral nerves that supply every part of the body. The bulk of the longitudinal cord is well kept up to the caudal ganglion, and this can only be explained by the existence of the "fibres of reinforcement" of Newport, or fibres from one ganglion to another, and going no further. The former connect one part of the periphery with another on the same side of the body, joining the cord by the lateral nerves of one ganglion, passing either upwards or downwards, reinforcing the cord at that part, and then passing away as part of the nerves of the next ganglion, or those of a more distant one. According to no recognised law of nervous conduction can these

* Valentin, "De Functionibus Nervorum," p. 8.

fibres receive any influence from the centres through which they merely pass, and they can only serve to connect different parts of the body by means of that nervous apparatus which all recent investigations prove to exist at the periphery. Why the nervous filaments should take such a course to connect parts so near as the segments supplied by contiguous ganglia, and not go directly from one to the other, I cannot pretend to explain, except it be taken as an explanation that they do so for greater protection from injury, or, it may be, in consequence of the mode of development of the nervous system.

The next question that arises about these and similar fibres is, whether they have anything to do directly with reflex action; in other words, whether they originate as excitor and terminate as motor nerves. It would be contrary to all that we know of the laws of reflex action to suppose that they do; for wherever in the animal body we have reflex action, we have ganglionic matter in the central parts of the nervous system that supply the parts. But although not directly ministering to reflex action, they seem to be in some way connected with it, for they exist in much larger numbers where reflex action is best seen. Where muscular action is complex, and there are many small muscles acting in different directions, those fibres abound most. Their number seems in fact to have some relation to the complexity of action.

An examination of the absolute amount of nervous matter, both fibres and cells, in different regions, and a comparison of this with the number and size of the muscles which are supplied, throws much light on this and other questions connected with reflex action. In the thoracic region, the muscles are small, but numerous. There are fourteen legs, besides foot-jaws and mandibles, each leg having seven joints bending in opposite directions, requiring of course a flexor and extensor muscle at each joint. There are 196 independent muscles, therefore, connected with the legs alone, and we find that it is in the thoracic region that the ganglia are very large, and the longitudinal fibres numerous, as shown by the thickness of the two cords, and the fibres running from one side of the body to the other are numerous also, as shown by the large nerves, at least one-half of which pass from one side to the other across the ganglia. In the abdominal region, on the contrary, the ganglia are small, and the longitudinal cord not the size of one of its divisions in the thorax. The muscles, however, are at least six times as bulky; the whole space included within the rings of the abdomen being filled with an immense mass of muscular structure for the propulsion of the animal through the water. This muscular mass is very differently arranged from the 196 separately-acting muscles of the thorax. It forms large single muscles, whose fibres act in concert, except the slender extensor fibres. If we now compare one leg with another, where the conditions are similar as to the number of joints, but different as to the mass of muscular structure, we find the same rule exemplified. The larger claws contain bulky and enormously strong muscles, the smaller ones very slender and weak muscles, while the absolute number is the same in both; but we do not find the size of the third thoracic ganglion that supplies the large claws at all in proportion to the bulk of the muscles. It is certainly larger than the other thoracic ganglia, but its bulk is principally made up on the abdominal surface by the large lateral nerves, a great part of which cross from one side to the other. The ganglionic matter in it is not much more than in the others. The first and second thoracic ganglia too, which supply ten small nerves on each side to the foot-jaws, and mandibles, contain more ganglionic matter than any of the other ganglia, except the cephalic, yet the *mass* of muscle supplied by them is very small, while the *number* of muscles is large. The caudal ganglion too contains much ganglionic substance,—much more than any of the abdominal ganglia,—while the muscles it has to supply are small but numerous. What conclusions can be drawn from these facts?

1. The ganglionic matter subserves the purpose of reflex action, and is essential to it.

This is beautifully shown by Professor Owen, by a comparison of the abdominal nervous cord of the hermit crab with that of the lobster.* In the one animal, there are no muscles in that region, but only viscera, and a large surface of very sen-

* Owen's Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals, vol. i. p. 171.

sitive skin; in the other, the muscles are strongly developed; in the former, there are no ganglia, but merely a nervous cord, to transmit impressions upwards; in the latter, there are large ganglia.

2. The so-called "fibres of reinforcement," and the fibres that cross from the lateral nerves of one side to those of the other, without being connected to ganglionic cells,—all those fibres, in fine, which directly connect different parts of the periphery, whether on the same or on opposite sides,—are muscular at both extremities,* and are not the channels through which reflex movements take place, but they serve to *connect, harmonize, and render consentaneous* the action of muscles otherwise independent, on the same and on opposite sides of the body. Where the number of muscles is great, both these kinds of fibres are numerous; and they also have some relation to the size of the muscles, as we see the number of cross fibres much larger in the third thoracic ganglion than in any of the others.

3. The number of the ganglionic cells is in direct proportion to the number of the muscles and the complexity of movement, and not to the mass of muscular structure.

4. The action of those muscles which always move simultaneously, and for a definite end, is combined and regulated by the ganglionic cells (in which the muscular nerve-fibres terminate) arranging themselves in groups,—each group ministering to a limited number of muscles.

Thus the "fibres of reinforcement" and the cross fibres are supplementary to the groups of ganglionic cells in the perfect production of reflex movement, and, by their conjoined action, give that harmony of muscular action and adaptation to definite ends which is one of the most wonderful of all the wondrous provisions of existence in the animal body.

5. Each of those groups of cells has a connection to the cephalic ganglion, and to the neighbouring groups.

6. The groups of cells send their fibres to the same side of the ganglion in which they lie, but chiefly to the opposite side, and to the muscles of the opposite side.

The fibres from the groups at *f*, *k*, and *i*, in Plate I. fig. 7,

* The commissural fibres of the optic must be excepted.

are those to which I refer. We cannot suppose that those at *f* and *k* all go to join the cephalic and caudal ganglia, and they must therefore join the lateral nerves of other ganglia above and below. The groups of cells like those at *i* which send their fibres to the lateral nerves of the opposite side, while they also have a connection with the longitudinal cord of the same side, are equivalent to a crossing of the longitudinal cords, so far as reflex movements are concerned, and explain the production of reflex movements on both sides of the body after one longitudinal cord had been divided, the stimulus having been applied to the head. In each of those ganglia we have a mechanism quite sufficient to account for its independent action so far as its own segment of the body is concerned, and its co-operation with, and relation to the other ganglia, in producing, regulating, and combining the motions of the hundreds of muscles on the same and opposite sides of the body.

The third, fourth, and fifth conclusions are those to which Schrœder Van der Kolk comes in regard to the arrangement of the cells in the vertebrata.* Doubtless, as further advances are made in our knowledge of the far more complicated structure of the spinal cord of mammalia, the other conclusions will be proved by demonstrative evidence also to apply. In this lies the peculiar value of careful investigations into the arrangement of the cells and fibres in animals of a lower class where they are not so much concentrated and crushed up, as it were, that they pave the way for the discovery of similar facts in the higher class. Although the "fibres of reinforcement" and cross fibres cannot be demonstrated in the spinal cord, yet there can be little doubt that they exist, and have the same relation to the cells and their processes, as well as the same function, as in the *Astacus marinus*.

From the structure I have already demonstrated, we may infer that the cephalic ganglion corresponds to the brain of the vertebrate animal. That its functions are analogous has been abundantly proved by Valentin and Newport, and confirmed by my own repetitions of their experiments. When we endeavour to ascertain the corresponding parts in the brain of a lobster and a fish, considerable difficulties present them-

* Van der Kolk on the "Spinal Cord," Syden. Soc. Trans., p. 73.

selves. The structures which I have called the "hemispherical ganglia," with their concentric rows of nuclei and slight connection with the other parts of the ganglion, are so very unlike anything that we see in the brains of mammalia, that we are puzzled to discover their homologues. Nor does their relation to the roots of the cephalic nerves, or the origin of the interganglionic cord, appear at first to explain their nature. Fibres pass into them from the groups of ganglionic cells at the roots of the various cephalic nerves; some of the fibres from those nerves may pass into them directly, but this I was never able to demonstrate; and by means of their peduncles joining the longitudinal cords, they have a direct connection with all the other ganglia. They would therefore seem to have a function different from the ordinary nerve-cells—a general and diffused function, which has no special relation to any part of the animal, or to any of its sensory or motor apparatus, but is supplementary to, and conjoined with, the action of those cells, wherever innervation exists in the body. It is no unjustifiable inference to suppose, that in them reside the higher manifestations of nerve-force which the animal exhibits. The lobster is not a mere machine, that responds to impressions made on its nervous system from without through its organs of special senses, or on the extremities of its afferent nerves The actions which it performs as the result of these may be explained by means of the arrangement of cells which we have seen in the ganglia, and at the roots of the cephalic nerves; but we cannot so account for its great cunning and perseverance in the search for food, its sexual appetites and instincts, its regular migratory habits from deep to shallow water at certain seasons, its strongly developed instinct of self-preservation, &c. These approaches to psychical manifestations doubtless require special nerve-tissue for their exhibition; just as we know that in the higher animals the psychical functions are connected with the cerebral hemispheres; and the only part of the nervous system in the lobster containing nerve-cells, to which no other function can be assigned, are these hemispherical ganglia. We therefore conclude, that in them originate those manifestations of a higher animal life.

The terminations of the nerves of special sense in the cephalic ganglion of this animal are extremely interesting. Some of the fibres end in cells precisely similar to those of the thoracic and abdominal ganglia. And not only are the cells the same in size and appearance, but they are distributed into groups in the same way. Their other fibres run to form part of the interganglionic cord directly. The mechanism of nerve cells for special sensation is therefore, so far as we can ascertain it, the same as for general sensibility through the body. Of course there must be a difference in the mode of activity of those cells, the nature of which will probably for ever remain inappreciable by us; but we thus see that impressions made on the special senses are followed by muscular movements, just in the same excito-motor way as impressions on any other part of the body. The muscles of a lobster's large claw may be thrown into action, either when this claw is touched, or when a foreign body is seen; in the one case the impression being transmitted upwards by the afferent nerve-fibres of the organ to the groups of cells which control its muscles; and in the other case, the impression being transmitted along the optic fibres, which we have seen to join directly the interganglionic cord, to the same groups of nerve cells, and with the same result,—viz., to cause a combined muscular movement by the nerve-force originated in those cells, and transmitted along the efferent fibres. In both cases it is probable that an impression is also transmitted to the hemispherical ganglia, and that the sensation of pain which the animal is undoubtedly capable of feeling resides there. These ganglia constitute, therefore, a true sensorium in the literal meaning of that term. The animal is endowed with such a high degree of functional activity—far higher in this respect than some members of the vertebrate division—that we must assume the existence of an organ to correspond in function to the ganglia which constitute the brain in fishes. The difference between the brain of a fish and that of a lobster seems to be, that in the former, the cells which minister directly to the excito-motor function—those through which impressions from without are followed directly by action in some form—are mixed and more intimately connected with the cells whose higher function it is to direct and control all the other nerve-cells in the body, and give the animal its sensational and psychical functions; while in the latter the two kinds of cells are separated. A lobster without the hemispherical ganglia would be a mere excito-motory organism, capable of no sensation, properly so called, and showing no desires or instincts, that would move in answer to impressions on its nerves of common and special sense, and only in answer to those stimuli.

A careful consideration of the minute structure of the nervous system of any invertebrate animal, such as the one we have just been examining, shows us that histologically and physiologically the vertebrate and the invertebrate animals are nearly allied. In every essential point the ganglia and inter-ganglionic cord of the lobster correspond to the spinal cord of the vertebrate, while the cephalic ganglion is analogous both in structure and function to the brain. The tendency to segmentation seen in both sub-kingdoms is most marked in the nervous system of the invertebrate, because in this division the nervous system does not form the centre round which all the other parts are developed, as is the case with the spinal axis of the vertebrate. Such an examination makes us esteem lightly, too, such generalizations of the mere external form of the nervous system, as that made by Audouin and Milne-Edwards in the Crustacea. No doubt they were useful, as the Linnæan classification of plants was useful, as a prelude to a more natural and scientific classification; but that we are to conclude an animal to be high in the scale, merely because its nervous system happens to be compressed into a mass to accord with the external shape of the body, seems as rational as to affirm, that the nervous cord of the earth-worm and nematode is more analogous to the spinal cord of the vertebrate than that of the lobster, because it happens to have ganglionic cells all the way down.

Description of Plates.

PLATE I.*

Fig. 1. Cross section of sheath of interganglionic cord.—*a*, Outer longitudinal layer of fibres; *b*, inner circular layer; *c*, nerve-tubes cut across.

* The original drawings for the Thesis were made by my friend Dr Sibbald, from my own sketches, and with the microscopic preparations before him.

Fig. 2. *a*, Nerve-tubes of different sizes from interganglionic cord. What appear to be minutely striated fibres at one end, are at the other (where there are fewer of them) seen to be merely smaller tubes; *b*, a large tube split up into fibrillæ; *c*, nerve-cells from caudal ganglion; *d*, the same, with what appear to be stellate nuclei.

Fig. 3. *a*, Small cells from cephalic ganglion; *b*, one of the nuclei from a hemispherical ganglion.

Fig. 4. Cross section of abdominal interganglionic cord.—*a*, Large nerve-tubes; *b*, sheath, which is thickened on the dorsal surface at *d*; *c*, septum; *e*, the motor-nerve, which springs from the cord between the ganglia, lying at this part in apposition to it.

Fig. 5. Section of about one-fourth of a thoracic ganglion.—*a*, Longitudinal fibres of interganglionic cord; *b*, fibres of lateral nerve; *c*, cross fibres from one lateral nerve to the opposite side; *d*, fibres from longitudinal cord joining lateral nerves; *e*, sheath; *f*, a group of cells, with most of their fibres passing towards the head; *g*, another group, with fibres passing across to opposite side; *h* and *i*, large nerve-cells; *k* and *l*, scattered bipolar nerve-cells; *m*, a bundle of nerve fibres cut across.

Fig. 6. A section of the same ganglion as that from which fig. 5 was made, but more towards its dorsal surface.—*a*, Interganglionic cord; *b*, lateral nerve; *c*, a group of cells whose "pedicle" passes backwards towards the caudal extremity; *d*, another group, whose "pedicle" passes to the opposite side; *e*, longitudinal fibres cut somewhat obliquely; *f*, isolated nerve-cells.

Fig. 7. Diagram of an ideal ganglion, embodying the results of all the sections made.—*a*, Longitudinal fibres; *b*, cross fibres; *c*, fibres from longitudinal cord to lateral nerves; *d*, *e*, fibres of "reinforcement;" *f*, group of cells sending its "pedicle" forwards, but with connections to other groups; *g*, group of cells sending its "pedicle" to opposite lateral nerve; *h*, group between the cords, sending two bundles of fibres, *m* and *n*, to lateral nerves of opposite sides; *k*, group of cells sending "pedicle" towards caudal extremity; *l*, group of cells whose "pedicle" joins lateral nerve of same side.

Plate II.

Fig. 1. Cross section of thoracic ganglion, showing *a*, *b*, lateral nerve (in outline) cut across; *c*, a few of the fibres of longitudinal cord cut across; *d*, *e*, groups of cells whose pedicles pass to opposite side; *f*, group with pedicle passing to lateral nerve of same side; *g*, group whose connections have been cut away.

Fig. 2. Longitudinal section of an abdominal ganglion.—*a*, Longitudinal cord; *b*, lateral nerve cut across; *c*, group of cells, a few of whose fibres pass among the longitudinal fibres, and at *d* join them; *f*, other groups of cells, whose fibres converge towards the lateral nerves.

Fig. 3. The two cords connecting the cephalic to the first thoracic ganglion, with the sheath taken off one of them, magnified four times.—*a*, Ganglionic swelling at root of pneumogastric nerve; *b*, pneumogastric

The preparations were also examined by Professor Goodsir, before the "Defence of the Thesis." I must here express my great obligations to Dr Sibbald for the manner in which the illustrations were done.

nerve; *c*, one cord, with its sheath dissected partly off; *d*, other cord; *e*, cross nerve from one to the other, whose fibres, *g*, are dissected away from the cord, so as to show how they join the pneumogastric ganglion and nerve; *f*, accessory pneumogastric.

Fig. 4. Section of cephalic ganglion in the plane of entrance of longitudinal cords and optic nerves.—*a*, Optic nerve; *b*, longitudinal cord; *c*, fibres from longitudinal cord of opposite side to optic nerve; *d*, fibres to optic of same side; *e*, commissural fibres of optics; *f*, fibres from second cephalic nerve; *g*, *h*, groups of ordinary ganglion cells; *i*, group of ganglion cells in front of optic commissure (the whole space vacant in the drawing had been filled up by those cells, but they had been dislodged); *k*, a few commissural fibres from one longitudinal cord to the other.

Fig. 5. Cross section of the cephalic ganglion, slightly anterior to the centre.—*a*, "Hemispherical ganglion;" *b*, "Peduncle;" *c*, longitudinal cord cut across; *d*, oval striated mass below hemispherical ganglion; *e*, group of small stellate cells; *f*, *h*, ordinary ganglion cells; *g*, another group of cells similar to those at *e*.

Fig. 6. Vertical section of anterior part of cephalic ganglion, in the line of one of the optic nerves.—*a*, Optic nerve fibres; *b*, layer of small stellate cells, which many of the optic nerve fibres join; *c*, hemispherical ganglion; *d*, bending of the optic nerve fibres over the hemispherical ganglion at an acute angle.

Reply to some Comments of Mr F. Marcet on the Power of Selection ascribed to the Roots of Plants. By CHARLES DAUBENY, M.D., Professor of Botany, Oxford.*

A friend pointed out to me, a short time ago, in the February Number of the *Bibliotheque Universelle*, some comments on a paper of mine relative to the power attributed to plants of rejecting abnormal or poisonous substances presented to them by the soil in which they grow, the substance of which paper was communicated to this Section at the Meeting of the British Association for 1861.† These remarks, proceeding as they do from the respectable pen of M. Francis Marcet, seem to call for some notice on my part, and I therefore propose to offer, on the present occasion, a few observations in reply. I do not, however, intend to dwell at any length upon the points of difference between his views

* Read at a Meeting of the British Association, on Tuesday, October 7th, 1862.

† See also my paper in the "Journal of the Chemical Society of London," vol. xiv. for 1861.

and my own, because I am quite prepared to admit that the subject is one which requires a more extended and perhaps a more careful set of experiments than has been hitherto instituted.

I would only now wish to point out, that there really seems to be nothing irreconcileable between the results obtained by Saussure and by Marcet himself, and those which I have deduced from the experiments to which allusion has been made by the physiologist alluded to.

Normal substances, as both sides admit, are taken up by the roots in the ratio of their respective powers of permeating membrane. Hence, gummy matters, as Saussure has shown, pass through them less rapidly than saline solutions. Nor can there be any dispute as to the power residing in the plant to reject by its roots such matters as may chance to be in excess.

The difficulty which we entertain relates, not to the case of substances which usually enter into the circulation of a plant, but to that of those which are abnormal or poisonous. Are we to suppose, with respect to the latter, that they are first taken in and afterwards excreted, or that they are denied entrance into the system by virtue of some property belonging to the roots, which seems in some way connected with their vitality, as it is not possessed by dead membrane? This is the problem which I have proposed to physiologists, and which, whilst suggesting the latter alternative as the more probable one, I never concealed from myself or from them, was yet open to further inquiries.

I would merely observe, in justification of the view which I have preferred taking, that the presence in the vegetable system of poisonous matters, where the latter are exhibited to their roots in large quantities, whether this be inferred directly by analysis, or indirectly, as in the case of the vegetable poisons to which M. Marcet alludes, by their effect upon the system, is by no means inconsistent with the power I have ascribed to the spongioles of rejecting, when in a healthy state, such bodies, inasmuch as the first effect of the application of poisons to the roots in sufficiently large doses would be that of destroying their vitality, and thus of reducing them to the condition of dead membrane.

For this to happen, it is by no means necessary, as Mr Marcet contends, that the poison should be of a corrosive nature, since the destruction of life would be equally brought about, if the noxious matter acted directly upon the irritability of the plant, like the extract of opium, belladonna, or nux vomica. Mr Marcet, indeed, suggests, that the negative results I obtained in my experiments may have been due to the smallness of the dose applied, and to the substances combining with some base present in the soil, by which they were rendered insoluble. But if so, why were the same solutions absorbed, when the quantity administered was slightly increased, as the effect produced on the plant plainly demonstrated to have been the case? It would seem strange, that not a particle should enter the plant in the one instance, when it was so easily recognisable in it in the other.

Those, however, who prefer the latter hypothesis, which I have suggested as the other alternative, and imagine the poison to have been first absorbed and afterwards excreted, accounting for its non-detection in the plants from the extreme minuteness of the quantity in which it was present at any one time, must at least admit my general position, that a principle allied to vitality has a share in the effect brought about; inasmuch as no such consequence would ensue in the case of a dead membrane, where, on the contrary, whatever once found admittance would go on accumulating in the tissue, in proportion as capillary attraction continued to furnish fresh supplies of moisture, from taking the place of that got rid of by exhalation.

The power of selection, which must in any case be ascribed to the entire vegetable tissue, is a phenomenon at least as remarkable as that of rejecting certain substances, which I have suggested as belonging to the roots; and one or other alternative must, I think, be adopted by all who consider the very varying proportions in which different plants absorb the normal ingredients which are presented to them, when growing in the same solution.

Both these I regard as residual phenomena, which cannot as yet be explained, except by invoking a principle present in organic, but wanting in inorganic matter, and which I have therefore ventured to refer to the operation of laws connected with vitality.

On a New Character observed in the Fruit of the Oaks, and on a Better Division of the Genus Quercus. By M. ALPHONSE DE CANDOLLE. Communicated by the Author.*

The general and differential characters of the oaks have been well studied for several years, more especially by M J. Gay, who is noted for his exactitude. I was therefore not surprised to find the greater part of the questions elucidated, when I came to examine the Genus Quercus and its allied genera for the "Prodromus." The only difficulties which I encountered had reference to the synonymy of species and their limits. I propose in a future memoir to discuss the species of oaks, but at present I shall limit myself to the notice of a character which appears to have been overlooked. I shall at the same time take this opportunity of speaking of some other characters of the fruit which have not been studied in a sufficient number of species.

Two excellent observers, Andrew Michaux and his son, proved that certain oaks ripened their fruit at the end of the first year, while others did so in the course of the following year. We neglected this character for half a century, and it is to M. Gay that the merit is due of bringing it again into notice, and of confirming it by the examination of several species belonging to the old world. He has more especially discovered that, under the name of *Quercus Suber*, two species have been confounded,—one with annual, and the other with biennial fruit.

Struck with the fact that forms so nearly allied might present two periods of maturation, I examined attentively this character, with the view of ascertaining if it is constant, and if it is connected with other circumstances more easily verified and more apparent. I have therefore studied it, not only in all the species the fruits of which I could obtain, but

* Translated from the copy sent by the Author; and read to the Botanical Society of Edinburgh, 11th December 1862.

also in hundreds of specimens of the same species, and in perhaps two thousand specimens of different species contained in the rich herbaria placed at my disposal.

It is in general easy to determine the duration of fruits even on a dried branch. It is sufficient to examine whether the ripe fruit is connected with the wood of the year, or with that of the preceding year. This observation is easily made, as the peduncles persist until the maturity of the fruit. We meet, however, now and then, with specimens which may lead into error and cause difficulty, especially in species with persistent leaves; but with a certain degree of attention, and by the careful examination of several fruit-bearing branches, we can generally solve all doubts. These difficulties depend on the circumstance that the small fructiferous branches of one year may cease to elongate or to ramify the following year, while continuing to ripen their acorns. We may thus mistake a biennial for an annual fruit. On more close examination, however, we usually detect some differences of colour, of thickness, or of pubescence, in the branches of one year compared with those of the succeeding year, or a difference of consistence in the leaves of the two years, which enable us to recognise the true age of the branch. We meet also in herbaria with fruit-bearing branches of the second year which have lost their leaves by desiccation, and which being in the axil of an old leaf, appear to be the peduncles of the year. In such cases, the scars of the young leaves and the pubescence of the branch, as compared with that of the principal axis, enable us to detect the truth. We find that the character, when once determined, is perfectly fixed in each species.

Unfortunately, however, the character is not linked with any other, and consequently two species very analogous may present fruits, in the one annual, and in the other biennial. This may be shown by reference to the following species:—

Quercus microphylla, Nee, has annual fruit, and *Q. Castanea*, Nee (*Q. mexicana*, H. & B.), has biennial fruit; *Q. Seemanni*, Liebm., *Q. Ghiesbregtii*, Martens & Gal., *Q. Tlapuxahuensis*, A.DC., have annual fruit, while *Q. acutifolia*, Nee, has biennial fruit; *Q. scytophylla*, Liebm., has annual fruit, and *Q. calophylla*, biennial; *Q. obtusata*, H. & B.

(*Q. Hartwegi*, Berk.), *Q. tomentosa*, Willd., *Q. reticulata*, H. & B., have annual fruit, and *Q. crassifolia*, H. & B., biennial. In addition to these, we have already mentioned *Quercus Suber*, L., and *Q. occidentalis*, Gay, which are so like as to have been frequently confounded together as one, and yet have a marked difference in regard to their fruiting.

When I had become fully familiarised with the minutest details of the characters of oaks, I found it impossible to determine whether the maturation of the species was annual or biennial, without seeing a specimen bearing ripe fruit. This shows how slightly the character is connected with others, and how unfit it is for the purpose of natural classification. I have therefore used it only for subdivisions (under the form of paragraphs) of the natural genera or subgenera, and in particular of the subgenus *Lepidobalanus* of Endlicher, which constitutes the greater part of the oaks.

There exists in the oaks another character which has not been taken up by any one, and which seems, theoretically, to be of some importance, but which, as in the other case, cannot be detected at a glance. I mean the position of the atrophied or undeveloped ovules relatively to the single perfect seed, or to the ovary. The remarkable external resemblance between the acorns of all the species of oak has led to the belief that they resemble each other in their interior. This, however, is not the case, and at times when I have searched for the five abortive ovules around the single one which is changed into the seed, and have seen how easy it is to detect them, I have been astonished that authors have not long ere this thought of the character I am about to mention. The fact is, that none of them have alluded to it. Even M. Schacht, who of all others has best described the young ovules of *Quercus Robur*,* in speaking of the development of the fruit, says:—"There remains scarcely a trace of the ovules which we saw at the epoch of fructification." But the fact is, that in *Q. Robur* we find constantly five abortive ovules below the seed which fills the acorn at the period of maturity. They are placed close to the spermoderm among the irregular remains of septa.

* Schacht, Beiträge, i. p. 37, t. iii. This plate is reproduced in his work entitled "Der Baum."

They sometimes attain the size of a millimetre (0·03937079 of an inch), and when less, they can still be seen either by the naked eye, or by means of a moderate lens. They are held by the remains of the placentas under the seed at the bottom of the ovary; their primitive semi-anatropal evolution can be easily recognised. This *inferior* position confirms the very accurate observation of Schacht, that the ovules of *Q. Robur* arise from the face of ovarian loculaments, and are *ascending;* whilst most authors describe them as pendulous, or as changing their position during evolution.* It is a universal law, at least I have verified it in several families, for instance in Myrsinaceæ and Hippocastaneæ, that the ovules, once formed, are not detached when they become abortive. We find them always at their points of origin, if we take the trouble to search for them; and the examination of the ripe fruit is sometimes a convenient method of ascertaining the primary position of the ovules.

All the oaks with annual maturation seem to have the atrophied ovules under the seed; at least inferior to the middle zone of the seed. I have determined this in a great number of American species, as well as in those of Europe. The oaks which ripen their fruit the second year, on the contrary, have the abortive ovules sometimes at the base, sometimes at the top of the ovary; and all the oaks of the other sections, as of that called *Lepidobalanus*, as well as the genera *Lithocarpus*, *Castanopsis*, and *Castanea*, have their abortive ovules at the summit of the seed. Thus, in the sub-genus Lepidobalanus, the *Quercus Cerris*, the fruit of which ripens the second year, and which has deciduous leaves, has ovules inferior, as in *Q. Robur;* while *Quercus pseudo-suber*, *occidentalis*, *coccifera*, *Vallonea*, &c., of Europe, and *Q. crassifolia*, *splendens*, &c., of America, with biennial fruits and persistent leaves, resemble *Q. Robur* and *Cerris*, as regards their ovules; but a long series of American oaks, with biennial maturation, and leaves either caducous or persistent, such as *Q. falcata*, *rubra*, *Xalapensis*, *acutifolia*, &c., have the abortive or atrophied ovules placed above the seed. It will astonish the American botanist to be

* Endlicher says (Genera, p. 274) *ovula apice anguli interioris appensa.* The younger Nees (Gen. Plant. Flor. Germ. fasc. i.) says, *ovula primum erecta, mox pendula.* Gay (Bull. Soc. Bot., 1857, p. 506), not having been able to verify the position, has said nothing on the subject.

told, that on opening the acorns of their most common species, we find the abortive ovules sometimes at the base, sometimes at the apex of the seed. For instance, in *Q. macrocarpa*, *Prinus*, *stellata*, *alba*, *virens*, the ovules are below, as in *Q. Robur*; while in *Q. ilicifolia*, *falcata*, *rubra*, *palustris*, *coccinea*, *Phellos*, *imbricaria* and *nigra*, they are superior as regards the seed.

So far as I have been able to determine by the examination of several species, the position of the atrophied ovules in the ripe fruit depends on their position at their origin: thus, when the ovules remain at the apex of the ovary, above the seed, it is because they were primarily pendulous; when they are at the base, it is because in their young state they were ascending. The imperfect condition of our herbaria has not allowed me to verify these statements so frequently as I should have wished.

This diversity in the attachments of the ovules appears at first sight a matter of importance, whence we may derive a division of the genera or sections. When we consider the matter, however, more carefully, and observe how often analogous species have two kinds of ovules, the character loses much of its value. The ovules always grow sideways, on the re-entering and usually imperfect septa which divide the ovary into three cells or loculaments. They arise either near the base or near the apex of the ovary, or sometimes at a certain appreciable distance from these two points. The evolution is always semi-anatropal, the exostome being turned upwards, and that alone proves that the upper ovules do not come exactly from the superior angle of the loculament. In *Quercus Suber*, at least in some specimens which I have been able to observe in different states of evolution, the ovules arise a little above the base of the ovary, and the walls are separated as far as the middle, as in *Q. Robur*; but the ovules being at their origin higher than in the last-mentioned species, they are found at maturity around the seed, disposed in a spiral manner, and the highest atrophied ovule scarcely reaches the middle of the length of the seed. If this evolution is constant, it will present a specific difference between *Q. Suber* and *Q. occidentalis*. The latter, so far as I can judge from a small number of acorns, has the atrophied ovules completely below, as in *Q. Robur*. Two Mexican species have the atrophied ovules above the base, but still below the middle of the seed, and in some species, with the ovules above, we find the position a little below the apex. The character, therefore, is not so exact as we might have thought. I shall take this character, along with duration of the fruit, to aid in the subdivision of the sections in the "Prodromus."

The following is the division at which I have arrived, after careful study and examination. The species of the genus *Quercus* are grouped in five natural sections or sub-genera, according to the nature of the involucre or cupule, combined with the inflorescence and habit. They are nearly the sections indicated by Endlicher (*Supp.* iv.), and by Blume (*Museum Lugduno-Bat.*), with certain modifications. The following is an abridged tabular view :—

Quercus.—Sectio I. *Lepidobalanus* (Quercus, L.; Quercus, sect. Robur, Cerroïdes, Erythrobalanos, Cerris, Gallifera, Suber, Coccifera, Spach; Quercus A, Lepidobalanus, Endl. excl. spec.)—Amenta gracilia, pendentia; floribus omnibus masculis solitariis, absque rudimento pistilli; bracteis solitariis, caducis, interdum (in spec. Americanis) deficientibus. Stamina plerumque erga perigonium non manifeste symmetrica. Cupula squamis imbricatis tecta, ore aperta. Ovula abortiva, nunc prope basin, rarissime in medio, nonnunquam prope apicem seminis persistentia. Omnes ex hemisphærio boreali.

II. *Androgyne* (Q. densiflora, Hook., species sectionis Lepidobalani, Endl.)—Spicæ imâ basi flores femineos, supra masculos gerentes, erectæ. Flores masculi fasiculati, fasciculis 3-bracteatis, singuli absque rudimento pistilli. Stamina numero duplici loborum perigonii, antheris minimis. Stigmata 3-6 in div. floribus rami. Cupula, sect. Lepidobalani. Ovula abortiva erga semen supera.—In Californiâ.

III. *Pasania* (sect. Lepidobalanus, Endl. partim, Quercus § 2. Blume Mus. Lugd. Bat.; sect. Pasania Miq. fl. adjunctis char.)—Amenta erecta, floribus masc. sæpius fasiculatis, fasiculis 3-bracteatis. Pistillum rudimentarium, liberum. Stamina sæpius numero duplici loborum perigonii. Flores feminei secus spicas segregatas vel basi spicarum androgynarum. Flores fem. et ideo fructus sæpe involucris conniventibus. Cupulæ Lepidobalani. Ovula abortiva supera. —In Asiâ meridionali.

IV. *Cyclobalanus* (Endl. gen., anno 1847; sect. Gyrolecana, Blume Mus. Lugd. anno 1850.)—Inflorescentia et flores masculi Pasaniæ. Flores feminei distincti. Cupula ore aperta, squamis in lamellas concentricas vel subspirales, integras vel sero crenatas lateraliter coalitis. Ovula supera.—In Asiâ meridionali.

V. *Chlamydobalanus* (Endl. gen. anno 1847; sect. Castaneopsis, Blume Mus. Lugd., non Castanopsis, Don.)—Inflorescentia et flores masculi Pasaniæ et Cyclobalani. Flores feminei distincti. Cupula glandem undique tegens, sæpius apice irregulariter fissa (in eodem ramo clausa vel fissa), concentrice squamis connatis verticillatis cincta. Ovula supera. —In Asiâ meridionali.

This last section touches the genus *Lithocarpus* of Blume, in which the acorn is said to be adherent to the involucre, which covers it entirely. From this we pass to the genus *Castanopsis* of Spach, which has the inflorescence and the flower of the oaks in the section *Pasania* and following sections, with the hedgehog-like fruit of *Castanea*, and which differs from the latter in its trilocular ovary. *Castanea* with a 6-7-celled ovary, and *Fagus* are too well known to require description.

I have not admitted the genus *Synædrys* of Lindley, founded on the existence of incomplete partitions, which penetrate into the spermoderm and the cotyledons. This character, which is a remarkable one, is found in some oaks,—as *Quercus Skinneri* of Mexico, *Q. cornea* of Loureiro, and *Q. Korthalsii* of Blume, in the Indian Archipelago, which have no other special relation to each other; and it is awanting in species more nearly allied. We also see many transitions in other species, under the form of slight foldings, partially penetrating, or in undulations of the cotyledons; and even in the species already noticed the foldings are irregular.

The *Quercus virens* of Aiton (*Q. oleoides*, Cham. and Schl.), a species widely spread in the southern parts of North America, presents a very singular character, the value and constancy of which I have not yet been able to determine. In the four seeds which I examined the radicle was imbedded in a homogeneous substance, which represents either two adherent cotyledons or a single cylindrical one. The position in the centre, towards the upper part of the fruit, indicates rather two cotyledons intimately united. I have seen nothing like this in the allied species *Q. Ilex*, nor in any other. It will be interesting to examine the development of the seed. The state of these specimens, in the Herbaria to which I have access, has not allowed me to examine the matter fully.

The most troublesome point of classification is the subdivision of the natural section *Lepidobalanus* of the genus *Quercus*. It alone includes more than a half of the species, and some which appear at first sight very different, for instance, *Quercus Robur*, *Cerris*, *Vallonea*, *Libani*, *rubra Xalapensis*, &c., I should have wished to form natural groups around those species which seem to present very distinct characters. In other words, I should have wished to constitute sub-sections analogous to Spach's numerous sections in Endlicher's genus *Lepidobalanus*. Webb, Endlicher, and especially Gay, have endeavoured to do this; but I must say, if they have arrived at a certain point in this subdivision, it is only by leaving out a great number of species from Mexico and Southern and Western Asia, which have been little known for some years. Gay, with his usual candour, admits this; and he allows that the subdivisions are by no means definite.* For my own part, after careful study, I have been led to conclude, that in the present state of science there is no good subdivision of the sub-genus *Lepidobalanus*. When we become acquainted with the male flowers of many species which are still unknown, and when we have examined the evolution of the buds, it is possible that we may be able to establish a truly natural division, but, at present we can only, by means of the fruit and leaves, arrive at artificial sections which frequently separate nearly allied species.

The form and direction of the scales of the involucre is a kind of character which is too liable to variation to be employed as a means of division. Besides, it would isolate some species, as *Q. Cerris*, while it would bring an immense number into a single group.

The duration of the leaves, according to Webb and some

* Ann. des Sciences Nat. Serie iv. vol. vi. p. 238.

other authors, is variable in certain species, as *Quercus Lusitanica* and *humilis.* It has also the inconvenience of being difficult to determine either in herbaria, or during a journey through a country. Webb has distinguished in oaks, *Folia decidua, subdecidua,* and *persistentia ;* but these alone show a want of fixedness in the character. In many southern species, particularly in Mexico, it appears that the leaves fall in the second year, shortly after the first appearance of the new foliaceous organ, and in these circumstances we scarcely ever find them upon specimens in herbaria, which are usually gathered with the fruits in autumn. In general, the very persistent leaves are easily seen ; but the distinction of the leaves falling a little before or a little after the succeeding foliation, is too variable in the species, and too momentary to be of practical use.

I have therefore been compelled to divide the group *Lepidobalanus* in a rather artificial manner, following, in the first instance, the characters of the duration of the fruit, and of the position of the ovules, which are fixed and important characters, then taking into account the duration of the leaves, which is an uncertain and inconstant character. The result is as follows :—

1. Abortive ovules inferior. Maturation of fruit annual.
   a. Leaves caducous. *Quercus Robur, Toza, Lusitanica, alba, Prinus, macrocarpa, polymorpha,* &c.
   b. Leaves persistent. *Q. tomentosa, microphylla, virens, Ilex, Suber,* &c.
2. Abortive ovules inferior. Maturation biennial.
   a. Leaves caducous. *Q. Cerris.*
   b. Leaves persistent. *Q. pseudo-suber, occidentalis, Vallonea, Libani, coccifera,* &c.
3. Abortive ovules inferior. Maturation biennial.
   a. Leaves caducous. *Q. falcata, ilicifolia, rubra, Phellos, Xalapensis, calophylla,* &c.
   b. Leaves persistent. *Q. acutifolia, aquatica, Castanea, cinerea.*

This last subdivision passes into the other sections of the genus *Quercus ;* and I repeat, that independent of this arbitrary classification of the species of the principal section, all the sections themselves, and all the genera, depend on a truly natural combination of characters.

On the Nocturnal Cooling of the Superficial Layer of the Soil, compared to that of a Stratum of Air in contact with the Earth. By CHARLES MARTINS, Montpellier.*

On 7th November 1861, Professor Marcet communicated to the *Societé de Physique et d'Histoire Naturelle de Genève*,† some remarks having reference to a memoir published by me, in regard to the nocturnal increase of temperature with the height.‡ He points out the marked accordance between the results at Montpellier and those which he had obtained twenty-three years previously at Geneva.§ I was glad to be able to confirm the laws first noticed by M. A Pictet|| at Geneva, and now verified by Marcet. There is one point, however, on which I cannot agree with Marcet. I stated, that during the night the temperature of the surface of the soil was above that of the stratum of air in contact with it. M. Marcet affirms the contrary. This disagreement is more apparent than real. By the surface of the soil I do not mean the mathematical surface, or the plane of separation between the air and the soil, but rather the most superficial layer of the soil, the thickness of which is a little greater than the diameter of the bulb of the thermometer used in the experiments. This layer was two centimetres in thickness, while the diameter of the thermometric bulbs was $0^{m}\cdot015$. It is the temperature of this superficial layer of the soil which I wished to ascertain, as it has reference to vegetable physiology. When M. Marcet lays a thermometer on the soil, the instrument only touches the earth by a small portion of its surface, the greater part of the surface is surrounded by air. This thermometer only gives a kind of mean between the temperature of the lowest stratum of air and the surface of the soil. In this mean the temperature of the air predominates, because it covers the larger portion of the bulb of the thermometer. Thermometers with a lenticular bulb, which I have seen used by M.

* Communicated by the author, and translated from the French.

† Bibliotheque Universelle, Archives, tom. xii. p. 267. 1861.

‡ Mem. de l'Academie des Sciences de Montpellier, tom. v. p. 47. 1861.

§ Mem. de la Soc. de Phy. et d'Hist. Nat. de Genève, tom. viii. 1838.

|| Essai sur le Feu, p. 179. 1790.

Walferdin, will give a more accurate mean between the air and the surface of the soil. The thermometer of M. Marcet, with a spherical reservoir, when placed on the soil, indicated a temperature slightly different from that of the air in contact with the surface of the earth. But, according to his experiments and mine, this stratum of air is colder than all the layers placed above it. M. Marcet calls this the temperature of the surface of the soil; and he has, as a matter of course, found it almost always lower than that of the air, which is five centimetres above it.

In order to clear up the facts of the case, I resumed my experiments this winter (1861–62) in the Botanic Garden at Montpellier. I selected four minimum thermometers, as like as possible, and carefully compared. The bulb of the first was placed in the most superficial layer of the soil, two centimetres in thickness. The second was laid on the surface of the soil. The third was placed on two small wooden props or trestles five centimetres,* above the surface of the soil. The following are the mean minima of eighteen very severe nights in January and February 1862, as indicated by these thermometers:—

Thermometer in superficial layer of soil,	$-5°\cdot15$ C.
Thermometer on surface of soil, . :	$-6°\cdot05$,,
Thermometer at $0^{m}\cdot05$ above soil, . .	$-6°\cdot01$,,

These results accord with those which I had previously obtained. The most superficial layer of the soil was *warmer* than the air with which it was in contact. The thermometer placed on the surface of the soil indicated a temperature lower than that of the soil, but nearly equal to that of the free thermometer, placed five centimetres above the soil,—the difference being only 0°·04 of a degree of Centigrade.

Marcet suspects that the more elevated temperature of my thermometer in the soil was owing to the slight covering of earth, which diminished its nocturnal radiation. In order to ascertain if this was the case, I placed upon small supports three minimum thermometers. Their bulbs were raised five centimetres (rather more than one and a half inch) above the soil. The bulb of the first was uncovered; that of the second

* A centimetre is 0·3937079 English inch.

was covered with a thin layer of garden earth; while that of the third was enveloped in chimney soot, which was made to adhere by means of gum. The mean minima of seven perfectly calm nights of March 1862 were as follows:—

Uncovered thermometer, ...	−4°·25 C.
Thermometer covered with soot, . . .	−4°·28 ,,
Thermometer covered with earth, . .	−4°·34 ,,

It will be seen that the three thermometers indicated very nearly the same temperature, although their radiating powers were very different. We know that this radiating power is proportional to the absorbing power. In order to determine directly the absorbing power of my thermometers for solar heat, it was sufficient to observe them between ten o'clock and mid-day, when they were fully exposed to the sun. They were then all equally exposed to the same sources of heat,—the direct rays of the sun, and the reflection of heat from the soil. The following are the results,—the numbers being the mean of ten days' observation:—

Thermometer covered with soot, . .	33°·38 C.
Thermometer covered with earth, . .	30°·29 ,,
Thermometer uncovered, ...	28°·49 ,,

This order is just such as might have been anticipated. Nevertheless, the uncovered thermometer, which absorbed the smallest amount of solar heat, indicated, during calm nights, a minimum a little below that of the two other covered instruments. The cooling of a thermometer during the night is not therefore owing solely to the contact of the air, and the radiation towards the zenith; for, if that were the case, then the thermometer covered with soot would have indicated the greatest cold, then that covered with earth, and finally, that with the naked bulb. The difference of the result depends on this, that the thermometers placed at five centimetres from the soil are subjected to two opposite calorific influences,—the radiation towards the zenith, which cools them, and the absorption of heat emitted from the earth, which warms them. The thermometer which radiated most being thus that which absorbs the most, there results a compensation, in virtue of which the naked thermometer, and those covered with earth or with soot, indicate minima which only differ from each other by one-tenth of a degree, as we have seen above.

To remove all doubt as to the heating effect of the surface of the soil, which during the night radiates heat towards the thermometers placed at five centimetres above it, I noted, on ten successive calm nights of April, the minima indicated by four thermometers, naked, or covered with earth, and raised five centimetres. Two were above the natural soil, while the other two were separated by a bright tin plate laid on the soil, As this plate absorbed by conductility the heat of the earth on which it lay, it is clear that the two thermometers placed above it were removed from the action of terrestrial radiation. They were no longer heated by the soil, and ought to indicate a lower temperature than the two others. This is shown by the following Table, which is the result of observations made during ten calm nights :—

Mean Minima of the Night.

Thermometer above the Natural Soil.		Thermometer above a Plate of Tin.	
Thermometer naked, . .	2°·44	Thermometer naked, . .	1°·56
... covered with earth,	3°·25	... covered with earth,	2°·60

The mean difference of 0°·81 between the two thermometers exposed to the calorific radiation of the soil, and those which were removed from that radiation, is the expression of the heat emitted by the soil, which counteracts the effect of the zenithal radiation, and of the proper temperature of the air.

I think, therefore, that I have established by experiments the following facts :—

1. During the night the superficial layer of soil is less cooled than the stratum of air in contact with it.

2. The emission of heat from this superficial layer warms to a small extent the bodies placed above it.

This excess of heat in the superficial layer of soil, compared with the stratum of air in contact with it, is easily explained. The solar heat which strikes the soil during the day, penetrates into the interior at the rate of about a decimetre in three hours ; the heat of the day is therefore stored up in the soil, and compensates in part for the loss due to nocturnal radiation. The excess, also, of the temperature of the soil above that of the air in contact with it is greater in summer than in winter, as I have already shown in my memoir on the increase of nocturnal temperature with height.

Note to "Notice of a Mass of Meteoric Iron, found in the Village of Newstead, Roxburghshire." By JOHN ALEXANDER SMITH, M.D.*

Since this paper was read, the half of the Meteorite, which was broken into two portions, has been cut into several sections or slices; and in the process of doing so, it was found that the lobed or rounded portion was very hard and dense, resembling cast-iron in its character, it was harder than untempered steel of the best quality, but not so hard as the prepared steel plate of the engraver; while the pointed portion was softer and tougher, and was stated to resemble iron to which a small portion of malleable iron had been added. The slices showed that the mass was dense and metallic throughout, with the exception of a small part of the pointed portion, next the deep furrow which partially divided the mass (and by which it became separated into two); the metal here was marked over with dull spots, like corrosions, and seemed less pure and crystalline, appearing as if mixed with dross. A portion of this latter part was given to Dr Murray Thomson to examine specially for the presence of magnetic oxide of iron; and Dr Thomson has accordingly added some notes on the subject to his previous communication.

The mass of iron was apparently not malleable, but brittle in its character. It would therefore, according to the classification proposed by Professor C. U. Shepard in his Report on Meteorites, belong to the 2d SECTION—*Alloyed*, of the 3d ORDER—*Brittle*, of his 1st CLASS—METALLIC METEORITES. (See "Silliman's American Journal" for 1846 and 1847.)

An opportunity was also taken of repeating, on one of the polished slices, the etching with acid, to see if it was possible to get a more distinct display of its peculiar crystalline structure, by watching the action of the acid on the metal. In place of using the mixed nitric and glacial acetic acids of the steel

* *Vide* Journal, vol. xvi. July 1862, p. 108.

engraver, as was formerly done, nitric acid alone was used; but little or no effect was produced, with the exception of a very slight etching on the part first touched. The nitric acid was then diluted with about an equal quantity of water, and on its being again applied to the metal a rapid action took place, with a considerable evolution of gas, and a brownish or dark-coloured matter (carbonaceous ?) was seen to rise and mix with the acid solution, not from the coating protecting the rest of the metal, but from the bitten surface of the metal itself. The presence of this brown-coloured matter is stated not to be observed when ordinary steel is etched. Instead of making, as before, a large etched patch at the line of separation or fracture of the rounded and pointed portions of the mass of iron, a small patch was etched near the middle of the rounded

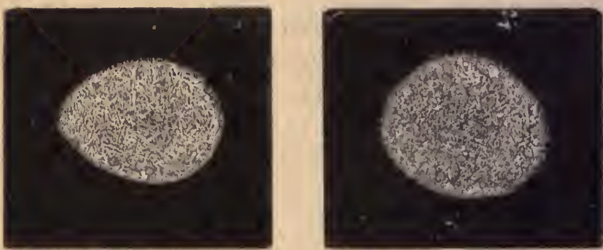

Fig. 1. Fig. 2.

Impressions of etched portions of the meteoric iron.

or lobed portion (fig. 1), and this displays very distinctly the characteristic and beautiful frosted-like lines of crystallization, crossing one another at various angles. As formerly stated, these lines are finer, or more minute, than in many meteoric irons. This finer texture seems to be also present in other brittle irons; at least it is mentioned as occurring in those described by Professor Shepard in his Report. (See "Silliman's American Journal," 1847.) I am inclined to think it not improbable that this fine, or less-distinctly marked texture may be simply dependent on the rapid cooling, or any other cause which gives the iron its brittle character. Another patch of etching was made near the narrow extremity of the pointed portion of the mass (fig. 2). Here the crystalline structure of crossing lines is less distinct, the metal being apparently more granular in its texture, and exhibiting a series of shining points. The action of the diluted acid on the metal was closely watched, and was stopped occasionally, so as to preserve the appearance of the etching, when its character was most distinct. Wax squeezes and electrotype casts were taken from these etched surfaces, and are here printed from as woodcuts (figs. 1, 2). They may therefore be compared with that figured before, which was taken in a similar way from the central part of the meteoric iron.

A portion of this meteoric iron, with plaster cast of the entire mass, are now preserved in the Natural History Museum, Edinburgh; the principal part of the iron is in the British Museum, London.

Note to "Analysis of the Meteorite described by Dr John Alexander Smith, M.D." By MURRAY THOMSON, M.D., F.C.S., Lecturer on Chemistry.*

As formerly stated, the specific gravity of the meteorite, in its entire or undivided state, was 6·517. From an unfortunate inadvertence, however, some of the details of the weights and specific gravities of the divided portions of this meteoric iron were incorrectly printed in the communications published in this Journal in July last. It will therefore be necessary to substitute, for those formerly given in Dr Smith's paper (p. 118), and in my analysis (page 125), the following correct table of the different weights and specific gravities :—

1. Of the halves into which the iron was cut, one was rather larger and heavier than the other, and weighs :—

In air,	18 lbs.	2 oz.	7½ drs.	(Avoir.)	
In water,	15 ,,	5 ,,	12½ ,,	,,	
Its specific gravity is therefore				.	6·499

II. The smaller half, now broken into two portions, weighs:—

1. The larger or pointed portion,

In air,	7 lbs.	9 oz.	8½ drs.	(Avoir.)	
In water,	6 ,,	7 ,,	8 ,,	,,	
Specific gravity,		.		.	6·7400

* *Vide* Journal, vol. xvi., July 1862, p. 125.

2. The smaller or rounded portion :—

In air,	5 lbs.	10 oz.	2½ drs.	(Avoir.)	
In water,	4 „	11 „	9½ „	„	
Specific gravity,	.	.			6·1919

After the communication on the Analysis was written, and as a portion of the mass had been cut into pieces of various sizes, another opportunity was had of taking the specific gravity of a slice (separated into two portions), embracing the whole thickness of the mass. These pieces being more manageable for the purpose of taking density, it is to be presumed that the following numbers express, with the utmost accuracy, their specific gravity :—

Slice from the pyramidal or pointed portion gave,	6·750	sp. gr.
„ rounded or lobed „	6·350	„

It was also noticed, in examining a small portion of the first of these slices, where the metal was corroded-looking, and showed various black spots on its surface, that this iron was very brittle ; so much so, that no difficulty was experienced in reducing a fragment of it to powder in an iron mortar.

I would likewise here record, that a further chemical examination was made, chiefly in search of magnetic oxide of iron, which is so frequently a constituent of meteorites, but, as before, I could obtain no evidence of the existence of this substance.

It has been already stated that the portion of the meteorite used for analysis was that obtained by filing the exposed faces of its halves ; it might therefore be objected, that the material so procured, at least from the harder portion, was likely to be mixed with particles of the file used, and especially that the percentage of the carbon in the meteorite might thereby come out too high. It certainly cannot be denied that minute particles of the substance of the file would mix with the filings ; but from the texture of the mass these must have been but a very trifling proportion, compared to the bulk of the filings. To be certain, however, that no substantial error had crept in from this source, another determination of the carbon and silica was made on a solid piece of the meteorite, the result being to show the presence of these constituents in the following proportions :—

Carbon,	. . . .	0·56 per cent.
Silica,	. . . . .	0·90 ,,

These new percentages being so close to the last, we may regard the first analysis as quite correct.]

Address delivered at the Opening of the Session of the Royal Society of Edinburgh, on Monday, 1*st December* 1862, *by* Principal FORBES, D.C.L., F.R.S., Vice-President of the Society.

GENTLEMEN,—I propose to address you on this occasion with reference to the following points :—

First, to recapitulate briefly the origin, the objects, and the Constitution of Societies similar to our own.

Secondly, to trace the rise and general history of the Royal Society of Edinburgh.

Thirdly, to consider what changes the progress of science and of society render necessary or desirable in the working of associations like ours, and how far such changes are safe and prudent.

Lastly, to recall the history of this Society during the past twelve months, especially with reference to the Fellows whom it has lost.

I. *To recapitulate briefly the Origin, Objects, and Constitution of Societies similar to our own.*

Societies having any true analogy to the academies of modern Europe, or to the Royal Societies of London and Edinburgh, or the Royal Irish Academy, have arisen within about 300 years. Italy was their birth-place, and perhaps, on the whole, in no country have they flourished more. They appear to have been the direct offspring of the spirit of inquiry so active in that country throughout the sixteenth and seventeenth centuries. According to the literary historians of Italy, the cultivation of literature by academicians, salaried by the Government, commenced at Rome in 1514, under the Pontificate of Leo X. It is well known, that the cultivation of literature and the fine arts continued to be fostered in Italy by similar institutions during many generations. The *Accademia della Crusca* (named after the Italian word for bran or chaff, from the fanciful analogy of sifting the pure from the heterogeneous parts of the language), and the Society of Arcadians, which still exists or existed lately, are familiar examples. But the number of such associations was vastly greater than we can find a parallel for in other countries or in more recent times.

After all, the typical form of the modern Royal Society or Academy is traceable to the astonishing impulse given to the experimental physical sciences in Italy in the sixteenth century. The first such society recorded by Tiraboschi and Libri, the chief annalists of the revival of letters in Italy, was called "Accademia Secretorum Naturæ," founded at Naples in 1560, of which the celebrated Baptista Porta was president. It was suppressed, however, by the influence of the priests. The Society of *Lincei*, or Lynx-eyed scrutators into natural phenomena, of which Galileo was a member, held its sittings at Rome. It was founded in 1604 by Cesi, a noble Roman, and still survives, though after a long intervening period of inactivity.*

It is easy to see how the newly-born interest of mankind in the investigation of nature by experiment, must, far more than mere literary discussion or dialectical argument, have fostered such associations. In those glorious days when a virgin mine of natural phenomena was first opened to the intelligent exploration of mankind, the succession of inventions, discoveries, and capital theories in physical science, kept every thoughtful mind on the stretch. The comparatively recent art of printing served to disseminate rapidly both facts and doctrines; the promulgation of the true system of the world by Copernicus, the improved astronomical observations of Tycho, the mechanics of Da Vinci and Stevinus, the telescope of Galileo, kept all Europe in a tremble of expectation for the discoveries of each succeeding year. What *could* men do in such circumstances but assemble with others like-minded, and see with their own eyes the facts which seemed to contradict the experience or prepossessions of ages, and either maintain or overthrow the new philosophy? It was under such circumstances that the Florentine Academy, "del Cimento" was founded in 1657,† under the patronage of the Grand Duke Ferdinand II. of Tuscany, and with the personal support of his brother Leopold. The withdrawal

* See Drinkwater Bethune's Life of Galileo, p. 37.

† First meeting, 18th June 1657. *Saggi*, &c., Edit. 1841; Introd. p. 95. As its name imports it was an association for making *experiments*.

of the latter from Florence in 1667, on being made a Cardinal, was followed by the decline and virtual extinction of this remarkable Society. This is considered by Mr Hallam as a proof of the inconveniences attending such exalted patronage of literary societies; yet it does not seem to afford a sufficient reason for the cessation of the labours of a society which gave such indisputable proofs of vigour, whose Transactions remain a book of reference to this day, and whose members, including the best and ablest pupils of Galileo, were well able to sustain their position amongst the learned men of Europe.

The wide reputation of the Florentine Essays contributed, no doubt, to the establishment—also under Royal sanction—of the Royal Society of London. This took place in November 1660, immediately after the Restoration, and from that time their proceedings may be traced with minute precision. Founded originally upon the basis of a private Society for the cultivation of Natural and Experimental Science instituted in 1645, it was incorporated by charter in 1662, four years before the Academy of Sciences of Paris was instituted in 1666 under the auspices of Colbert. This last was incorporated with the previously existing *Academie Française* founded for the cultivation of the French Language and Literature, much after the manner of the Crusca Academy in Italy.

The Academy of Sciences and the Royal Society of London subsist, it is needless to say, to this day; and each in their own sphere, and in varying ways, according to the exigencies of the time, have contributed in the most important way to the improvement of the Physical and Mathematical Sciences. The unbroken series of Transactions of both are without a parallel in the history of knowledge for continuity and importance. The publication of the "Philosophical Transactions" commenced in monthly numbers on the 1st March 1665. Our own Society has very recently acquired for the first time a complete set of these publications from the commencement,—an acquisition of some difficulty and importance.

An hundred and twenty years elapsed before the progress of knowledge and of organisation in the sister kingdoms of Scotland and Ireland sufficed for the formal institution of associations on similar principles and with similar ends to the Royal Society. The

Royal Society of Edinburgh was formally constituted in 1783, and that of Dublin, or the Royal Irish Academy, in 1785. Both arose out of societies previously existing, though of a more private character, and not incorporated. As most interesting to us, I shall presently proceed to trace the rise of the Royal Society of Edinburgh.

But before giving an account of this, let me interpose a remark on the organisation of such societies generally. Even in early times, they differed from one another in respect of being either under the direct influence of the State, or of being merely private associations. This distinction continues to the present day. The French Academies, for example, are national institutions, and the members receive salaries from public funds. The Royal Societies of this country, on the other hand, are free from even the vestige of State control, and pursue their aims without pecuniary objects, and according to their own regulations. This is not the place to discuss the advantage of the two systems, in favour of each of which something may be said. The place of a salaried academician is often really desirable for those whose fortunes do not enable them to pursue the unremunerative paths of science and literature. On the other hand, the pecuniary gain is liable to give rise to motives less pure than mere honorary distinctions can do, on the part both of candidates for the post and of the academical electors. It appears from the history of the *Academie Française* in its origin, that the enlargement and incorporation of it under the State influence of Cardinal Richelieu was much resented by its original members.

The two forms of constitutions—the one creating a power in the State with corresponding advantages to its associates, the other receiving an impulse entirely from within—are really so distinct, that it seems almost invidious to compare them. The latter appears, from the history of our country, to be most congenial to English habits in such matters; and perhaps we have no great reason to regret the absence of an "Institute" under Imperial or Royal administration.

But another question arises with reference to such Societies as those of London, Edinburgh, and Dublin: Whether, in default of substantial endowments in connection with membership, an artificial standard of literary and scientific distinction is to be held up as regulating the entrance or refusal of candidates?—whether, in short, the members of our Societies are to be held as unsalaried academicians,—men selected for intellectual attainment alone, and forming therefore a learned class?

On this point, which is one of considerable importance, I confess that I entertain little doubt. Whatever disadvantages may attend the admission to Societies like this of persons who have no pretensions to what, for convenience, one may call a *professional* acquaintance with science, art, or literature, I think that they ought to be eligible. It is little likely that where no emoluments or distinctions present themselves, the privilege of membership will be sought except by those who feel *some* sympathy with pursuits for which they have probably a secret leaning, but from which they have been withheld by force of circumstances. I say, Let them come, and freely, and let us regard their adhesion to our ranks as a compliment on either side.

In Britain, all experience points to this resolution of what may be in some respects regarded as a difficulty. From the day of the foundation of the Royal Societies, both of London and Edinburgh, the rule of mixture of classes, and the absence of an academic standard of exclusion, has been all but universal. The co-operation of men of all ranks, and of the most varied occupations and acquirements, was the very corner-stone of these institutions. While they diffused a taste for science amongst the nobility, gentry, and professional men, this very mixture enhanced, in no small degree, the interest of the proceedings of the Societies themselves, and conduced to the respect shown to literature and science. It also indirectly aided the progress of the latter, by raising a large fund for the publication of Transactions and the conduct of experiments.

To attempt to enforce a contrary principle, would be to reduce the members of our Societies to a select few, without the advantages which academicians properly enjoy, and without the cordial sympathy which the lay-members (as they may be termed) contribute to diffuse amongst an intelligent public, whose sentiments in such matters is never to be despised.

II.—*Rise and Progress of the Royal Society of Edinburgh.*

Guided by an interesting passage in the "Life of Lord Kames,"* it would appear that the germ of our Society is to be found in the *Rankenian Club*, instituted in Edinburgh in 1716, for literary social meetings, and which had the unusual duration (for such associations) of almost sixty years. It expired in 1774. It included among its original or early members, Principal Wishart, Bishop Horsley, Colin Maclaurin, John Stevenson, Professor of Logic, Lord Auchinleck, several of the ministers of Edinburgh and neighbouring gentry, and, finally, Sir John Pringle, afterwards President of the Royal Society of London. No publications are known to have proceeded from this Club.†

Contemporary, in part, with the Rankenian Club was a Society for the Improvement of Medical Knowledge, instituted in 1731. This Society, of which little perhaps is now remembered save its published Transactions, appears to have been conducted with an enlightened sense of the dignity and importance of associations for the promotion of science, which its founders justly considered to be more advanced by publishing able papers, than by making a parade

* [By Lord Woodhouselee] two vols. 4to. Edin. 1807, vol. i. p. 174, and list of members, Appendix p. 50.

† Since the reading of this address I have been indebted to Professor Fraser of the Edinburgh University for a reference to an interesting allusion to the "Rankenian Club," contained in Dugald Stewart's First Dissertation on the Progress of Metaphysical and Ethical Philosophy, part ii. sect. 4, where he speaks of Berkeley's celebrated system of Idealism having "attracted very powerfully the attention of a set of young men who were then prosecuting their studies at Edinburgh, and who formed themselves into a society for the express purpose of soliciting from the author an explanation of some parts of his theory which seemed to them obscurely or equivocally expressed. To this correspondence the amiable and excellent prelate appears to have given every encouragement; and I have been told," adds Mr Stewart, "by the best authority, that he was accustomed to say that his reasonings had been nowhere better understood than by this club of young Scotsmen." To which Mr Stewart adds this note: "The authority I here allude to is that of my old friend and preceptor, Dr John Stevenson, who was himself a member of the *Rankenian* Club. . . . . . ." Mr Fraser justly remarks, that the dates tally well with this statement; Berkeley's "Dialogues" having been published in 1713, and the Rankenian Club having (as stated above) been founded in 1716

of ceremonious meetings and printing lists of dignified office-bearers. With a reticence which we all must regret, the six volumes of *Medical Essays* give no clue to the constitution of the Society, the nature or frequency of its meetings, the names of the presidents, nor even of the diligent secretary by whom, no doubt, its Proceedings were edited.*

I think I am entitled to assume that the papers were fully equal in point of merit to those contributed on medical subjects to the Royal Society of London, or any similar institution. They went through more editions than one, were translated into foreign languages, and were highly commended by the celebrated Haller. It is reasonable to believe that the wide reputation of the Edinburgh Medical School dates from the publication of these important Essays.

In a paper on the Climate of Edinburgh, which I contributed a few years ago to the Royal Society's Transactions,† I have brought into view the early meteorological observations contained in the *Medical Essays*, though by whom they were made does not appear.

The six volumes of Medical Essays terminated in 1744. In 1737, at the suggestion of the celebrated Maclaurin, the objects of the Society had already been extended so as to include general science and literature.‡ It had not existed for many years in this form before political troubles antecedent to and during the insurrection of 1745–6 seriously impaired its usefulness, and probably prevented the separate publication of its Transactions, which was from the first contemplated.§ The death of Maclaurin, in June 1746, which

* An incidental notice, however, in the Introduction to the first volume of the Royal Society's Transactions, informs us that the secretary was the first Professor Monro, who was also a large contributor to the *Essays*.

† Vol. xxii. p. 327.

‡ The date usually assigned is 1739. But from two letters of Maclaurin printed in the "Scots' Magazine" for June 1804, the earlier date is certainly correct. Mr David Laing has shown me a pamphlet (of sixteen quarto pages) containing the Regulations of the Society and a List of Members. The List of Members is dated 1739; but at page 3, the first Thursday of December 1737 is fixed as the first day of meeting.

§ The papers read at the Society were in part printed in the later volumes of the *Medical Essays*, in the *Philosophical Transactions*, and in *Maclaurin's Fluxions*. It appears from a notice in Mr R. Chambers's *Domestic Annals* (vol.

was immediately traceable to his exertions on the side of the English in the melancholy struggles of the period, was a heavy blow to its usefulness, and a mass of papers connected with it were found to have been in his possession, which could be only partially recovered. Some of these were published in 1754, under the title of *Essays and Observations, Physical and Literary, read before a Society in Edinburgh*, and they were followed by two other volumes in 1756 and 1771. The first president of the Philosophical Society was the Earl of Morton (afterwards president of the Royal Society of London), Maclaurin and Dr Plummer (Professor of Chemistry) were secretaries. Afterwards Professor Monro (*Secundus*), and the celebrated David Hume, acted as secretaries. The Society then held its meetings in the Advocates' Library. Medical subjects still greatly predominated in the Transactions; but among the contributors appear the names of Maclaurin, Lord Kames,* John Stewart (Professor of Natural Philosophy), Matthew Stewart, Porterfield, Melvill, and Joseph Black.†

It is no small credit to this unpretending Society that it not only gave from its members two Presidents to the Royal Society of London, but reckoned amongst its contributors perhaps the two most eminent disciples of the Newtonian school which Britain produced in the whole of the eighteenth century,—namely, Colin Maclaurin and Matthew Stewart. The Philosophical Society of Edinburgh was the immediate parent of the Royal Society.‡

The Royal Society of Edinburgh took its rise in a meeting of the Professors of the University of Edinburgh, many of whom were also members of the Philosophical Society,§ on the proposition of Prin-

iii. p. 477), that, in 1743, the Society advertised for specimens of stones, ores, saline substances, bitumens, &c., to be sent to their secretary, Dr Plummer, and it is stated that "the Society undertake, by some of their number, to make the proper trials at their own charge for discovering the nature and uses of the minerals, and to return an answer to the person by whom they were sent, if they are judged to be of any use, or can be wrought to advantage." The quotation is from the *Edin. Evening Courant*, 22d Aug. 1743.

* Henry Home, Lord Kames, became president about 1769, and contributed greatly to the success of the Society.

† Dr Black's sole contribution was his celebrated "Experiments on Magnesia Alba," Essays, &c. vol. ii. p. 157.

‡ See Life of Kames, i. 184, and Trans. Roy. Soc. Edin., i. p. 6.

§ The last survivors in our body of the Philosophical Society were, Profescipal Robertson, towards the end of 1782. It is stated to have been founded "on the model of some Foreign Academies," and so far differed from the Royal Society of London, that literary objects were equally promoted with science, and the interests of literature represented by a Literary "Class" or subordinate Academy, having distinct meetings and office-bearers. It appears from a curious letter of Professor Dalzel, in Professor Innes's *Life of Dalzel*,* that the Royal Society was more particularly modelled on the Berlin Academy, and that its rise was partly due to a contest between Lord Buchan and the Society of Antiquaries on the one hand, and the University and Faculty of Advocates on the other. The result, however, of this party-war was in favour of the interests of science and literature; for the Society received a Royal Charter, and was formally constituted at a meeting held in the College Library on the 23d June 1783, under the presidency of Principal Robertson, at which were also present the Lord Provost, Lord Justice-Clerk Miller, Professors Cullen, Monro (*Secundus*), Hugh Blair, John Walker, Adam Ferguson, John Robison (who was then appointed secretary), the Solicitor-General Ilay Campbell, and several members of the Faculty of Advocates, the celebrated Adam Smith, and Mr Hunter Blair, M.P. for the city of Edinburgh.

The Society started at once into vigorous existence, and, looking especially to the reputation of the members of the Literary Class, few societies in any country have given a fairer prospect of a distinguished career. The members were either Resident, Non-Resident, or Honorary. The number of Original Residents was 102, and of Non-Residents, 71; and this before the Society had ever held a meeting. A short time later, the total number of members belonging to the Physical Class was 101, and to the Literary Class, 114. An excerpt from the MS. list of original members, in Professor Robison's handwriting (exclusive of those who have been named as founders of the Society), will give no mean idea of the eminent position of Edinburgh in the literary world of that day:—

sor James Russell and Sir William Miller, Lord Glenlee. The latter died so lately as 1846, in his ninety-first year. The Minute-Books of the Philosophical Society were expressly conveyed to the custody of the Royal Society (see Minute, R.S., of 4th August 1783); but they are, it may be feared, now irrecoverably lost.

* Page 39 (30th Nov. 1782).

The Physical Class included Joseph Black, Clerk of Eldin, Sir John Dalrymple (Lord Hailes), James Gregory, James Hutton, John Playfair, Dugald Stewart, Lords Bute and Dundonald, Sir James Hall, James Watt, Dr Small of Dundee, Patrick Wilson; and in the Literary Class we find the Lord President, Chief Baron, and Lord Advocate, John Home, David Hume, Henry Mackenzie, Alexander Tytler (Lord Woodhouselee), the Duke of Buccleuch, Archibald Alison, Dr Beattie, Edmund Burke, Lord Morton, Lord Hopetoun, John Hunter of St Andrews, Thomas Reid, Young of Glasgow, Dalzel, and Mr (afterwards Sir Robert) Liston. The earliest meetings of the Royal Society (as well as that of its incorporation) took place in the University Library. A large subscription towards the erection of the New College was made by the Society, on the understanding that the Society should be accommodated within its walls; and space was actually allotted on the north side of the building. How this was frustrated I do not know. The formal meetings continued to take place usually in the same place (the Library), at least until 1808, with an occasional substitution of the Physicians' Hall. In 1810, the Society purchased a house, No. 40 George Street, where they were accommodated until 1826; when they removed to the rooms which they still occupy, under a lease from Government, in the Royal Institution Building in Princes Street.

I proceed to trace rapidly the fortunes of the Society, which almost on the very day that I address you has completed the eightieth year of its existence.

The first President was the Duke of Buccleuch. He was succeeded in 1812 by Sir James Hall, who, resigning in 1820, was followed by Sir Walter Scott. On the death of the latter in 1832, Sir Thomas Makdougall Brisbane filled his place, to be succeeded at his decease in 1860 by the Duke of Argyll. Thus we have the remarkable and very unusual fact, that the first four presidencies endured over seventy-seven years. The chief secretaryship has in the same period been held by only five individuals, of whom but two were removed by death.

The earliest period of the Royal Society, and also the earliest volumes of its Transactions, were marked by the efficiency of the literary department. The first two volumes show a substantial if not precise equality in the extent of the published contributions devoted to literature and to science. The balance will even preponderate on the literary side, if we include the elegant biographies of deceased Fellows drawn up by accomplished authors. About 1793—only ten years from the origin of the Society—the activity of the Literary Class had already become materially impaired. But indeed at no period could the literary papers bear comparison in point of merit, as a whole, with those on science. The great men of letters, who lent the weight of their names to the institution, hardly maintained its reputation by their pens. The Robertsons, the Reids, the David Humes, the Fergusons, and the Adam Smiths, hardly contributed to the pages of the Transactions.

It appears from the minutes of the Physical and Literary Classes which are now before me, that towards the end of last century the meetings of the Literary Class became rare—not averaging three in a year—in consequence of the deficiency of communications. In 1807, when, owing to the interest excited by the geological discussions of the period, in which Sir James Hall, Professor Playfair, Lord Webb Seymour, Professor Jameson, Dr Thomas Thomson, Mr Thomas Allan, and Mr Macknight took active parts, the business of the Physical Class literally overflowed into the Literary Class, the evenings appropriated to the latter, and not taken up by literary papers, being devoted to science. In the following year the minute-book of the Literary Class ceases altogether, and the separate meetings appear to have been discontinued from that date (1808). Afterwards a few literary papers were received at the ordinary meetings, without any attempt at separation. It was, however, only in 1827 that the distinction of the two classes was finally abandoned in the annual election of office-bearers, and *that*, not from any disinclination on the part of the Society to afford honourable room to literary papers, but simply from the cessation of such communications. It is perfectly understood that a renewal of these would be considered to be a credit to the Society, and I hope that our literary friends will be induced to give us the benefit of their support and their contributions.

With the exception of the Literary Class, the Proceedings of the Society were at no time marked by more energy and importance than during the first twelve or fifteen years of the present century, when the geological discussions to which I have referred made Edinburgh the chief centre of information on such subjects. They gave rise to the masterly papers of Sir James Hall, with which at that time the Transactions were enriched.* These were followed or accompanied by the early communications of Sir David Brewster on Polarization and other parts of Optics, which added much to the scientific reputation of the Society.

The accession of Sir Walter Scott to the presidency in 1820 did not reanimate the Literary section of the Society. He contributed no paper, although he at one time very regularly presided at the ordinary meetings. From 1832, when the printing of the "Proceedings" at every meeting commenced, to the present time, nothing in the history of the Society calls for special remark. During that period, as at former ones, there have been fluctuations in the prosperity of the Society, both as regards the number and value of the communications received, and the interest taken in the meetings by the Fellows at large and by the general public. That such must occur the founders of the Royal Society were sufficiently aware. At the very opening of our Transactions we find it observed, that "Institutions of this kind have their intervals of languor as well as their periods of brilliancy and activity. Every associated body must receive its vigour from a few zealous and spirited individuals who find a pleasure in that species of business, which, were it left to the care of the members in general, would be often reluctantly submitted to, and always negligently executed. The temporary avocations, and still more the deaths of such men, have the most sensible effects on the societies to which they belonged. The principle of activity which animated them, if not utterly extinguished, remains long dormant, and a kindred genius is required to call it into life."† The truth of these remarks must be apparent to all who have had experience in such matters. They ought to encourage us to keep alive the interest of our meetings, and to maintain the character of our Society at times when

* The last meeting at which Sir James Hall appears to have presided, was that of the 5th June 1820. He resigned the presidency in November following. His last paper printed in the Transactions, "On the Consolidation of the Strata of the Earth," was read in March 1825.

† Trans. R. Soc. Edin., vol. i. p. 6.

either may appear to be in danger of flagging, resting well assured that the development of knowledge, and the intellectual resources of new generations, will ever from time to time give lustre and importance to associations destined not to meet the caprices or fashions of a time, but to promote the great cause of scientific and literary progress.

III.—I now proceed to consider *what changes the progress of science or of society renders necessary or desirable in the working of associations such as the Royal Society, and how far such changes are safe and prudent?*

The most casual reader of history, or observer of men, knows that the inevitable progress of change—material, intellectual, and social—deprives of the character of permanence all human institutions. Those Institutions are most likely to be perpetuated, in which a wise forecast of progressive change adapts their parts to the wants and circumstances of the age. If this be true of political Constitutions, of Churches, of Universities, of Charities, nay even of public Amusements, it is no less true of learned Societies. Considering that the Royal Society of London and the French Academy of Sciences are each two centuries old, we rather must wonder—taking into view the astonishing progress, or indeed reconstruction, of the sciences during that time—that so much of their original constitution still remains, than that changes have been needed, or are still required, to meet the wants of successive generations.

I shall consider some of the most obvious changes of condition under which learned associations pursue their vocation now and formerly. In doing so, I shall speak principally of their relations to the natural and experimental sciences.

The Florentine Academy was an excellent *type* of what a physical association of the seventeenth century was and ought to have been. The members collected apparatus, they had a laboratory, they furnished funds for these; and the associated philosophers (who were select in number) met to witness the experiments, and to argue upon the conclusions to be drawn from them. The Royal Society of London, as well as the lesser societies from which it sprung, took a precisely similar course: they had a paid Operator and Editor of their Transactions; and they remitted to individual members or small committees to try experiments, and to report the results to a succeeding meeting.

This seems to be the most perfect constitution of a society for investigating nature which we can well imagine. It bears a close analogy to the *Philosophical College* of Bacon,—the *Solomon's House* in the allegory of the New Atlantis,—which is generally believed to have been really an antecedent (in the way of suggestion) to the formation of the Royal Society of London. But it is now less practicable than formerly, for many reasons, of which I will enumerate a few. For example, these Societies include in our time so many members that they can no longer consult as a committee, but must rather listen as an audience. Again, the minute subdivisions into which the sciences are now split, render a perfect comprehension of one science alone almost the occupation of a single life. Hence, unless such a society were to consist all of chemists, all of astronomers, all of comparative anatomists, and so forth, the proceedings, and even the experiments, which in a former age interested nearly all well-informed men alike, are now interesting or intelligible to only a small section. In like manner, an experimental investigation is no longer the simple and absolute thing which it was. A member of the Royal Society is no longer instructed, as in former times, to try, for instance, whether spirit of wine burns or not in an exhausted receiver; whether salt is separated from water in freezing; to dissect an oyster; to measure whether pebbles and other minerals grow or not; whether eggs frozen continue fecund; to repeat the Magdeburg and Torricellian experiments; to determine the relative weight of lead and water; and to report the result of any such experiment at next week's meeting.* But the investigations are now-a-days complicated, the experimental means alone furnish matter for long and anxious preliminary consideration; the precision needed, and the calculations on which it depends, are matters consuming time, and often can be better attained by the patient efforts of an individual, than through any amount of co-operation; nay, the very results, unless involving a capital discovery (which is a rare and fortunate accident), cannot be stated without an amount of detail often wearisome to those who are not especially interested.

* These instances are all taken from the early Journals of the Royal Society of London.

These, among others, are causes why men cannot now do the hard work of science in their collective capacity as associations. How rarely do we even see two philosophers (at least in this country) engaged in a common investigation!

One result of what has been stated is the breaking down of scientific communities into special aggregations or societies for the promotion, say, of astronomy, or geology, or chemistry, or even minuter subjects, such as microscopic anatomy, numismatics, or entomology. Such associations bear testimony to the difficulty, which increases year by year, of rendering the sciences intelligible and interesting, in respect of new discoveries, to the mass of even well-educated men. They are so far a protest against the utility of associations at all, since they tend to reduce the prosecution of science more and more to an individual affair.

In communities less numerous and comprehensive than those of London or Paris, the difficulty is not less felt, though the means of meeting it (at least temporarily) are not so attainable. The largest provincial town or district cannot possibly maintain the group of associations which, even in London, may be said to enjoy a precarious intellectual subsistence. I do not mean to say, that more subordinate special associations are unadvisable, even in the provinces; on the contrary, I believe that they may do much good. But one may fairly deprecate the encouragement of a spirit of rivalry towards the larger and more national and permanent institutions which already exist, such as the Royal Society may fairly claim to be. To maintain the character, for energy and stability, of one central Society, is in reality the common interest of all of that not very numerous body of persons who cultivate science for its own sake. Delightful and instructive meetings may advantageously be held by a local body of geologists or chemists, or naturalists; but such associations require immense vitality to be permanent. Practically, they fall into abeyance, in perhaps twenty or thirty years, or even less; and if they have attempted to record their labours by publication, these publications having never attained more than a very limited circulation, become inaccessible and forgotten. The matured written results of those labours which properly form a subject of almost private discussion in minor societies, are best consigned for final preservation to the publications of a central and enduring association. A good example of what I here intend to indicate, may be found in a private Parisian Society, founded early in this century, called *La Societé d'Arceuil*, from the name of the country-house of its president, Count Berthollet, where it met. It consisted of the *élite* of the French Academy of Sciences, including Laplace, Humboldt, Gay Lussac, Biot, Arago, Decandolle, &c. But the Memoirs (in three volumes) published by this most distinguished and delightful club, including such papers of capital importance as Malus's original one on the Polarization of Light, Humboldt's on the Isothermal Lines, Thenard on Ethers, and Arago on the Colours of Thin Plates, must be considered as in fact withheld from the Proceedings of the national Academy, and they must now be sought for consultation in a small printed collection in the hands comparatively of few. It is needless to add, that the Society lasted for but a few years.

I may also include among the causes which have of late years affected the prosperity of our own and similar societies, that tendency to *centralization* which, during the last half century, has affected so many interests, political, social, commercial, and also scientific and literary. The facility of communication with London has facilitated that tendency to southward emigration, so long, and not unjustly, attributed to Scotchmen. But far from aiding their return, the facility seems to be all in one direction. The larger arena for practical talent to be found in the metropolis attracts even our writers of literary essays, and our labourers in the cause of physical science. It is a fact which admits of no doubt, that the Scottish Geological School, which once made Edinburgh famous, especially when the Vulcanist and Neptunian War raged simultaneously in the hall of this Society and in the class-rooms of the University, may almost be said to have been transported bodily to Burlington House. Roderick Murchison, Charles Lyell, Leonard Horner, are Scottish names, and the bearers of them are Scottish in everything save residence. Even the field of their labours is in no small measure Scottish; and the Silurian standard is waved over half the length and breadth of our "primitive" Highlands. Our younger men are drafted off as soon as their acquirements become known. Professor Ramsay was early called from his voluntary labours in

Arran to English soil; and we only retain the services which our townsman Mr Geikie volunteers for our instruction, so long as the central forces of Jermyn Street suffer him to linger within the Scottish border. Others, who still reside in Scotland, not unnaturally seek a larger audience, and a more rapid publicity for their memoirs, by transmitting them to London. This is reasonable and inevitable. Yet a certain feeling of patriotism might still retain a portion of their labours for the Transactions of our Scottish Royal Society. Indeed, it is remarkable that the centralization of which I have spoken seems to reside in London chiefly; for we do not find much tendency in Scottish towns or universities (with a few honourable exceptions) to contribute to the literary and scientific wealth of our national metropolis. I believe that the original list of the Royal Society of 1783 includes more provincial members, at all events from the Universities, than we can reckon in 1862. Of all the changes which have befallen Scottish science during the last half century, that which I most deeply deplore, and at the same time wonder at, is the progressive decay of our once illustrious Geological School. Centralization may account for it in part, but not entirely.

But I have allowed myself to be partly withdrawn from the enumeration of the causes of change which have affected the business and functions of societies for the promotion of science and literature. Another of these is the alteration of domestic habits in some important particulars. Most of the older societies commenced in *Clubs*, which met at taverns, in conformity with the all but universal usage of the period. The "Philosophical Club," which foreshadowed the Royal Society of London, met in 1649 at the Bull's Head in Cheapside; and the germ of the Royal Society of Edinburgh was a club meeting at Ranken's Tavern. All this is past and gone. The Drydens, the Addisons, and the Johnsons of our day, hold forth no longer at "Will's" or "The Mitre." If a more domestic, we are certainly a less "clubable" generation.* The effect tells even upon our literary and scientific undertakings. The clubs of modern London are rather institutions for the luxurious accommodation of individuals than for social intercourse; and the attempt of Sir H. Davy and others to combine them systematically with literary conversation, in the case of the "Athe-

* "Boswell is a very *clubable* man." Johnson, in *Boswell's Life.*

næum," proved a failure. An analogous influence is found in the vast expansion of intellectual intercourse through the means of the press, and in the filtering of knowledge of all kinds—of scientific knowledge, perhaps, especially—through the widely extended system of popular lectures. In these two features of the age, we find sufficient reasons alone to account for much of the social change to which I have referred. Newspapers, magazines, and ephemeral literature of every kind, supplant the oral intercommunication characteristic of the days of clubs. A man takes home with him to his fireside the gossip, the jokes, the discoveries, the discussions, grave or gay, of the day. And in matters of science it is somewhat the same. Much he finds of all that is most occupying the thoughts of able men pursuing natural knowledge set down in the pages of the "Athenæum," or "Macmillan," or "Good Words," perhaps by the very persons who really are most able to speak of such things. Nothing of importance can be communicated to a society which does not soon become matter of public notoriety through such channels.

But still wider is the influence of those popular discourses or lectures which now practically supply to many persons of general information, but not professed students, the intellectual interest formerly sought in the meetings of our learned Societies, and I believe I might add, in the case of Edinburgh, in some measure from our University courses also. The Royal Institution of London commenced this system with splendid advantages, and its popularity (which could scarcely increase) has been maintained with little if any diminution for sixty years. But in fulfilling its own task of instructing intelligent persons in the latest results of scientific discovery, often from the very mouths of the discoverers themselves, it has deprived of one great attraction the meetings of the Royal Society, the great fountain and source whence such knowledge ought naturally to flow. Similar influences have prevailed in Edinburgh, to the diminution of the attendance in this place. Those who can look back to the audiences assembled in this room when ordinary scientific papers were read, from twenty-five to thirty years ago, will corroborate my testimony as to the change which less than even one generation has brought about. The social spirit of coming together for common objects, self-improvement in the first place, and the charm of a periodical, a fortnightly meeting with like-minded persons (seldom perhaps met with in the interval), counteracted the tendency to criticise, and the intolerance of hearing something read not immediately or directly interesting to the hearer.

Were I to enumerate the names of that large band of our fellow-citizens, our professors, our distinguished lawyers, our country gentlemen and mere amateurs, who, meeting after meeting, used to occupy almost the same individual places on these benches, so that their loss or absence could in a moment have been noticed—I should recall to many, even now present, the different phase, in this respect, which the society of Edinburgh presented then from now. Let me first name, almost at hazard, a few of those whose images live in my memory as I now address you, as among those who as a rule attended, and as a rare exception were absent: There was the ever animated, zealous, and punctual president, Sir Thomas Brisbane; the polite and decorous Dr Hope; the indefatigable, unassuming Lord Greenock; the sagacious Dr Abercrombie; the lively, unresting Sir George Mackenzie; the hospitable Professor Russell (whose academic suppers are not even now forgotten); the beneficent, large-minded Dr Alison; the kindly, genial Professor Wallace, close to whom usually sat Mr James Jardine, with his finely chiselled features and intellectual forehead, the accurate Mr Adie, and the conscientious, modest astronomer, Mr Henderson: there was also the ingenious Sir John Robison, fertile in expedients; the frank and manly Dr Graham; the quietly humorous and ornithological Mr James Wilson; the encyclopædic Dr Traill; and the shrewd and well read, but reserved Mr W. A. Cadell. Besides, there were many others who, if they rarely took an active part in the business of the Society, were not the less persevering in their attendance,—thus giving evidence of an interest in its welfare and permanence, which any exigency, or even opportunity, would have called in action: there were Sir Henry Jardine and Lord Meadowbank; Dr Brunton and Dr Neill, occupying probably the same bench with Mr R. Stevenson and Mr Bald; Mr John Craig, Sir William Newbigging, Professor J. S. More, Mr William Wood, Archdeacon Williams, Mr George Swinton, Sir Joseph Straton, Dr Borthwick, and Mr Stark. I could far more than double the list by including those who, though not absolutely regularly, attended so frequently that their faces were familiar in this room, and their presence missed in the social gathering round the tea-table later in the evening.

I fear, gentlemen, that we now-a-days allow ourselves to become too mechanically intellectual, and also too intellectually fastidious. If the recent movement which has been set on foot for deepening and enlarging the interest felt by the members in our meetings is to take any root and produce any results, I am persuaded that it must be, though not solely, yet mainly by our Fellows recollecting that though the meetings of the Royal Society are intended for the communication of knowledge by the reading of papers, they always were, and still are, intended quite as much to promote a cordial feeling amongst those (at best but a small number in the midst of a teeming and busy population) who profess an interest in the progress of literature and science, and whose presence and conversation may contribute to this end, as well as the more formal contributions of others. I ask the more numerous portion of our Associates, if they are not disposed to contribute papers to our meetings, at least to make a contribution of *themselves*—their personal attendance, their approving interest, their mite of influence towards our commonwealth of letters. We have seen how much popular lectures have done elsewhere towards individual improvement, and the increase of a certain kind of knowledge amongst various classes; we have attributed a still wider and more beneficial influence to the periodical literature of the day; but neither of these is a *social* form of scientific and literary effort. It is *that* which we claim as one of the two remaining (perhaps only permanent) functions of our great Societies planted in different times from the present: the *one* is to afford to authors, especially to the authors of learned dissertations on science, the means (otherwise wholly unattainable) of bringing their labours in a printed form before the scientific public; the *other* function is to encourage, by an expression of personal sympathy and interest, the labours of those who devote themselves to the too often ungrateful toil of original investigation.* To the utility of the first, our Transactions bear, I

* To the two permanent functions of scientific associations mentioned in the text—namely, the printing and circulation of memoirs, and the promo-

will take it upon me to say, satisfactory testimony. Of these Scotland has just cause to be proud. Nor, on the whole, have we to complain of any deterioration in the memoirs by which this Society becomes known to the learned world. The second fulfilment of our objects of incorporation seems in some danger of being forgotten. While the older members of the Society must feel a pleasure in meeting, fortnight by fortnight, those with whom they worked in earlier days, or with whom they perhaps strove in generous rivalry, thus keeping alive those embers of mutual interest which the changing gales of life are too ready to disperse and extinguish, they may also lend their countenance to the efforts of younger men who are treading in their steps, and who may soon, if they have not already done so, occupy their own seats of influence or of honour. They may thus aid in giving coherence to the chain which binds generation to generation in the pursuit of truth, and in establishing a *personal* relation between the intellect of each, the impressive influence of which we are too apt to forget. I say, gentlemen, that this is a personal affair, which no abstract ideas can supersede,—I say that no popular lecture, listened to by hundreds of persons immediately to be dispersed into their specific individuality, no perusal of scientific digests in the study or at the fire-

tion of personal intercourse amongst literary men—we may add a *third*, that of rewarding meritorious papers or discoveries by medals and other more or less honorary distinctions. Such have existed both in British and Foreign Societies from an early period until the present. They are of two classes : rewards offered by anticipation for researches on definite subjects proposed (this obtains mostly abroad) ; and premiums awarded to the best paper or most considerable discovery, either in science generally, or in some specified branch of it. This last form is more usual in this country ; and such premiums are our Keith, Brisbane, and Neill medals. I think we must conclude that the foreign system has worked best. Many considerable memoirs of the last century on physical astronomy and similar subjects were offered in competition for such prizes. The stimulus is one which addresses itself variously to different minds, and on the whole seems to be less effective in these later times. One disadvantage of the award of medals for researches not previously defined, is the greater difficulty of awarding them without partiality or bias. A *fourth* kind of encouragement to science which our societies sometimes exert is the bestowal of funds for the prosecution of experimental investigations. This is frequently a stimulus of no small value. It was first systematically applied in this country by the British Association ; and the Government of the country have wisely committed an annual fund for such purposes to be dispensed by the Royal Society of London.

side, can replace such influences. I could speak from personal experience, if necessary, of the influence of meetings like ours, dull and commonplace though they may appear to some, upon the mind of the young student; of the zest with which he feels himself, perhaps for the first time, made the recipient of knowledge in its actual dynamic progress, not through its past hoarded acquisitions merely; the enthusiasm with which he sees (perhaps also for the first time) men of whom he has read in books, and on whom he looks with possibly excessive, yet still elevating and generous respect; how, meeting after meeting, he approaches somewhat nearer to those thus distantly regarded, and finally addresses them, though with something of reverence, as friends having a common interest in common and noble pursuits. If such alone were a result of our periodical meetings, such would alone be an adequate object for us to aim at. It is only by a certain measure of self-denial, a certain throwing off of passive or indolent habits, that we can hope to render our meetings attractive to ourselves and to one another. If all come, all will be interested; let each man, instead of pleading his inability to contribute his share to the literary and scientific proceedings, contribute at least his countenance. There is something magnetic in the concourse of intelligent persons. Not only does each element attracted increase the aggregate by its adhesion, but the aggregate so increased draws new molecules with greater force within its sphere, till the whole gathers in an increasing progression, and (as physical philosophers tell us) evolves by the mere act of aggregation that heat and light which maintain energy and vitality even to the bounds of the universe.

We all know the history of the British Association for the Advancement of Science; some here remember its origin; few have not been present at some of its meetings. Let me remind you how small a fraction of that animated whole is composed of direct contributors to the advancement of those sciences which the Society was formed to promote. Let me ask you, what would be the result if every member were requested to withdraw, who had not some paper to communicate or some remark to offer. You may imagine the dire scramble which would ensue, the clearing of benches, the faces of dismay. The dismay would not be all on the side of the retreating listeners. The small knot of studious philosophers left behind would feel discouraged by the removal of that sympathising auditory. Have we not all heard with patience, sometimes almost with interest and admiration, papers read, from which we must afterwards have confessed to ourselves, if not to others, that we were able to carry little or nothing away? Yet that intelligent concourse of partially instructed persons gives life to the meeting, sanction and encouragement to the really knowing, a taste for knowledge, respect for its professors, and some portions at least of positive acquirements to those who are not so. I believe that we ignore too much this element as inherent in the constitution of our learned societies. If we continue to do so, we shall degenerate (I venture to call it a degeneracy) into mere publishing clubs, whose Transactions are read by a select few, but which exist and shine by a mere "*lumen siccum*,"—disembodied existences claiming no sympathies, calling forth no regard, combining no diversities of interest.*

* I may perhaps be allowed to call attention to a striking change (on the whole) in the character of the publications of learned societies; I mean the great detail into which the papers generally run, especially in those on experimental Physics, mixed Mathematics, and Natural History. The bulk of these communications is, it may be feared, too often out of proportion to the intrinsic value of the matter which they contain. It is by no means without example to see the pages of Transactions (as well Foreign as British) occupied by a description of experiments of which the results were merely negative, and by mathematical investigations with no less indefinite conclusions. Such papers are rarely read by any one. They increase the bulk and expense of Transactions, and bewilder the unaided student. Even in cases less extreme they are encumbrances to scientific literature. An author, who has before him no fear of a printer's bill, or the remonstrances of an impatient publisher, is but too apt to please himself by expanding a small amount of matter over a goodly number of those handsome quarto pages, in which his lucubrations appear so advantageously to the eye. Even where numerical precision in the results is of primary consequence, excessive elaboration in printing the steps of calculation and instrumental corrections is often unnecessary, as well as extreme minuteness in describing forms of apparatus, and results of chemical reactions, especially where such details are not remote from common apprehension. A stricter editorial censorship than the Councils of societies usually venture to exert (similar in *kind*, though not in *degree*, to that which the editors of our leading periodicals exercise over contributors not less eminent in their departments), seems to be called for, by the expanding bulk of the volumes published by learned Bodies.

An evil nearly allied to this, is the fragmentary manner in which authors are apt to contribute the results of their inquiries. This is a consequence of

IV.—*On the Changes in the Society during the last Twelve Months.*

The past year has produced more than the usual number of casualties both on the home and foreign lists of the Society. During its course the Society has had to deplore, in common with the whole British Empire, the premature decease of H.R.H. the Prince-Consort. It would be out of place here to offer a detailed eulogy on one whose connection with our body was comparatively slight and indirect, but whose loss has been profoundly felt in nearly every home in these islands. An enlightened patronage of Science and the Arts was one of the especial characteristics of his patriotic, unselfish, and too short life.

Amongst Foreign and Honorary Fellows we miss three, all of whom were on the verge of, or had exceeded, fourscore years. These would by themselves afford topics for an address. I must allude to them very briefly.

The venerable JEAN-BAPTISTE BIOT was born 21st April 1774. He has been an Honorary Member of this Society for the uncommon period of forty-seven years, having been elected in January 1815.* He had become a member of the French Academy of Sciences in 1803, his jubilee having been celebrated nearly ten years ago. But it is also a singular and probably unprecedented fact, that at the time of his death he was a member of three out of four of the Academies composing the Institute of France; that is, of the *Académie Française*, and that of Inscriptions and *Belles Lettres*,

the struggle for priority in even second and third rate results of scientific investigation, though these are often no more than corollaries to propositions well established, or assumed to be so. Such *caveats* are better adapted for the weekly or monthly journals, where they properly and reasonably find a place. It seems to be the business of societies to consult more than they usually do, the instruction and convenience of readers, and less exclusively the sometimes inconsiderate demands on the part of authors. There is, perhaps, no society to which these remarks do not more or less apply; but the case of the *Comptes Rendus* of the French Academy of Sciences supplies an example of excessive publication so generally admitted to be an embarrassing evil that it may be referred to as a warning.

* I find by the old minute-books of this Society, that a paper by Biot on the Polarization of Light by Crystals, was read by Sir David (then Dr) Brewster at the ordinary meeting of the 15th January 1815.

as well as of the Academy of Sciences. His diversified abilities as an author are well exemplified in the miscellaneous writings collected by him before his death under the title of *Mélanges Scientifiques et Littéraires.**

His fame, however, chiefly rests on his scientific productions, especially in connection with the polarization of light. His writings on astronomy, though voluminous, are not original, except, perhaps, in their historical and antiquarian aspect. Even in his own subject, that of optics, there did not fall to his share so many capital discoveries as from his opportunities, zeal, and unbounded perseverance, might perhaps have been expected. His discovery (independently of Seebeck) of the rotation of the plane of polarization caused by liquids, is the chief of these, and he pursued it with unflagging energy into its numerous consequences during at least forty years. Biot was an instance of all that mere talent and perseverance, unsustained by great genius, can attain. His long life was one scene of intellectual labour from first to last. Brought up at the feet of the great Laplace, he was perfectly conversant with his writings, and with all that belonged to the most advanced state of mathematics of the time. His optical researches were pursued according to the traditions of the same school, as contained in the Emission- or Corpuscular-Theory. First in his latest years did he begin to betray a consciousness that Young, Fresnel, and Arago might be right, and that light is an undulation after all. But the imperfect concession had then lost all grace. His theory of Moveable Polarization, and generally his modes of conceiving complex physical phenomena, were more elaborate than satisfactory.

One of Biot's most considerable contributions to science was his determination of the length of the seconds-pendulum in different latitudes. It was the occasion of (I believe) his only visit to Scotland, which took place in the summer of 1817, when he made numerous observations at Leith Fort, and then undertook his memorable journey to the Isle of Unst, the northmost of the Shetlands, of which he has left an interesting memorial in the first volume of his published Essays.† Thus he had the no small distinction

* 3 vols. 8vo. Paris, 1858.

† Taken from the Memoirs of the Academy of Sciences.

of having carried on these important labours, under very great difficulties, over a terrestrial arc of 22° of latitude, extending from the Isle of Iviça in the Mediterranean, to that of Unst, not very far from the Arctic Circle. Of his true devotion to the scientific career which he had proposed to himself, it is impossible to speak too strongly. No distinctions except literary ones had any attraction for him. He carefully eschewed those political promotions coveted by too many of his academic compeers. His views on politics, though definitely monarchical, were never obtruded. The isolation induced by his habits of unremitting study fostered a coldness of disposition often manifested by him towards other scientific men. He had few intimate friends out of his family circle, and his encouragement towards young aspirants was cautious and intermitting. It is worthy of being added in his favour, that during the last thirty years of his life he recognised, in a marked manner, the obligations of his religious creed. Notwithstanding his very advanced age, he continued his studies on Indian astronomy to within a very short time of his death, which he met with Christian composure, on the 3d February 1862, when he had nearly completed his eighty-eighth year.

Friedrich Tiedemann, the eminent anatomist and physiologist, was born at Cassel in 1781, and died on the 22d January 1861, in the eightieth year of his age. His death was inadvertently not noticed at our last anniversary. Tiedemann was one of the most eminent comparative anatomists and physiologists of Europe. His earliest paper of note, that on the Circulation of the Echinodermata, obtained a prize offered by the French Academy of Sciences. He became Professor of Anatomy at Heidelberg in 1816, and continued so until 1848. During this period he published a celebrated work on the Human Brain, and another on that of the Monkey, as well as several works in conjunction with Oppel and Treviranus. He was blind during some of the later years of his life, but recovered his sight through an operation for cataract. Subsequent to his leaving Heidelberg, he lived in great retirement at Bremen and Frankfort.

Louis Albert Necker, honorary Professor of Mineralogy and Geology at Geneva, was born there in 1786, and died at Portree, in the Isle of Skye, on the 20th November 1862, in his seventy-sixth year. Mr Necker was far more intimately connected with this country and with this Society than our foreign members usually are; indeed he might be called a naturalised Scotchman, and he contributed papers to our Transactions. It was my intention to have entered on his biography here at some length. But I think it will be best to bring before the Society in a separate form the facts and reminiscences which I have to offer.

On our home list, we have to lament the loss of 12 of our Ordinary Fellows; a considerable number of whom had, however, also attained the full term of human life. Their names are,—Robert Bald, John Cockburn, Norwich Duff, James Forsyth, James P. Fraser, John Fyfe, J. Burn Murdoch, James Russell,* John Russell, Thomas Stewart Traill, James Walker, and Alex. Maconochie Welwood.

To replace these we reckon also 12 new Fellows,—namely, Professor Archer, Rev. W. G. Blaikie, Mr Henry Cheyne, Mr Nicholas A. Dalzell, Mr A. M. Edwards, Rev. V. G. Faithful, Dr James Hector, Dr J. P. Macartney, Dr W. B. Mackinlay, Mr Edward F. Maitland (now Lord Barcaple), Dr E. Ronalds, and Rev. Robert B. Watson.

Our numbers, therefore, remain the same as last year.

I must confine myself to a very short obituary notice of a few of our deceased Fellows who showed most interest in the proceedings of the Society.

The senior in standing as a Fellow was Mr Alexander Maconochie Welwood, better known during his active life here as Lord Meadowbank. His father also bore the same title; and was a man of much acuteness, and an original Fellow of this Society. The late Mr Maconochie Welwood was born in March 1777, he joined the Faculty of Advocates in 1799, was made Lord Advocate in 1816, and a Judge in 1819. He retired from the Bench in 1843. He joined this Society in 1817, but was not, so far as I know, a contributor to our Proceedings. He, however, took an interest in them, and for many years attended the meetings regularly. He had a large circle of acquaintances in and out of the Society; and

* Who died since the Annual Lists were made up.

though in public matters his manner was occasionally dogmatic, he was of a kind and hospitable nature, and was much regarded by a large circle of personal friends. The frequency of his attendance here contributed to excite a spirit of interest in the meetings. For about twenty years past he had lived in calm retirement in the midst of his family, and on the property which he had an hereditary pride in cultivating and adorning. He died at Meadowbank on the 30th November 1861, in the eighty-fifth year of his age.

Elected in the same year with Mr M. Welwood, but his senior by one year, was Mr Robert Bald, who for many years occupied a very high position as a mining engineer. He was born at Culross, in Perthshire, in 1776, and soon after removed to Alloa, where he early gave his attention to mining, and attracted the notice of the Earl of Marr. He was ultimately engaged in the extensive Marr Collieries,—a connection which he held for a very long period. He commenced general practice as a mining engineer in Edinburgh about the year 1820, and was very extensively employed in Scotland, England, and Wales. He was requested by the Swedish Government to report on the coalfields of that kingdom, and received from the King of Sweden marked acknowledgments of the value attached to his report by the Government of that country. Mr Bald was elected a member of the Royal Society of Edinburgh in 1817, and was a contributor to its Proceedings. He was author of a "View of the Coal Trade,"* of the article "Mine" in the Edinburgh Encyclopædia, and of numerous other papers bearing on his profession. Mr Bald was universally esteemed; and during his long stay in Edinburgh he formed many lasting friendships, which death alone terminated. He was for long in ill health, and bore his protracted and severe illness with truly Christian resignation. The latter years of his once active life were spent in retirement at Alloa, where he died in December 1861, in his eighty-sixth year.

As connected by the nature of his occupations with Mr Bald, I next notice a third octogenarian among our Fellows, Mr James

* In this work he made a benevolent and much required appeal on behalf of the miserable lot of women then employed in coal mines, under the name of "Bearers."

Walker, the eminent civil engineer, who was born at Falkirk on the 14th of September 1781. He was educated at the parish school of Falkirk, and thereafter removed to Glasgow, where he studied at the University. He went to London in the year 1800, and commenced the study of engineering under his uncle the late Ralph Walker, who was then engaged in constructing the West India Docks. Mr Walker devoted himself almost exclusively to marine engineering, in which important branch of the profession, though his rise was gradual, he ultimately attained the position of the first authority of his day. He had not a very inventive cast of mind, but he had great caution and sound judgment, and above all the faculty of profiting by his large and varied experience. His works were, in consequence, eminently successful. It would be out of place in this brief notice to attempt even an outline of his works, so varied were they in character, and so many in number. It may be sufficient to say that at the time of his death he was conducting, as Government engineer, the national harbours of refuge at Dover, Alderney, and Jersey, and the refuge harbour at the mouth of the Tyne. As engineer to the Trinity House of London, he constructed various lighthouses, including that on the Bishop's Rock, a very exposed situation. He was largely consulted in navigation and canal works; and the Stockwell Street Bridge at Glasgow may be adduced as a favourable specimen of his bridge architecture.

Mr Walker received the degree of Doctor of Laws from the University of Glasgow. He was appointed president of the Institution of Civil Engineers on the death of Mr Telford in 1834. He was a fellow of the Royal Society of London; and in 1824 he was elected into the Royal Society of Edinburgh. He had been for some time before his death in declining health, but to a robust constitution he added an abundant flow of cheerfulness and spirit; and even on the day before he died he was writing a report to the Admiralty on the subject of Alderney Harbour of Refuge. He was suddenly seized with a stroke of apoplexy, and expired on the 8th October 1862, in his eighty-first year. At his own request, his remains were interred in his family burial-place, at St John's Chapel, Edinburgh.

Dr Thomas Stewart Traill was born on the 29th October 1781, at Kirkwall, in Orkney, of which place his father was minister. Throughout his life he retained a most affectionate interest in his native islands. "He was," as we read in a contemporary notice, "*Orcadiensibus orcadiensior*, and his face lighted up, and his hand gave an extra grip, when he met with a man whose young eyes had seen the Old Man of Hoy, and who had heard the roar of the Pentland Firth from the south."

He graduated in medicine in the University of Edinburgh in 1802, where he had been the fellow-student of Lord Brougham, Sir David Brewster, Principal Lee, and other eminent persons. He is believed to have settled in Liverpool in 1804, where he constantly resided as a physician in good practice until 1832. He was highly esteemed, professionally and personally, in that great mercantile city, and formed intimate friendships with its leading men. He promoted warmly the societies founded there for the diffusion of literature and science, especially the Royal Institution of Liverpool, of which he was one of the founders and the first secretary. He maintained throughout life an intimacy with Lord Brougham, having a common interest with him in many philanthropic objects. In 1832, he was appointed to the Chair of Medical Jurisprudence in this University, which he filled until his death thirty years later. He took great pleasure in lecturing. Chemistry, mineralogy, and meteorology, were his favourite sciences. In 1804, he delivered a popular course on chemistry for a benevolent object in Kirkwall. This is said to have been the first course of the kind given in Scotland. He lectured frequently in Liverpool; and after he became a professor in Edinburgh, he not only delivered his own course of lectures, but also repeatedly that of Professor Jameson on natural history; and once at least he lectured for a session in the chemical class, during Dr Hope's decline.

He was a diligent attender on this Society, and for many years curator of the library, with a seat in the Council. He contributed a great many papers to our Proceedings, and some are printed in the Transactions.* They are not always of an important class, but are of a kind very serviceable in promoting the interest of

* In volume ix., "Account of a Mineral from Orkney," and "Electro-magnetic Observations and Experiments." Vol. xiv., "On a New Writing Ink." Vol. xv., "On Fossil Fishes found in the New Red Sandstone of

meetings such as ours, and a taste for science generally. This, indeed, was Dr Traill's *forte.* His tenacious memory storing up the results of considerable reading and extensive conversational intercourse, supplied him with ready materials for illustrating any topic brought under his notice. It is not surprising that, trusting largely to memory, his accuracy is not in all cases perfectly to be relied on. He was nominally editor of the eighth edition of the Encyclopædia Britannica, and he certainly contributed to it some forty articles; but his responsibility was, I believe, chiefly confined to the earliest volumes, the greater part having been practically edited by the able publisher, Mr Adam Black.

Latterly, owing to infirmity, Dr Traill ceased to attend the meetings of this Society, where he had, for a quarter of a century, occupied a familiar place. But his lectures he never discontinued, and persevered with them until within twelve days of his death. It was well known to his colleagues, that had he lived to complete that course, which was his thirtieth, he would then have resigned his chair. He died at Edinburgh, on the 30th July last, in his eighty-first year, being the *fourth* octogenarian on our list.

Yet one more venerable colleague and useful member remains to be noticed.

Mr John Russell, writer to the Signet, and for eighteen years treasurer of the Society, was born 22d February 1780. He was descended from three generations of men who had exercised in Edinburgh the same respectable calling. By his mother's side, however, he inherited of right a taste for literature; for she was daughter of Principal Robertson, an honourable connection, which Mr Russell always loved to recall. In point of fact, Mr Russell retained throughout an active professional career both the tastes and acquirements of a well-educated man and a scholar. He was intimate with many of

Orkney," and on "*Berg-meal*, or Mineral Flour of Degersfors, in Swedish Lapland." In vol. xvi., "Memoir of Dr T. C. Hope." In vol. xx., "On a Peruvian Musical Instrument." In vol. xxi., "On the Torbanehill Mineral." These titles give a good general idea of the varied subjects of Dr Traill's communications. His last contribution to the Society seems to have been that made on 15th February 1858, "Description of the Sulphur Mine of Conil [in Spain], preceded by a Notice of the Geological Features of the Southern portion of Andalucia." An abstract appears in our "Proceedings," vol. iv. p. 77.

those who, some forty years ago, rendered the literary society of Edinburgh famous, with not a few of whom he was associated as one of the founders of the Edinburgh Academy, in which he took a lifelong interest. He became a Fellow of this Society in 1822, and its Treasurer in 1838. He fulfilled the duties of the latter office in a very exemplary manner, as I can testify from personal knowledge. He devoted to it not a little of his time, and brought the finances into a better state than they had been for a long time previously. For a good many years past his health prevented him from taking his place at the evening meetings; but so long as he possibly could, he assiduously attended at council meetings, and in 1857, when he could no longer do so, he resigned his office. On that occasion he received from the Society a piece of plate as a recognition of his valuable services. His latter years were tranquilly spent at Southbank, near Edinburgh, a charming villa bequeathed to him by his uncle, General Robertson. I have very often visited him there, and found him ever cheerful and occupied, generally with literary pursuits, in which to the last he took a real pleasure. At my very latest visit I found him refreshing his recollections of the Latin Classics. He was a man of wide sympathies, and had many friends of all parties. He was a sincere Christian, and died at peace with all men. This happened on the 30th January 1862, when he had almost completed his eighty-second year. He is therefore the *fifth* octogenarian on our list, besides foreign members.

Of the remaining names on our obituary list I do not feel called on to say much. But I must mention Dr Fyfe, a highly respectable chemist, and a well-known lecturer in Edinburgh. He was at first chemical assistant to Dr Hope. In and after 1817, he lectured at the Society of Arts, and in 1844 was appointed to the Chair of Medicine in Aberdeen, having already been President, the year before, of the Royal College of Surgeons of Edinburgh. He died on the 31st December 1861, aged nearly seventy years.

Admiral Norwich Duff, born in 1793, was descended from the first Earl of Fife. His earlier years were spent in active service in various parts of the world. Even before he was twenty he had taken part in several great naval battles. About the time of entering this Society, in 1823, he was well known in Edinburgh, where he spent several winters, though he may be perhaps recollected by few persons now present. He married in 1833 a lady of Bath, and he died in that city in the course of last summer.

Mr Burn Murdoch and Mr John Cockburn (brother of the late Lord Cockburn) both frequently attended our meetings, but otherwise require no detailed notice here. The former was an active agriculturist and country gentleman, and died in August last in his seventieth year.

Dr James Russell, whose death, at the age of sixty-one, occurred only on the 21st November last, was the eldest son of Mr James Russell, Professor of Clinical Surgery, and grandson of the Professor of Natural Philosophy (also in this university), who was the predecessor of Dr Robison. Dr Russell lived a retired life, and although a physician, had not for many years practised his profession.

I have now, gentlemen, with some prolixity I fear, attempted to go over the ground which I had in view when we started. My great object has been to induce you to give a fair consideration to the claims which the objects of this really national institution—the Royal Society—has upon you, its members. I have asked you to look back to your origin,—to the constellation of eminent men who assisted at your incorporation,—to the important labours which the Transactions include,—to the social meetings which, with varying brilliancy and significance, have for eighty years connected generation with generation of the literary and scientific men of this metropolis and university-seat with one another; and I ask you to assist now, by your personal efforts, by your literary contributions if possible, at least by your attendance at our evening meetings, in adding to the interest and value of these meetings; I ask you to encourage those who labour for the promotion of original research, to maintain the credit of a society established for purposes the most disinterested and humanizing, and by so doing to justify the position which the Royal Society of Edinburgh assumes, of representing in some degree before the academies of Europe the intellect and original talent of our native country.

REVIEWS AND NOTICES OF BOOKS.

The Earth and its Mechanism, being an Account of the various Proofs of the Rotation of the Earth. By HENRY WORMS, F.R.A.S., F.G.S. London: Longman & Co., 1862.

A very handsome volume,—unfortunately this is all we can say in its favour, for, on attempting to peruse it, we found it to resemble too truly the famous apples of the Dead Sea, most ruddy-cheeked and luscious in appearance, but—full of ashes.

Criticism would be wasted on such a book, but we may give an extract or two. The following are from the "*popular*" part, "adapted," as we are told, "to the comprehension of the general reader."

"'How can it be imagined,' writes Tycho, 'that one and the same body should have two motions so different, one which translates its centre of gravity, the other which changes the position of its axis?'"

Now, step forward, Mr Worms, and explain this in a manner "adapted to the comprehension of the general reader."

"The answer is, that the parallelism of the axis does not require a specific motion, as he supposed, for it is a fixed position."

Comment on nonsense like this would be useless. It follows from the exquisite geometrical demonstration in p. 24, that the tangential component of any force acting on the surface of a body produces *no motion of the centre of gravity.* This is the more remarkable, since, at the top of p. 25, the effects of such a force are correctly enough stated. This little point is worthy of notice; we shall have occasion to remark on the system of discordances, of which it is a specimen.

The tradewinds are due to the fact that, (p. 59)—"in consequence of the rotation, every particle of air transferred from the pole to the equator must slacken its rotatory motion."!!!

Had we confined our reading to the first or "popular" part of the book, we should have at once set it down as the production of one of those extraordinarily gifted individuals who now and then appear on earth, capable of comprehending the true character of that gigantic imposture which was perpetrated by Newton, and which, to the disgrace of this enlightened age, still holds its ground amongst so-called men of science.

But such luminaries disdain the deceitful and dangerous aid of the differential calculus, another fraudulent production of Newton. Mr Worms, on the contrary, in his second part revels in glorious displays of differential equations, elliptic integrals, and what not.

We know him now—we have met some of his race before. We remember some years ago dealing with a work which much resembles this in character. It was called, if we mistake not, an "Analytical View of Newton's Principia," and was written by a distinguished nobleman of the most versatile powers.

The style of this work is much the same—*attempted* popularity in parts, and *attempted* profundity in others. Alas, however, the author ventures to add something of his own to the popular part—some specimens of Mr Worms' additions we have already given. But in writing the profound part there has been a simple adaptation, for it cannot be called *translation*, of some portions of the more difficult writings of Laplace, Gauss, and Hansen,—and not only are *essential* portions omitted, but fancied defects are supplied, and the result is truly marvellous. Laplace's investigation of the effect of the earth's rotation on the fall of heavy bodies has taken, by a few applications of these processes, a form in which its author could not possibly recognise it—in which most of the *points* are lost, different symbols confounded, and little hints added, which show the utter ignorance of the perpetrator. This is totally distinct from the question of misprints, of which the number is really astounding. One *amusing* blunder, however, occurs which puts us into good humour again, as we close the book. Laplace takes as his unit of time the second (according to the decimal division of time decreed by the French Republic). Mr Worms *translates* the passage thus (the italics are our own)—

"If we take the *second decimal*, or the $\frac{1}{100,000}$ of the mean day as the unity (*sic*) of time."

Enough. We hope we shall never meet Mr Worms again—on *this* subject at all events.

The True Figure and Dimensions of the Earth, in a Letter addressed to George Biddel Airy, Esq., M.A., Astronomer Royal. By JOHANNES VON GUMPACH. Second Edition, entirely recast.

Lest our reader may suppose the author is merely contending for a small alteration in the value of the earth's ellipticity, let us at once inform him that the contest is one of much greater importance. We have before us a champion of the most illustrious pretensions,—one who, if his accuracy equals his self-assertion, must be classed with Galileo and Newton, if indeed the latter be not entirely deposed by his formidable opponent. And while the gauntlet is thus thrown to the great master of science, meaner humanity is called upon to gaze with respectful admiration, and behold the earth, which had previously been flattened into an orange, squeezed out into a lemon. Gumpach cometh! And first let us listen to his modest apology:—

"How I dare to oppose my individual judgment, in a matter like this, to the conclusions arrived at, and upheld by, the whole scientific and intellectual world? Let the reader remember that Galileo and Copernicus did the same, and were in the right."

We see elsewhere in the preface, how a sense of duty and of the interests at stake ultimately overcomes the pardonable diffidence of the author.

"I had reason to believe, I remarked in my pamphlet, that naked truth, in opposition to the established system of theoretical astronomy, would stand but a poor chance of a hearing. But when it has in its train, I added, the wreck of colossal national wealth, and the corpses of thousands of our fellow-beings, hurried into eternity by the abstract idea of universal gravitation, its voice is certain to make itself heard, sure to command the attention even of the Astronomer Royal."

Afterwards, we find that ten thousand human beings, besides property worth from five-and-twenty to thirty million pounds sterling, have perished at sea solely in consequence of Sir Isaac Newton's erroneous theory.

The argument in favour of the opposite theory is then developed by the author in a volume of 265 pages, but we think it may be stated in somewhat shorter compass.

The supporters of the old theory plead their cause thus:—A degree of latitude means that the direction of the plumb-line, and consequently that of the tangent, to the surface, has changed one degree. Now, in order to obtain this change, it is necessary to traverse a greater space at the pole than at the equator, whence it is inferred, that the earth's curvature changes more rapidly at the equator than at the pole, or that the globe has the shape of an orange.

But, according to the author, these plumb-lines must all meet at the centre of the earth, so that here we have two similar triangles, each with a vertical angle of one degree, of which that at the pole has the greatest base, and consequently the greatest side,—that is to say, the pole is farther from the earth's centre than a point of the equator.

It is thus that the globe is made to be lemon-shaped, and we leave it to the reader to criticise the operation. Let us, however, give one hint to the author. He says in his preface—

"Unless I greatly mistake the temper of the people of England, they will not suffer the practical solution of a question of this nature and magnitude to remain long in abeyance."

As we fancy the receipts of his publisher will have already convinced him that he has mistaken the temper of the English people, we shall now tell him how he may obtain a hearing.

Let him not only assert but prove that a number of shipwrecks have happened through a mistake of position, and that these would not have taken place had the Gumpachian theory been adopted, and we shall all swallow his life pills, although he discharge them at us in a very violent manner.

And now, one word in the author's favour before we conclude.

From an expression in page 11, we infer that he has not altered the relation between the diameter and the circumference of a circle. We indeed rejoice to think that our venerable and valued friend π has escaped the general catastrophe; and we owe a debt of gratitude to the author for exhibiting an amount of consideration which has not always been shown by this class of philosophers.

On Eccentric and Centric Force; a new Theory of Projection. By HENRY F. A. PRATT, M.D. London: Churchill, 1862. 8vo. Pp. 296.

This performance is one of a class usually exempted from serious criticism in scientific journals. It is a formal attempt to explode the laws of motion, disprove the laws of Kepler, demolish the Newtonian theory, and expose the fallacy of all that is generally accepted as truth in mechanical philosophy. The book is unexceptionable in form, is illustrated with twenty-six well executed diagrams, and is divided, after the manner of scientific treatises, into four parts, forty-four sections, a Preface, and an Appendix.

It will be conceded, that an author who professes to make short work of Sir Isaac Newton, should, at all events, be a mathematician of the first order; other qualifications may be desirable, but this one seems wholly indispensable. And, if it should unfortunately appear that such an author is destitute of even ordinary mathematical knowledge, it may be very safely inferred that his most energetic assaults will fail to shake the foundation on which the Newtonian theory reposes.

Now, in Dr Pratt's appendix, there exist abundant materials for guaging the depth of his mathematical attainments. We do not find there, it is true, any elaborate parade of algebraic formulæ and mysterious pothooks; on the contrary, there is a bewitching simplicity of calculation, conducted entirely by the aid of simple numbers, manipulated in professed accordance with the more elementary rules of arithmetic, but leading to results of the most surprising kind. Thus, from actual measurement of the side of a square and its diagonal, the author discovers (page 271–3) that they bear to each other the ratio of 12 : 17; and after remarking that the area of the square is, when deduced from the former number, 144, while calculation founded on the latter number indicates an area of $144\frac{1}{2}$, he inquires, "*Can it be that this points to one of those inappreciable differences brought about by change in form? for the diameter or radius* (diagonal or its half) *clearly represents a departure from the rectangle.*"

In perusing Dr Pratt's remarks on the mutual relations of the circle, the square, the cube, and the sphere, we perceived indications of a horrible hankering after the quadrature of the circle; but, in fairness, it should be recorded, that at page 275 and elsewhere, he states his conviction, that the area inclosed by a circle cannot be numerically *squared.*

At p. 276 we are introduced to a process, which (its author being a medical man) we shall take the liberty of terming the "dissecting calculus." Its principle, if we rightly apprehend it, is simply as follows:—A circle of known radius being drawn, is divided into any number (usually 24) of equal parts, by lines radiating from its centre; and these parts being cut asunder, and arranged close together, heads and tails, in a row, constitute a sort of parallelogram, whose longer sides, regarded as straight lines, will be equal to the circumference of the parent circle, while the sum of the shorter sides will be equal to the diameter of the circle, and the product obtained by multiplying a long side by a short one will give the area of the parallelogram, which will be equal to that of the circle. By actually measuring parallelograms thus constructed, Dr Pratt appears to have satisfied himself (p. 278) that a radius of 15 gives a diameter of 30, a circumference of 96, and an area of 720. He uses 15 as the radius in order to avoid fractions; but his ratio of diameter to circumference is of course 1 : $3\frac{1}{5}$! These discoveries, of necessity, suggest the inference, that the area of the circle is $\frac{4}{5}$ths of that of the circumscribing square; and we find it gravely asserted at page 288, that the contents of the sphere must be $\frac{4}{5}$ths of the contents of the circumscribing cylinder, and not $\frac{2}{3}$ds only, as hitherto erroneously taught by geometricians!

Such being a few specimens of Dr Pratt's mathematical discoveries, it seems unnecessary to follow his argument, when he deals with the laws of motion, exposes the "fallacies" of Newton, and builds his own original theory on the ruins of the doctrine of gravitation.

In conclusion, we shall notice very briefly one objection, which the author urges as fatal to the Newtonian theory. (See preface. pp. 8–9.) "One peculiar feature of the Newtonian theory must not be passed over here—its absolute mechanical character —which is such a very grave defect, that it ought long since to have led to its rejection, for it inferentially, if not directly, dispenses with the sustaining power of God in the orderly management of the universe. . . . .

"And, indeed, gravity, according to his theory, is sufficient for the movements of all the heavenly bodies; but in admitting its sufficiency, one of His highest attributes is taken from Almighty God, and transferred to a material force, which is thus practically made the Lord of the created worlds: and if their Lord, why not also, in conjunction with the chemical theory of the origin of life, &c., their Creator.

"Such views, when broadly stated, are of course utterly repugnant, not only to the reason, but to the innate consciousness of every well-ordered mind, and yet they originate in, and are the expression of principles developed by the Newtonian theory. It is not surprising, therefore, to find that such a material and mechanical theory is as much opposed to common sense as it is to Christianity, &c."

In other words, a pure system of mechanics must not be mechanical; and it is impious to believe, that from the outward manifestations of the Creator's power indications of order or of general laws can be extracted.

On the Climate of Scotland, as determined by Temperature. On the Profitable and Unprofitable Culture of Farm Crops in Scotland. Reports of the METEOROLOGICAL SOCIETY of SCOTLAND for Quarters ending March and June 1862.

The Report of the Scottish Meteorological Society for the quarter ending March 1862, contains an interesting and elaborate paper by Mr Buchan, on the Climate of Scotland as determined by Temperature, based on five years' observations, from 1857 to 1861 inclusive. A complete set of tables accompany the paper, the great practical value and importance of which it would be difficult to over-estimate. To the physician and the agriculturist they are especially valuable, considering the intimate relation which exists between temperature on the one hand, and the public health and farm crops on the other. A number of diagrams are appended, which show at a glance the chief results arrived at in the investigation.

Scotland is divided in the Report into four well-marked meteorological districts,—the outlying islands, the west coast, the east coast, and the central districts of the country. The mean annual temperature of these districts are,—islands, 45°·8; west coast, 47°·9; east coast, 47°·1; and inland, 47°·2. The east and inland districts are therefore nearly equal, the west nearly a degree higher than the east, and the inland considerably under the mainland.

"The most remarkable fact which the table of mean temperature presents, is the low mean annual temperature of the island stations; for, whilst the mean for all Scotland is 47°·3, that of the islands, Bressay in Shetland, Sandwick in Orkney, and Stornoway in Lewis, is only 45°·8, being a degree and a half below the general mean temperature of the country. This is a result which was quite unexpected; the contrary, indeed, being supposed to be the case. The fact is, however, undeniable; and an inspection of the mean temperature of these stations for each of the five years, shows that it does not arise from any chance combinations of anomalous years. On the contrary, each one of the three stations is below the mean in each of the five years. The nearest approach to the mean shown by any of them is Stornoway, in the exceptional year 1860, when it was only 0°·6 below it; but it is to be remarked that, in the same year, Bressay was as much as 1°·8 below the mean. All the other elements of temperature included in the tables which accompany this report, bear out the same view. The mean temperatures are—Bressay, 45°·4, Sandwick, 45°·9, and Stornoway, 46°·1; being respectively under the mean for all Scotland, 1°·9, 1°·4, and 1°·2. It will be observed, in regard to these differences, that they increase with the latitude —a view which the mean temperature of Tongue, the next most northern station, appears to confirm. Its mean temperature is 46°·6, forming thus an intermediate link between the islands and the west coast. Its winter temperature corresponds more to that of the islands, but its summer temperature shows a decided approach to that of the west coast."

"On comparing the mean annual temperatures of the several stations, it will be found that, with the exception of the islands and stations on the west coast, their mean temperatures are almost equal; the greatest deviations from the mean of all Scotland being Arbroath, Elgin, Kettins, and Baillieston, whose mean temperature is 46°·8, or half a degree below the mean; and East Linton and Thurston, which are 47°·7, or 0°·4 above the mean. On comparing these stations in reference to their small deviations, we are unable to see any common cause which might serve to explain them. We are therefore inclined to ascribe them to causes purely accidental, which further observation may be expected to remove."

That the difference in mean temperature between any two of these stations is less than a degree, is a very remarkable result, and reflects as it does the highest credit on the Society's observers, and on the efficient working of the Society.

"Though thus the mean annual temperature is almost the same over Scotland, the way in which it is distributed over the year is widely different in different places. Upon this depend the peculiar climates of particular localities.

"The geographical distribution of temperature through the months of the year suggests some interesting and important results. The mean winter temperature of the islands and west coast is considerably above the rest of Scotland. Leaving Easdale out of view as quite anomalous, the winter temperature of the islands is 39°·5; west coast, 39°·2; east coast, 38°·2; inland 37°·9;—the east coast being thus 1°·3, and inland places 1°·6, under the islands. The extreme stations are Sandwick, 39°·6, and Thirlestane, 36°·7; the difference being nearly three degrees.

"On the other hand, the mean summer temperature of the islands is more then proportionally lower. The summer mean of the islands is 54°·2; of the west coast, 57°·8; of the east coast, 57°·7; and inland, 58°·1:—the differences between the last three and the islands are therefore 3°·6, 3°·5, and 3°·9.

"In autumn the four groups are all nearly of the same mean temperature; and in spring the islands are about two degrees below the other groups, whose spring temperatures are almost identical.

"From this it appears that the low mean annual temperature of the islands is owing to their very low summer temperature, and to the excess of their winter temperature doing no more than counterbalancing the deficiency of their temperature in spring."

Another important result arrived at, on comparing the islands and inland districts together, is this, the more strictly inland any place is situated, the earlier and the more extreme are its seasons; and conversely, the further any island is distant from the mainland, the later and the less extreme are its seasons. The late harvests of Shetland and Orkney give ample confirmation of this statement.

The following are a few of the chief conclusions come to, from a consideration of the extreme high and low temperatures at particular localities:—

"From an analysis of the extreme temperatures for the several months of the year, it may be concluded, that the eastern slope of the country is the most powerfully affected by the sun's rays, and that the islands are the least affected; that, on the other hand, the places which suffer the greatest intensity of cold are all situated in narrow valleys enclosed by hills; and that the places where severe cold is least experienced are on the west coast, and open to the warm waters of the Atlantic."

"Generally speaking, the highest day temperatures are at those stations which are also the highest above the level of the sea; and it is to be noted with regard to the same stations, that they have also the lowest night temperatures. This arises from the circumstance that such stations all happen to be situated in hollows, surrounded by rising grounds or by hills, which when warmed by the sun's rays, reflect their heat to the low grounds during the day, thus raising their temperature above what it would otherwise be; but during the night, on the other hand, as the earth parts with its heat by radiation, the air in contact with its surface becoming cold, acquires greater density, and accordingly slips down the sloping surface, and accumulates in the plain below. By this means the minimum or night temperature of relatively low grounds is considerably lowered below what is due to their radiation alone. However much the maximum and minimum temperatures may vary through the year at particular places, as compared with each other, their mean annual temperatures remain the same. Each place receives its annual quantum of heat from the sun, but it does not receive it in the same way."

It would scarcely have been expected that the climate of Scotland could have included two such widely different climates as those of Sandwick and Thirlestane, which will appear from the following:—

"The contrast presented between the islands and the inland stations is very striking. To take as examples Sandwick, and Thirlestane in Berwickshire, as the extreme stations of their respective groups, we observe that the protected thermometer has not stood higher at Sandwick than 70°·5, nor fallen below 15°·5; while at Thirlestane during the same time the thermometer has risen as high as 85°·0, and fallen so low as −8°·7, or nearly nine degrees below zero. Thus the extreme range of temperature at Sandwick during the five years has been only 55°·0; while at Thirlestane, on the other hand, the extreme range has been 93°·7, or 38°·7 more than at Sandwick. Again, at Sandwick the temperature has not fallen to the freezing point in any of the five months from May to September inclusive; while at Thirlestane it has fallen below the freezing point in every month except July and August. In none of the islands has the temperature fallen to the freezing point in June, July, August, and September; on the west and east coasts, in June, July, and August; but in every month the freezing point has been registered at some one of the inland stations. In the islands, the lowest temperature observed is 15°·0; on the west coast, 9°·0; on the east coast, 1°·5; and inland, 12°·0. Nookton, two miles distant from the sea, but from its position favourable to low temperatures, is the only station near the east coast where the temperature has fallen below zero. But at all the inland stations, except Elgin (12°·0) and Baillieston (1°·5), it fell to zero or below it."

Another important point established is, that at many places, at great heights above the sea, the summer temperature is equal to what obtains in places but little elevated above the sea; in other words, though the mean temperature of the whole year decreases proportionally with the height, the mean temperature of the seasons does not follow the same laws.

"From the day temperatures, it appears that during the day the temperature of high-lying valleys is raised quite as high by the force of the sun's rays as that of places but little elevated above the sea,—a fact not altogether in accordance with popular notions on the subject; but from the night temperatures, high-lying valleys are more exposed to frosts in the latter part of spring and in autumn than places nearer the sea-level. From this it follows—and it is of great importance to the agriculturist—that in valleys at a considerable elevation above the sea, there is sufficient sunshine for maturing and ripening the crops, provided they sustain no damage from the frosts that occasionally occur there in May and June, and more rarely in July."

It is concluded from the higher temperature of the West Coast, and from the higher temperature of places situated near the sea, and sloping up from the shore, that "the warmest winter residences which our island can hold out to invalids must be sought for near the shores of the Atlantic, on rising ground gently sloping up from the water's edge, and having no hills to the south-west, so as to insure less rain and damp, as well as a drier, clearer, and more cheerful atmosphere."

The following facts and reasonings, showing that the Gulf-stream reaches our Scottish coasts on the west, will be read with interest, as adding additional proofs to those already adduced by Mr A. Keith Johnston and other writers on this subject.

"The cause of the excess (0°·8) of the mean temperature of the West over the East Coast, and the amount of their summer and winter differences, cannot be explained by the south-west winds. The Atlantic is about three degrees (2°·9) above the North Sea for the six months beginning with October and ending with March, the greatest excess being nearly four degrees in December and January, and the least 1°·7 in October; while the North Sea is 0°·7 in excess during the other six months, the highest being 1°·5, and the least a tenth of a degree. On the mean of the whole year, the Atlantic is fully a degree above the North Sea. We may therefore assume that the observed difference (0°·8) between the temperature of the East and West Coasts is entirely due to the high mean temperature of the Atlantic, imparting a higher temperature to the south-west winds than would otherwise be the case; which anomalously high temperature they gradually lose by radiation in their passage north-eastwards across the island.

"The more inland character of the North Sea, as compared with the Atlantic, would naturally lead us to expect that the former would show greater extremes of temperature than the latter; but this alone cannot account for a deficiency in winter of four degrees, and an excess in summer of a degree and a half; and it is manifest the principle would entirely break down when we should attempt to explain by it a mean annual deficiency of more than a degree. For if the Atlantic were stationary, and there were no influx on our western shores, and no general movement northward through the Hebrides and Orcades of warmer waters from the south-west, it is evident that the mean annual temperature of the opposite seas would remain nearly equal, however differently it might be partitioned in each through the months of the year.

"That there is a general movement of the waters northward, will be still further evident from the temperature of the sea at three distant points, on a mean of four years, from 1858 to 1861 inclusive: Otter House in Argyle 49°·0; Harris, 48°·8; Sandwick, 48°·6.

"From the simple fact of the very considerable excess of these annual means over the mean annual temperature of the air on the west, the inference is obvious, that the temperature of the sea on the west must be abnormally raised by currents from warmer regions. But the manner of the excess of the mean sea temperature at these places above their respective annual means is the point to which we would specially direct attention. The annual means show a gradual decrease as we proceed northward, *but a decrease totally disproportioned to that of the air temperatures.* The mean annual temperature of the air for the West Coast we have shown to be 47°·9, and that for Sandwick 45°·9. Thus, while the excess of the sea temperature over the air temperature on the West Coast is one degree, the excess for Sandwick is 2°·7, or nearly three times as great. These facts all point in one direction, which is, that the Gulf-stream strikes on our shores from a direction probably a little to the south of west, and is thence deflected northward along the coast, parting with its warmth slowly, and in such a manner, that the farther north the greater is the difference between the mean temperature and that of the air."

The effect of large towns in raising the temperature above what it would otherwise be, is strikingly shown in the following extract:—

"The following table is a comparison of the mean temperature of Edinburgh with that of the East Coast; and the excess of the former over the latter for each month of the year is also given:—

	Jan.	Feb.	Mar	Ap.	May	Jun.	July	Aug	Sep.	Oct.	Nov	Dec.	Means
Edinburgh	40·7	40·7	43·5	45·4	53·4	59·1	61·2	61·4	57·2	50·7	43·2	40·9	49·7
East Coast Stations	37·6	38·5	40·9	43·3	50·3	56·6	58·2	58·4	54·2	48·1	40·9	38·5	47·1
Excess of Edinburgh Mean Temperature	3·1	2·2	2·6	2·1	3·1	2·5	3·0	3·0	3·0	2·6	2·3	2·4	2·6

"The observations having been taken in Melbourne Place, a crowded part of the city, the thermometers were exposed to an excess of those artificial sources of heat which a large city presents. The heat that arises from the consumption of fuel, and from large collections of living beings; the greater dryness of the soil as compared with the country, caused by its more thorough drainage, and, as a consequence, the loss of less heat by evaporation; the greater stillness of the air, owing to the obstruction which the houses offer to the winds: the vertical surfaces of the buildings, which readily absorb the sun's rays, and being thus greatly heated, impart, by conduction and radiation, a higher temperature to the surrounding atmosphere; the smoke, which, by constantly obscuring the sky, more or less intercepts radiation,—these, along with other causes, conspire to raise the temperature of large towns considerably above that of the adjoining district. By these means we see that the temperature of Edinburgh, in the more crowded parts, is constantly from 2°·0 to 3°·0 above the mean temperature of Scotland. If the observations had been made in any of the more open streets or squares of the city, there is no doubt that the mean temperature would have been less, and, as we approached the suburbs, would have approximated to the true mean temperature as uninfluenced by artificial sources of heat. It is almost needless to remark on the Edinburgh observations, that they are worthless as a means of arriving at the mean temperature of the city; for it is evident that the excess indicated in the table is not the excess of the city taken as a whole, but only of the particular spot where the thermometers happened to be placed,—the amount of the excess at each part of the city being always directly proportioned to the combined force of the sources of artificial heat in raising the temperature at the place of observation. But while of no use in determining these points, they are of high utility considered in a sanitary point of view. They show us that the town is to be preferred to the country in winter in the case of those invalids to whom low temperatures are known to prove fatal. Not only is the general winter temperature of towns higher, but in particular cases of severe cold it does not fall nearly so low as it does in the country in places similarly circumstanced. A comparison of the minimum temperatures of Edinburgh with other places will be sufficient to show this, these being the lowest temperatures observed in each month during the five years."

The investigation into the meteorological conditions which determine the profitable or unprofitable culture of farm crops in Scotland, originated with the Marquis of Tweeddale, president of the Society.

"In the beginning of 1861, the Marquis of Tweeddale, president of the Society, offered L.40, to be distributed in eight prizes of L.5 each, for the best sets of approved observations with self-registering thermometers, with the view of collecting data for ascertaining the meteorological conditions which determine the profitable or unprofitable culture of ordinary farm crops in Scotland. The following instructions were issued to competitors:—The thermometers to be sent to the Society's office, for comparison, before being used; the bulbs not to be blackened; as regards position, not to be placed in a shaded or sheltered situation, but exposed to the full influence of sun and weather, as field crops are; to be fixed at a height of four feet above the ground, and over old grass; and daily observations of the highest and lowest temperature to be carried on continuously for a year from 1st April 1861.

"Thirteen competitors began the observations; but from various causes five of these did not continue them, leaving thus eight who sent in complete sets of observations. These eight competitors, with the places of observation, are as follow:—The Rev. Charles Clouston, Sandwick, Orkney; Duncan Forbes, Culloden; David Dun, Baldinnies, Bridge of Earn; John Garnoch, North Esk Reservoir, Pentland Hills; John Storie, East Linton; Robert Laidlaw, Chapelhope, Head of Yarrow; Dr Rankin, Otter House, Argyle; and Dr Macgowan, Millport, Cumbrae. The height and distance from the sea of these Stations are such as to afford, on the whole, good illustrations of the chief local climates of the country, as respects latitude, elevation, exposure, and distance from the sea."

The greatest difference between the exposed and the protected thermometers, viz. 25°·1, occurred at Sandwick on the 26th of July,—the protected thermometer rising only to 55°·1, while the exposed thermometer rose to 80°·2. This is perhaps the most suggestive result arrived at by the observations; for it shows that, while the protected thermometer indicated a temperature no higher than 55°·1, the grain crops were ripening in a temperature of fully 80°·0. The greatest difference of the thermometer during the night was 13°·7 at Sandwick on the 22d of June. It appears that though the absolute range of temperature is much less in Orkney than further south, yet in the former place the temperature of exposed objects is subject to greater, more rapid, and more frequent fluctuations, which is probably due to its higher latitude, its insular situation, and more clouded atmosphere, where, consequently, gleams of sunshine, of short continuance, more frequently occur.

The causes why in some districts cereals ripen better than in others, are thus enumerated, together with the heat required to mature the several crops:—

"We now come to the chief object of this inquiry, which is to show why wheat, barley, and other crops, ripen well in one district and not in another; and what light observations with exposed thermometers throw on the question. The chief peculiarity of the climate of Scotland, with regard to the cultivation of the corn crops, consists in the mean summer temperature being within two degrees of the minimum temperature required for the perfect maturing of the wheat and barley crops. Hence the bad effects which the occurrence of a colder summer than usual has on the wheat crop over the whole country, but particularly in the north and higher districts, both of which approach still nearer to the limits beyond which its successful cultivation cannot be carried. On this circumstance chiefly depend the interest and practical importance which are attached to all inquiries of this nature.

"The wheat-growing districts of Scotland include the whole of the eastern and inland parts of the country as far north as Ross-shire, together with the West Coast south of the Firth of Clyde. It is not grown at all in Shetland and Orkney; and only to a very limited extent in the Western Isles, and in the north and west of the country as far south as the Firth of Clyde. In Dumfries, Kirkcudbright, and Dumbarton, the breadth sown is considerably under the average of the other grain corps. The height at which it may be grown under ordinary circumstances is about 500 feet in the south, gradually diminishing with the latitude, till, on the extreme north of the country, the limits of its successful cultivation may be considered to be confined to places but little elevated above the sea, and enjoying a southern genial exposure. In a few localities, where situation and other circumstances are highly favourable to its growth, superior samples have been produced at elevations considerably above 500 feet. Thus at Danskine farm, in Haddingtonshire, belonging to the Marquis of Tweeddale, wheat is successfully cultivated at a height of 750 feet above the sea. It is necessary, however, to state that the land, in addition to being completely drained, is subjected to the peculiar deep culture which is so very successfully practised on his Lordship's farms at Yester. The remarkable result is, that at a height of 750 feet, wheat was produced in 1852 weighing 66¼ lbs. per bushel, being thus able to compete with the best samples grown in any part of East Lothian. This is in accordance with a remarkable result arrived at in the Essay on Climate published in the Society's last Report. It was there shown, that though the mean temperature of the year falls 1°·0 for every 300 feet of elevation, the mean temperature of the seasons does not follow the same law; but that in valleys at considerable elevation there is sufficient summer heat for maturing and ripening the crops, provided they sustain no damage from the frosts which occur occasionally in spring and early summer. The great advantage of deep culture is, that it enables the roots of the wheat to penetrate to greater depth than the frost ordinarily reaches; and hence the young plants are better preserved, and are in a position to benefit by the first genial weather in spring.

"The superior kinds of barley require a summer temperature nearly as high as wheat; but the coarser sorts, along with oats and rye, grow and ripen in Shetland, and at the greatest heights to which cultivation is carried in Scotland. Oats are cultivated in Dumfriesshire and among the Pentland Hills, at 1250 feet above the sea; in Aberdeenshire, at Tomantoul and Cairnside, 1500 feet; in Glen Lui, 1600 feet; and in Strathdon, 1570 feet: and barley in Strathdon, from 1400 to 1500 feet. The greater height to which cultivation is successfully carried in Aberdeenshire, as compared with the rest of Scotland, may be explained by the greater length of the day, by the higher and more extensive platform of the hills, and the consequent higher summer temperature of the incumbent air, and by the greater dryness and clearness of the atmosphere, arising from the circumstance that the south-west winds, before reaching the Aberdeen hills, must necessarily be deprived of much of their moisture by the hills lying to the south-west, over which they had previously passed.

"According to M. Boussingault, wheat requires 8248° Fahrenheit, and barley 6969°, from the time they begin to grow in spring, in order to bring them to perfection. This heat must be so distributed as to secure for wheat a mean summer temperature of 58°·0 on the continent of Europe. In Scotland, however, a lower mean summer temperature is sufficient, because, owing to its higher latitude, the days are longer. The mean summer temperature of Scotland as far north as the Moray Firth ranges between 58°·0 and 57°·0; on the Pentland Firth it is only 56°·0; and as agricultural returns show that the cultivation of wheat has reached its northern limit there, we may infer that wheat will ripen in Scotland, provided the mean temperature be 56°·0.

"It is difficult to fix precisely the time when wheat begins to grow in spring; but considering that little growth can take place as long as the temperature falls repeatedly to the freezing point or below it, it may be assumed that wheat will not begin to grow till the mean daily temperature of the air be 40°·0 or 42°·0. In the spring of 1861 this happened about the 16th of March; and as confirming this view, the reports made by the Society's observers show that vegetation began to make decided advances about that time. In the following Table, the days wheat took to ripen are reckoned from the 16th of March to the date of cutting, and barley and oats from the period of 'brairding.' The gross amounts of the degrees of heat have been found by adding the means of the mean temperature of the days. It may be remarked that the observations were confined to one field of each kind of crop, and that the temperature is deduced from observations made with protected thermometers; it is therefore the temperature of the air that is given, and not that to which the crops were actually exposed.

Table *showing Temperature required to Mature Crops of Wheat and Barley.*

Stations.	Crops.	Appeared above ground.	When cut.	Degrees of heat received.	Days in ripening.
Culloden,	Wheat,	Nov. 22, 1860	August 20, 1861	8188	156
	Barley,	April 22, 1861	„ 19, 1861	6560	119
	Oats,	„ 20, 1861	„ 21, 1861	6767	123
East Linton,	Wheat,	Nov. 18, 1860	August 23, 1861	8362	159
	Barley,	April 6, 1861	„ 13, 1861	6900	129
	Oats,	„ 5, 1861	„ 16, 1861	7125	133

These results entirely corroborate the views of M. Boussingault regarding the amount of heat required to ripen wheat and barley,—the amounts for Culloden and East Linton being identical with those contained in his list of places, the means of which are given above. In addition to these, it will be observed that the amount of heat required for the ripening of oats is about 7000 degrees. The suitableness of oats for cold climates, therefore, is not that they require a less amount of heat to ripen them than barley, but that less heat requires to be concentrated on the crop between the dates of flowering and ripening. This remarkable fact appears from the table, that a less amount of heat and fewer days were required to ripen each of the three crops at the northern than at the southern station. The explanation is probably to be found in the circumstance, that, as their mean summer temperature is nearly equal, less time and less heat, as ordinarily estimated, is required to ripen the crops at Culloden, owing to the higher latitude and consequently longer summer sunshine of that place. The short periods within which crops ripen in high latitudes may be adduced as confirmatory of this view."

With regard to the ripening of the crops after being fully shot, the following are the results :—

" At Culloden and East Linton, wheat ripened in 50 days with a mean temperature of 61°·0 by the exposed thermometer ; and at Baldinnies, in 58 days, with a temperature of 58°·6. This would give for Baldinnies a mean summer temperature of about 56°·0 by the protected thermometer, which accords with the circumstance that wheat is cultivated only on the lower parts of the farm. Taking the mean of Culloden and East Linton, it appears, that with an exposed temperature of 61°·0, wheat will ripen after it is fully shot in 50 days, barley in 48 days, and oats in 47 days."

The following important extract deserves the attentive consideration of all interested in agriculture, and in the introduction of the finer sorts of grain into new localities :—

Meteorological Characteristics of Districts capable of producing Cereals.

"As far as concerns temperature, the climate of Scotland may be considered as quite sufficient for the ripening of wheat and barley at places less than 500 feet above the sea in the south, and 100 feet in the extreme north; and where the exposure is favourable, at still greater heights. How then does it happen, that in large districts of the country, wheat, or both wheat and barley, are not cultivated though they enjoy a temperature sufficiently high for this purpose? Is the amount of heat received directly from the sun, in addition to that indicated by the temperature of the air, less in these districts than elsewhere?

"The above table shows that not only as regards the temperature of the air, but also as regards the temperature to which the growing crops were exposed, Otter House, in Argyle, where wheat is not grown, is more favourably circumstanced than Culloden, Baldinnies, and East Linton are, where it is grown. The cause is not therefore owing to a deficiency either of solar or atmospheric temperature. The greater part of that wide tract of country extending from the Firth of Clyde northward along the western slope of the island, is removed by its height beyond the limits of wheat cultivation. There are many valleys, however, in this district, whose exposure and temperature would render them suitable for this object, if the moist atmosphere and heavy rains which there prevail did not offer a serious obstacle to the proper ripening and securing of the corn crops. On account of the moist atmosphere, the crops run rapidly into straw, which, being weak from a deficiency of silica, are more easily beaten down and 'lodged' by the torrents of rain and violent winds, which are of such frequent occurrence among the western hills. The autumnal rains also commence earlier in the west, thus increasing the risk of the grain being safely secured in the farm-yard. Hence the rearing of cattle, for which the climate is peculiarly fitted, to a great extent takes the place of agriculture in the West Highlands. We thus see that the rain-gauge is nearly as important as the thermometer in determining whether the grain crops may be profitably cultivated in any locality. Considering thus the great practical value of rain returns to the agriculturist, it is to be hoped that rain-gauges will come to be more extensively used by farmers than they have yet been. But after these deductions for height and rainy climates are made, there no doubt still remains large tracts of land in the west, which are in every way admirably fitted for the cultivation of wheat, barley, and oats, though, being generally believed not to be so, they are consigned to less remunerative purposes. The counties of Ayr and Wigtown, both on the west, constitute one of the largest as well as earliest wheat-growing districts in Scotland. This arises from the circumstance, that where wheat is grown in these counties, there are no hills lying to the west or south-west, which would serve as condensers to the moist south-west winds, and thus give a cloudy, moist, and rainy climate to all places situated immediately to the north-east of them. There seems to be no physical reason why the finer cereals are not cultivated in the western parts of Argyle, &c., where there may be many places whose western and south-western horizons are not broken by hills, and whose skies are consequently clear and genial, and rain moderate. That this is no mere fancy, the experiments made in the west of Argyle by Mr John Malcolm of Poltalloch afford ample confirmation. Having overcome the habits and prejudices of the natives,—the most serious difficulty to be contended with,—a large breadth of hitherto unproductive land was trenched and sown with wheat; and the samples produced, both as respects quantity and quality, are equal to any grown in Scotland.

"We may therefore conclude that the climate of Scotland is suited for a more extensive cultivation of the finer kinds of grain than is commonly believed.

"It may be interesting to inquire, whether wheat might be expected to be cultivated at greater heights than 750 feet. The temperature of Chapelhope, at the head of the Yarrow, 900 feet high, seems to warrant an answer in the affirmative, if the very fine samples grown on the Yester estates, at a height of 750 feet, did not point to the same conclusion. From an examination of the table, it will appear that the mean summer temperature of Chapelhope is higher than Culloden, and about equal to Baldinnies and East Linton; and the same remark applies to the mean spring temperature. There is, however, this important difference: the mean temperature of the night during spring is comparatively low at Chapelhope, and as appears from Table II., is subject to intense frosts, 7°·0 having been observed in March, and 19°·0 in April, and 17°·0 in May. It would be interesting to ascertain whether sub-soil trench ploughing would be successful at such great heights as Chapelhope. The autumn temperature appears to be sufficient to enable the young plants to push down their roots to depths where frosts rarely penetrate. The circumstance that at Baldinnies, where wheat is grown, the temperature fell to 19°·0 in May, and the mean temperature of the night in spring was nearly as low as at Chapelhope, is enough to show that we should not hastily come to the conclusion that such is impossible, before it has been experimentally proved.

"The position of Sandwick, in Orkney, appears to be peculiar. Judging from the extremes of temperature given in Table II., we might suppose that it is fully as favourably circumstanced as Culloden for the culture of wheat, higher exposed temperatures having been observed in Orkney than at Culloden. But these high temperatures are eminently exceptional. Their rare occurrence and generally brief duration render them of small importance in ripening the crops. Its mean temperature, both exposed and protected, seems to place Orkney just without the limits of wheat cultivation, while its clouded, moist atmosphere, and delayed summers, are still further disadvantageous. Any wheat grown in Orkney must therefore be inferior both in quantity and quality, and being withal so precarious, it cannot be expected ever to become an object of profitable culture."

"It appears, therefore, as the result of the whole inquiry, that *where the mean summer temperature is as low as* 56°·0 *by the protected thermometer, or* 58°·6 *by the exposed thermometer, the cultivation of wheat is quite possible, even though the character of the springs be comparatively cold and backward, provided always that the rainfall in summer and autumn is not in excess.* Hence it is most desirable that meteorological observations should be established in such non-producing districts as possess the physical features which have been above described, and, wherever the meteorological indications turn out as favourable as those at Baldinnies, there undoubtedly exist strong inducements to attempt the cultivation of wheat and barley crops."

The Mechanics of the Heavens: an Essay on Revolving Bodies and Centripetal Forces. By JAMES REDDIE. London: Hardwicke, 1862.

In our Number of last April we noticed Mr Reddie's pamphlet entitled "Vis Inertiæ Victa," and our remarks appear to have been unsatisfactory—and (this we regret) unprofitable—to him. In the few words which follow, we shall try a different mode of dealing with him,—namely, calm expostulation; for the energy he displays is really worthy of a better cause: and we shall endeavour to induce him to divert it to some new field, where his imperfect apprehension of the meaning of plain statements will not be prejudicial to his progress.

In the first place, he cannot understand that mass (or inertia) is *totally* independent of the idea of weight. We suggested a blow from a cricket-ball as something depending on inertia, and in reality nowise connected with weight. In a postscript to his new pamphlet he shows that he remains in his egregious error. Now, let us merely ask him to suppose himself placed in boundless space, where no attracting body is present save his own—and to suppose, further, that *there* a cricket-ball impinged upon him, as if straight from the redoubted arm of Jackson. Would it hurt, or no? We fancy the affirmative answer cannot be for a moment doubtful. Well, is the ball *heavy?* Here again a prompt negative must be uttered by our pupil, unless he be so sharp as to suggest that the attraction of his own body for it will give it weight. This would be strictly true, no doubt; but the amount would be inconceivably small, even in comparison with that of the puff-ball of his defiant postscript.

It would be tedious to our readers, and probably useless to our pupil, to go through the whole series of his blunders, and show him at every step how inconceivable is his dulness. His idea that a string can pull back a stone, while a wooden or metal rod cannot—his notion that a great number of very small things cannot in any case amount to a finite quantity—and his conviction that the advancement of science requires a careful investigation into the claims of his works—are all parallel cases, and deserve as effectual a snubbing as can be bestowed. But we prefer to consider him as one of those men whose mental bias is so strong, as to present a perfectly opaque barrier to the light of truth. We sincerely pity him, and restrain our uplifted hand. But it is otherwise with the "*John Bull*" and the "*Literary Churchman*," who have prostituted their position and character in favourably noticing his wretched vagaries, and thus in all probability encouraging him in his complacent delusion. Let him read with care some *elementary* work on Physics, and he may then return to the study of the Principia in a humble and docile spirit. Diximus!

Catalogue of the Economic Products of the Presidency of Bombay; being a Catalogue of the Government Central Museum, Division I., Raw Produce (Vegetable). Compiled by Assistant-Surgeon BIRDWOOD, M.D., Curator of the Museum, and Officiating Professor of Materia Medica in Grant Medical College.

This useful catalogue embraces Drugs, Agricultural Produce, Fruits and Vegetables, Narcotics, Condiments and Spices, Starches, Sugars, Gums, and Resins, Oils, Dyes, Tanning materials, Fibres and Woods. The plants in the different divisions are arranged according to their natural orders; the English and vernacular names being given with their habitat on the Continent of India, and valuable remarks as to their properties, uses, &c. This work will be prized by those who wish to become acquainted with the economic products of India.

PROCEEDINGS OF SOCIETIES.

British Association for the Advancement of Science, held at Cambridge, October 1862.*

Section A.—*Mathematical and Physical Science.*

Suggestions on Balloon Navigation. By Isaac Ashe, M.B.—The author proposed a simple contrivance by means of which the opening of the escape valve should depend, when desirable, on the relaxation of voluntary exertion on the part of the aëronaut, so that, in the event of insensibility supervening at great altitudes, the valve should open spontaneously by means of a weight attached to its rope, thus causing a descent of the balloon to safer altitudes, and obviating the danger to life incurred by Messrs Glaisher and Coxwell during their recent scientific ascent from Wolverhampton, in consequence of their becoming insensible.

Extract from an Account of a Visit to the Kew Observatory, presented to the Portuguese Government. By Professor J. A. De Souza, Professor in the University of Coimbra.—Dr Jacintho Antonio de Souza has published an account of a visit, in 1860, to the scientific establishments of Madrid, Paris, Brussels, Greenwich, and Kew; and of a second visit, in 1861, to the Observatory at Kew; both visits having been made by the desire of his Government, and having for their principal object to obtain information preparatory to the establishment of a Magnetical and Meteorological Observatory at the University of Coimbra. He selected the instruments and mode of observing adopted at Kew as the type of what he recommended for the adoption of his Government; and he reports, "that the Observatory at Kew, besides occupying itself with meteorological and magnetical phenomena, and the photographic registry of the spots of the sun, verifies meteorological and magnetical instruments, compares them with the excellent standards which it possesses, determines their constants, and improves the methods of observation."

On some Peculiar Features in the Structure of the Sun's Surface. By Mr J. Nasmyth.—Mr Nasmyth gave a sketch of the character of the sun's surface as at present known. He described the spots as gaps or holes, more or less extensive, in the luminous surface or photosphere of the sun. These exposed the totally dark bottom or nucleus of the sun; over this appears the mist surface—a thin, gauze-like veil spread over it. Then came the penumbral stratum, and, over all, the luminous stratum, which, according to him, was composed of a multitude of very elongated, lenticular-shaped, or, to use a familiar illustration, willow-leaf-shaped masses, crowded over the photosphere, and crossing one another in every possible direction. The author had prepared and exhibited a diagram, pasting such elongated slips of white paper over a sheet of black card, crossing one another in every possible direction in such multitudes as to hide the dark nucleus everywhere, except at the spots. These elongated lens-shaped objects he found to be in constant motion relative to one another; they sometimes approached, sometimes receded, and sometimes

* This abstract is taken partly from the "Athenæum" Report, and partly from abstracts furnished by authors.

they assumed a new angular position, by one end either maintaining a fixed distance or approaching its neighbour, while at the other end they retired from each other. These objects, some of which were as large in superficial area as all Europe, and some even as the surface of the whole earth, were found to shoot in thin streams across the spots, bridging them over in well-defined streams or comparative lines, as exhibited on the diagram; sometimes by crowding in on the edges of the spot they closed it in, and frequently, at length, thus obliterated it. These objects were of various dimensions, but in length they generally were from ninety to one hundred times as long as their breadth at the middle or widest part.

On the Extent of the Earth's Atmosphere. By Professor CHALLIS.—The object of this paper was to show that the earth's atmosphere is of limited extent, and reasons were adduced, in the absence of data for calculating the exact height, for concluding that it does not extend to the moon.

On the Augmentation of the Apparent Diameter of a Body by its Atmospheric Refraction. By the Rev. Professor CHALLIS.

On the Hindú Method of Calculating Eclipses. By Mr W. SPOTTISWOODE.

Description of an Optical Instrument which indicates the Relative Change of Position of Two Objects (such as ships at Sea during Night), which are maintaining Independent Courses. By Mr J. M. MENZIES.—This instrument consisted of a lantern-shaped case, containing a lens or eye in front and a concentric sheet of bent glass behind, at the focal distance of the lens ruled with parallel vertical lines. This was hung up so as to have its axis parallel to the course of the vessel, and the bright spot, the image of the lights of the approaching vessel, showed by its position and shifting the relative place and course of the approaching vessel.

On British Rainfall during 1860–61. By Mr G. J. SYMONS.—This paper was accompanied by a very voluminous series of tables, showing the amount measured in each month at more than 500 stations. Mr Symons drew attention to one result in particular, which these very ample returns had enabled him to deduce,—viz., that during the two years under consideration, although in the south of England, 1860 was nearly 50 per cent. wetter than 1861; yet, as just the reverse obtained in Scotland, the average fall for the whole country was nearly identical in the two years, 1860 being only 3 per cent. wetter than 1861.

On the Performance, under trying circumstances, of a very small Aneroid Barometer. By Mr G. J. SYMONS.

Observations on Three of the Minor Planets in 1860. By Mr NORMAN POGSON. Communicated by Dr Lee.

On the Mechanical Power of Electro-Magnetism, with special reference to Dr Joule and Dr Scoresby's Theory. By Dr J. CROLL.

Provisional Report on a Proposed Standard of Electrical Resistance. By Mr FLEMING JENKIN.

Provisional Report on Thermo-Electric Currents in Circuits of one Metal. By Mr F. JENKIN.—Experiments were described with loose contacts between wires of two dissimilar metals. The great intensity of the currents so obtained, compared with the ordinary thermo-electric currents from metallic contact between the two metals, was pointed out; and it was shown that an analysis of the results proved, beyond doubt, that the currents were of the same nature as those produced by unequally-heated metals placed in an electrolyte: the thin films of melted oxides of copper and iron constitute this electrolyte with equally-heated junctions at surface of the two wires.

Report on certain Dynamical Problems. By Mr A. Cayley.

On a certain Curve of the Fourth Order. By Mr A. Cayley.

On the Representation of a Curve in Space by means of a Cone and Monoid Surface. By Mr A. Cayley.—The author defined a monoid surface, gave and explained the equation which determined it, and then showed how, by following the point of contact of the cone with it, the several loops and singular points of the curve could be accurately traced and determined.

On a certain Class of Linear Differential Equations. By the Rev. R. Harley.

Some Account of Recent Discoveries made in the Calculus of Symbols. By Mr W. H. L. Russell.

On Meteorology, with a Description of New Meteorological Instruments. By Mr T. L. Plant.

On an Instrument for Describing Geometrical Curves, invented by Mr H. Johnston. Described and exhibited by the Rev. Dr Booth.

On Three New Craters in the Moon, not delineated in Beer and Mädler's Map. By Mr G. R. Birt.

Observed R.A. and N.P.D. of Comet II. 1862. By the Rev. R. Main.

On the Dimensions and Ellipticity of Mars. By the Rev. R. Main.—This paper gave the results of seven sets of measures of the disc of Mars, made for the determination of his ellipticity with the heliometer, by the method of contact of limbs of the two images formed by the half object glasses.

On the Zodiacal Light and Shooting Stars. By Professor Challis.—The phenomena of the zodiacal light, as gathered from observations made both in northern and in southern latitudes, were stated to be as follows:—As seen in north latitudes, it appears in the west after the departure of twilight, as a very faint light, stretching along the ecliptic, about 10° broad at its base in the horizon, and coming to an apex at an altitude of 40° to 50°. It is most perceptible in the west in the months of February and March, at which time its apex is near the Pleiades. Similar appearances are presented in the morning before sunrise in the east, in the months of August and September. The light seen in the autumn lies in the *same* direction from the sun as that seen in the spring. In the southern hemisphere, the appearances are strictly analogous; but the times and positions of maximum visibility are the evenings in autumn in the west and the mornings in spring in the east. The portion best seen in the southern hemisphere lies in the *opposite* direction from the sun to that which is best seen in the northern hemisphere. The portion seen and the degree of visibility depend on the inclination to the horizon of the part of the eclipse along which the light stretches. The greater the inclination the better it is seen. At the December solstice, opposite portions have been seen in the northern hemisphere, one in the morning and the other in the evening; and in the southern hemisphere opposite portions have been similarly seen at the June solstice. At these seasons the ecliptic is inclined at large and equal angles to the horizon, at equal intervals before sunrise and after sunset.

On Autographs of the Sun. By Professor Selwyn.—Professor Selwyn showed several *Autographs of the Sun*, taken with his "heliautograph," by Mr Titterton, photographer, Ely, which consists of a camera and instantaneous slide, by Dallmeyer, attached to a refractor of $2\frac{3}{4}$ inches aperture, by Dolland,—the principle being the same as that of the instrument made at the suggestion of Sir J. Herschel for the Kew Observatory; and the Professor expressed his thanks to Mr Balfour Stewart and Mr Buckley for their advice.

Report of a Committee to inquire into the Adequacy of existing Data *for carrying into effect the Suggestions of Gauss, to apply his General Theory to Magnetic Variations.* By the Rev. Dr H. LLOYD.

Mr F. J. EVANS read a Report, by Mr A. SMITH and himself conjointly, *On the Three Reports of the Liverpool Compass Committee, and other recent Publications on the same subject,*—undertaken at the request of the British Association. The papers included were severally by the Astronomer-Royal, the late Dr Scoresby, and Captain Johnson, R.N , on the deviation of the compass and the magnetism of iron ships; as also contributions in the same field of inquiry by the reporters. Among the conclusions arrived at are the following:—1. That the magnetism of iron ships is distributed according to precise and well-determined laws; 2. That a definite magnetic character is impressed in every iron ship while on the building slip, which is never afterwards entirely lost; 3. That a considerable reduction takes place in the magnetism of an iron ship on first changing her position after launching, but afterwards that any permanent change in its direction or amount is a slow and gradual process; 4. That the original magnetism of an iron ship is constantly subject to small fluctuations from change of position, arising from new magnetic inductions; 5. That the compass errors occasioned by the more permanent part of a ship's magnetism may be successfully compensated; and that this compensation equalises the directive power of the compass-needle on the several courses on which a ship may be placed.

Report on Double Refraction. By Professor STOKES.

Relation entre les Phénomènes de la Polarization Rotatoire, et les Formes Hémièdres ou Hémimorphes des Cristaux à un ou à deux Axes Optiques. By M. A. DES CLOIZEAUX.

On some of the Characteristic Differences between the Configuration of the Surfaces of the Earth and Moon. By Professor HENNESSY.

On an Experimental Determination of the Absolute Quantity of Electric Charge on Condensers. By Dr ESSELBACH.

On some Improvements in the Barometer. By Mr ISAAC ASHE.

On the Determination of Heights by means of the Barometer. By Mr J. BALL.—The object of this paper is to direct attention to the serious errors which are involved in the ordinary process of reducing barometric observations taken for hypsometrical purposes. This process involves two assumptions: first, that the volume of a column of air unequally heated is nearly the same as that of an equal weight of air of the same mean temperature; secondly, that the mean temperature of the column or stratum of air between the stations of observation corresponds to the mean of the readings of thermometers standing in the shade at each station. The error involved in the first assumption is not very considerable; that arising from the second is, on the contrary, highly important. Mr Bravais, who, along with Mr Charles Martins, has contributed largely to our knowledge of the meteorology of the Alps, was the first to propose a practical plan for applying a correction to the assumed mean temperature of the air depending upon the hour of the day and the season of the year at which observations are made; but it is to M. Plantamour, the distinguished astronomer of Geneva, that we owe the fullest investigation of this important subject. Having ascertained by careful levelling the true height of the Great St Bernard above Geneva, M. Plantamour finds that the mean of all the barometric observations made during eighteen years deviates by fourteen English feet from the true height; and he attributes this deviation, with great apparent probability, to an abnormal depression of the mean temperature of Geneva, owing to the neighbourhood of the lake. The readings of the barometer and thermometer at the Observatories of Geneva and the St Bernard are taken daily at nine hours or epochs. M. Plantamour assumes that, on an average of a long period of years, the mean of the observations taken at any one epoch in the twenty-four hours should give the true difference of height between the two stations, with an error due to the difference between the mean of the readings of the thermometers at both stations at the same epoch and the true mean temperature of the air in the intervening stratum. Calculating, then, the height of the St Bernard by the elements corresponding to each epoch of the day during the four summer months from June to September, he obtains a series of measures differing from the true height; those corresponding to the hottest hours being in excess, and those appertaining to the coldest hours in defect, of the true height. He then ascertains the amount of correction which, being applied to the mean sum of the readings of the thermometer at each epoch in each of those months, would bring out the true heights. In this manner he obtains a table showing what he calls the normal correction for each of the nine epochs of the day during the four summer months. There is good reason to believe that, in reducing barometric observations which are to be compared with Geneva and the St Bernard, the application of the normal correction ascertained in the manner above stated will, in general, give truer results than those where this is not applied; but as it is obvious that the conditions of temperature at the moment when a given observation is made are constantly varying from the mean of the corresponding day and hour, it follows that a further supplemental correction should be made on this account. To apply this further correction is a matter of no slight difficulty. The method employed by M. Plantamour is as follows:—He obtains from the observations at Geneva and the St Bernard, by interpolation when necessary, the elements corresponding to the day and hour of the observation which is sought to be reduced, and from these he calculates the height of the St Bernard. The height so obtained, when compared with the measure which is derived from the mean of the readings for the same day and hour, as shown in his table of normal corrections, furnishes a criterion by which to judge of the conditions with respect to temperature of the moment when the observations to be reduced were made. M. Plantamour thinks it not difficult to infer, from the observations themselves, and from the general state of the weather at the time, whether the moment was one of atmospheric equilibrium or the reverse. In the latter case, the observation is treated as one of inferior utility, to which a lower value should be assigned in the final calculation. Supposing, on the contrary, the observations not to betray a disturbance of equilibrium between the two stations, the deviation of the height as calculated for that particular moment from the height derived from the corresponding means, is the measure of the amount and sign of the supplemental correction corresponding to the moment of observation.

On the Volumes of Pedal Surfaces. By Mr T. A. Hirst.

On the Excentricity (or, as the author preferred it should be termed, the Excentrality) of the Earth, and the Method of finding the Co-ordinates of its Centre of Gravity. By Mr W. Ogilby.

Report on Luminous Meteors. By Mr J. Glaisher.

On a new Barometer used in the last Balloon Ascents. By Mr. J. Glaisher.—Mr Glaisher exhibited a mercurial barometer which had been designed and constructed by Messrs Negretti & Zambra, for the purpose of checking the readings of the Gay-Lussac's barometer, which had been used in the several late balloon ascents. The correctness of the readings of a Gay-Lussac's barometer at low pressure depended upon the evenness of the tube, and it is difficult to colligate so large a tube. Messrs Negretti & Zambra selected a good tube, 6 feet in length, attaching a cistern to its lower end. Mercury was boiled throughout the length of the tube; at the entrance of the cistern was placed a stopcock, by which means any definite quantity of mercury could be allowed to pass from the upper half of the tube into the cistern, and its height in the cistern noted and engraved; then a second portion, and so on. This process could be repeated. When the cistern was thus satisfactorily divided, the tube was cut in two, and to the upper half the cistern was joined; a scale was attached to this portion, and the reverse operation was performed,—viz., allowing portions of the mercury to pass from the cistern into the tube, which could be regulated by means of the stopcock, and thus the scale was divided. The process, in fact, is using the tube to graduate itself. In carriage, the stopcock locks the mercury in the tube. This instrument was used, and acted well on the extreme high ascent.

Report on Vertical Movements of the Atmosphere. By Professor Hennessy.—It appears that non-horizontal movements of the air are more prevalent, upon the whole, about mid-day than at any other diurnal period. Their sudden and abrupt commencement is usually a precursor and always accompanies great horizontal disturbances. Their gradual and regular diminution in energy seems to point to a steady tendency in the air towards a state of convective equilibrium, and frequently precedes fine weather. In general, the motion of the air is not strictly horizontal, but undulatory; and the mingling of such undulations with the effects of convection seems to point out the value of the study of the atmospherical pulse as a test of changes of the weather.

On the General Solution of the Linear Equation in Finite Differences. By Professor Sylvester.

On the Differential Equations of Dynamics. By Professor Boole.

On the Measurement of the Temperature of Active Volcanic Foci to considerable Depths, and of the Temperature and Issuing Velocity of the Steam and Vapours evolved. By Mr R. Mallet.

On the Relative Amount of Sunshine falling on the Torrid Zone of the Earth. By Professor Hennessy.

On the Form and Motion of Waves at and near the Surface of Deep Waters. By Professor Rankine.

On the Additional Evidence of the Indirect Influence of the Moon over the Temperature of the Air, resulting from the Tabulation of Observations taken at Greenwich, 1861–62. By Mr J. P. Harrison.—The author stated that the additional evidence derived from the observations of mean temperature at Greenwich for the years 1856–62 confirmed the conclusions arrived at from a tabulation of the observations for the forty-three years previous,—viz., that the temperature of the air at the moon's first quarter is higher than it is at full moon and last quarter, and that this is due to the amount of cloud at first quarter being greater on the average than it is at the periods of full moon and last quarter. The difference in the amount of rain also at first quarter was shown to have been 2·27 inches more in 1861–62 than at full moon on a mean of eighty-four observations at each period.

On the Distribution of Fog round the Coasts of the British Islands. By Dr Gladstone.

On the Hurricane near Newark of May 7, 1862, *showing the Force of the Hailstones and the Violence of the Gale.* By Mr E. J. Lowe.

European Weather Charts for December 1861. By Mr F. Galton.

On the "Boussole Burnier," a new French Pocket Instrument for measuring Vertical and Horizontal Angles. By Mr F. Galton.

On Objections to the Cyclone Theory of Storms. By Mr S. A. Rowell.

Meteorological Observations registered at Huggate, Yorkshire. By the Rev. T. Rankine.

On the Means of following the Small Divisions of the Scale regulating *the Distances and Enlargement in the Solar Camera.* By Mr A. Claudet.

On Eight Scientific Balloon Ascents. By Mr Glaisher.—The author detailed the objects of the experiments as follows:—The primary objects of the experiments were—the determination of the temperature of the air and its hygrometric state at different elevations, up to 5 miles. The secondary objects were—to compare the readings of an aneroid barometer with those of a mercurial barometer up to 5 miles; to determine the electrical state of the atmosphere; to determine the oxygenic condition of the atmosphere by means of ozone papers; to determine the time of vibration of a magnet on the earth and at different distances from it; to determine the temperature of the dew-point by Daniell's dew-point Hygrometer and Regnault's Condensing Hygrometer, and by the use of the dry and wet bulb thermometers as ordinarily used, and by their use when under the influence of the aspirator, so that considerable volumes of air were made to pass over both bulbs at different elevations, as high as possible, but particularly up to those heights where man may be resident, or where troops may be located, as in the high lands and plains of India, with the view of ascertaining what confidence may be placed in the use of the dry and wet bulb thermometers at those elevations by comparison with those found directly by Daniell's and Regnault's Hygrometers, and also to compare the results as found by the two hygrometers together; to collect air at different elevations; to note the height and kind of clouds, their density and thickness at different elevations; to determine the rate and direction of different currents in the atmosphere, if possible; to make observation on sound; to note atmospherical phenomena in general; and to make general observations. The instruments used consisted of mercurial and aneroid barometers; dry and wet bulb thermometers, also an exceedingly sensitive thermometer; Daniell's Dew-point Hygrometer; Regnault's Condensing Hygrometer; solar radiation thermometer; maximum and minimum thermometers; a small magnet for horizontal vibrations, hermetically sealed, and exhausted glass-tubes; ozone test-papers, &c. In the ascent on July 17, a height of 26,177 feet was reached; and in the descent a mass of vapour of 8000 feet in thickness was passed through, so dense that the balloon was not visible from the car. In that of August 18 an altitude of 11,500 feet was attained; then the balloon descended to 3200 feet; then ascended to 23,400 feet, where a consultation took place, and it was decided not to go higher, as clouds of unknown thickness and moisture had to be passed through. In the ascent on August 20 the air was almost calm; the balloon for a long time hovered over the Crystal Palace, and then over London, whilst it was lighted up, where they seemed to be destined to remain all night; finally, went above the clouds, and came down at night near Hendon. The balloon was then anchored for the night, the lower valve being closed with the hope that the gas would be retained. Before sunrise, on August 21, all the instruments were replaced and the balloon left the earth. It was a warm, dull, cloudy morning; clouds were reached at the height of 5000 feet; the light rapidly increased, and gradually the balloon emerged from dense clouds into a basin surrounded with immense black mountains of cloud, rising far above; shortly afterwards there were deep ravines of grand proportions below, bounded with beautiful curved lines. The sky was blue with cirri. The tops of the mountain-like clouds became silvery and golden; at the height of 8000 feet we were on their level, and the sun appeared flooding with golden light all space for many degrees both right and left, tinting with orange and silver all the remaining space. It was a glorious sight. As the sun's rays fell on the balloon we rose more rapidly, each instant opening to us ravines of wonderful extent, and presenting elsewhere a mighty sea of cloud. Here there were shining masses in mountain chains, some rising perpendicularly from the plains, dark on one side, and silvery and bright on the other, with summits of dazzling whiteness; some there were of a pyramidal form, a large portion undulatory, and in the horizon alpine ranges bounded the view. A height of nearly three miles was reached. On Sept. 1, when at the height of three-quarters of a mile over London, the whole course of the river Thames was visible from its mouth; and parallel to it, and bounded by its banks, a cloud or fog-bank extended the whole distance, following all its sinuosities. For half an hour before the descent, near Woking, in Surrey, the balloon was under one stratum of cloud, and above another; the upper surface of the latter was remarked as bluish white, the middle portion the pure white of the cumulus, and the lower surface a blackish white, and from which rain was falling on the earth. The balloon descended to a height of 1300 feet, but still above these clouds. It was afterwards learnt that rain had been falling from these clouds all the afternoon. On Sept. 5, the balloon ascended from Wolverhampton. At 29,000 feet from the earth Mr Glaisher became insensible; the balloon still ascended to fully the height of 35,000 feet or 36,000 feet, and may have gone even higher. Mr Glaisher recovered his consciousness on descending, when at about the same height as he lost it on ascending. The author had prepared and exhibited diagrams showing the path of the balloon and temperatures of the air at different elevations for each ascent, and extensive tables of all his observations. From these he deduced the following table, showing the mean temperature of the air at every 5000 feet of elevation above the level of the sea in each high ascent:—

Height above the Level of the Sea.	Mean Temperature of the Air.					Decrease of Temperature for an Increase of Height of 5000 feet.
	July 17.	August 18.	August 21.	September 5.	Mean.	
Feet.	°	°	°	°	°	°
0	61·2	69·6	62·0	62·2	63·8	...
5,000	39·7	48·0	43·3	41·4	43·1	20·7
10,000	28·0	40·7	32·0	31·0	32·9	10·2
15,000	31·0	31·1	19·0	21·0	25·7	7·2
19,500	42·2	...	...	...	...	...
20,000	33·0	25·9	...	10·6	23·2	2·5
25,000	16·0	23·9	...	0·0	13·3	9·9
30,000	...	...	...	−5·3	...	...
Decrease of Temperature for an Increase of Height of 25,000 Feet.	44·9	45·7	...	62·2	50·5	...

Report of the Proceedings of the Balloon Committee. By Col. Sykes.

On the Duration of Fluorescence. By Dr E. Esselbach.

On Electric Cables, with reference to Observations on the Malta-Alexandria Telegraph. By Dr E. Esselbach.

On the Curvature of the Margins of Leaves with reference to their Growth. By Mr W. Esson.

On the Disintegration of Stones exposed in Buildings and otherwise to Atmospheric Influence. By Professor J. Thomson.—Professor Thomson having first guarded against being understood as meaning to assign any one single cause for the disintegration of stones in general, gave reasons to show—1st, That there may frequently be observed cases of disintegration which are not referable to a softening or weakening of the stone by the dissolving away or the chemical alteration of portions of itself, but in which the crumbling is to be attributed to a disruptive force possessed by crystalline matter in solidifying itself in pores or cavities from liquid permeating the stone. 2nd, That in the cases in question the crumbling away of the stones, when not such as is caused by the freezing of water in pores, usually occurs in the greatest degree at places to which, by the joint agency of moisture and evaporation, saline substances existing in the stones are brought and left to crystallise. 3rd, That the solidification of crystalline matter in porous stones, whether that be ice formed by freezing from water, or crystals of salts formed from their solutions, usually produces disintegration, not, as has commonly been supposed, by expansion of the total volume of the liquid and crystals jointly, producing a fluid pressure in the pores; but, on the contrary, by a tendency of crystals to increase in size when in contact with a liquid tending to deposit the same crystalline substance in the solid state, even where, to do so, they must push out of their way the porous walls of the cavities in which they are contained, and even though it be from liquid permeating these walls that they receive the materials for their increase.

Report on Thermometric Observations in the Alps. By Mr J. Ball.

On a Brilliant Elliptic Ring in the Planetary Nebulæ, R.A. 20° 36′, *N.P.D.* 101° 56′. Communicated by Mr Lassell; by Dr Lee.

Some Cosmogonical Speculations. By Mr I. Ashe.

Account of an Electro-motive Engine. By Mr G. M. Guy.

Experiments on Photography with Colour. By Mr J. B. Reade.

On some Improved Celestial Planispheres. By Mr C. J. Villa.

On some Models of Sections of Cubes. By Mr C. M. Willich.

On the Cohesion of Gases and its Relation to Carnot's Function and to recent Experiments on the Thermal Effects of Elastic Fluids in Motion. By Dr J. Croll.

On Capillary Attraction: Comparison of Theory and Experiment. By the Rev. F. Bashforth.

Quaternion Proof of a Theorem of Reciprocity of Curves in Space. By Sir W. R. Hamilton.

On the Storms of the St Lawrence Valley and the Great Lakes of Canada. By Dr Hurlburt.

Some Facts relating to two Brilliant Auroras in Canada. By Dr Hurlburt.

On the Probable Origin of the Heliocentric Theory. By Mr J. Schwarcz.—The author, in an elaborate essay, traces the origin of the Copernican system to Pythagoras, through Aristarchus the Samian and Archimedes of Syracuse.

Remarks on the Complementary Spectrum. By Mr J. Smith.

On the Supernumerary Bows in the Rainbow. By the Rev. J. Dingle.—The author said he had investigated a method of approximating to the size of the drops of rain corresponding to any given position of the supernumerary bows produced by the interference of the two luminiferous surfaces proceeding from each drop.

On Electrical Tensions. By Mr L. Clark.

Section B.—*Chemical Science.*

On the Luminosity of Phosphorus. By Dr Moffat.—If a piece of phosphorus be put under a bell-glass and observed from time to time, it will be found at times luminous, and at others non-luminous. When it is luminous, a stream of vapour rises from it, which sometimes terminates in an inverted cone of rings similar to those given off by phosphoretted hydrogen; and at others it forms a beautiful curve, with a descending tint equal in length to the ascending one. The vapour is attracted by a magnet; it is also attracted by heat, but it is repelled by cold. It renders steel needles magnetic, and it is perceived only when the phosphorus is luminous. Results deduced from daily observations of the phosphorus in connection with the readings of the barometer, the temperature and degree of humidity of the air, with directions of the wind, for a period of eighteen months, show that periods of luminosity or phosphorus and non-luminosity occur under opposite conditions of the atmosphere; the former being peculiar to the equatorial, while the latter is peculiar to the polar current. By the catalytic action of phosphorus on atmospheric air, a gaseous body (superoxide of hydrogen) is formed, which is analogous to if not the same as atmospheric ozone, and it can be detected by the same tests. The author has found, by his usual tests, that *phosphoric* ozone is developed only when the phosphorus is luminous. Periods of luminosity and periods of atmospheric ozone take place under similar atmospheric conditions, and the conditions of non-luminous periods and periods of non-atmospheric ozone are the same. From the author's observations in connection with this matter, which extend over several years, it appears that 99 per cent. of luminous periods, and 91 per cent. of ozone periods commence with decreasing readings of the barometer and other conditions of the equatorial current; and that 94 per cent. and 66 per cent. terminate with increasing readings and conditions of the polar current. Luminous periods commence, and luminosity increases in brilliancy, on the approach of storms and gales, and ozone periods commence and it increases in quantity under similar conditions. There is, it would appear also, from these observations, an intimate connection between the approach of storms, the commencement of luminous and ozone periods, and disorders of the nervous, muscular, and vascular systems. Here the author gave the dates of many storms and gales, and the occurrence of diseases of the above class, showing their coincidence; and in corroboration of what he had stated, he mentioned the fact, that there was a concurrence in the issuing of Admiral Fitzroy's cautionary telegrams and these diseases. He also stated, that he views the part performed by ozone in the atmosphere as being similar to that performed by protein in the blood; the latter giving oxygen for the disorganisation of worn out tissues in the animal economy,—the former giving oxygen to the products of decomposition and putrefaction, and rendering them innocuous or salutary compounds. With these views he has used phosphorus as a disinfectant; and from the results he has obtained, he believes that by using ozone artificially formed by the action of phosphorus in localities tainted with the products of putrefaction, just in sufficient quantity to tinge the usual test-paper, all diseases of the pythogenic class would be prevented. Although the data are too few to theorise upon, Dr Moffat hoped that he would be excused for pushing the matter beyond a simple statement of facts and observations, as many facts had been observed in nature which strongly corroborated all he had advanced. Ozone, he observed, is in all probability formed wherever there is phosphorescence; and this is by no means an uncommon phenomenon. It is seen in life and in death, in the animal and vegetable kingdoms, and in the mineral kingdom. Here many instances of phosphorescent bodies were enumerated, among which the night-shining Nereis was named as becoming particularly brilliant with a direction of wind from points of the compass between east and south; and the fact that the sea becomes luminous on the approach of storms by marine animals floating on its surface was noticed. Many phosphorescent minerals were named,—the fluor spar being particularly pointed out as being not only phosphorescent on slight increase of temperature, but as giving off ozone. The author concluded by observing, that it is not improbable that atmospheric ozone is formed by the phosphorescence of these and similar bodies, and pointed to the absence of ozone and weak magnetic action during cholera periods, which are periods of non-luminosity, and to the disappearance of cholera with the setting in of the equatorial current, which is ozoniferous and favourable to luminosity. The aurora, the author thinks, may yet be proved to be a display of luminosity.

Description of a Rapid Dry Collodion Process. By Mr T. Sutton.

Remarks on Ozone. By Mr E. J. Lowe.

On the Essential Oil of Bay, and other Aromatic Oils. By Dr J. H. Gladstone.

On the Existence of Aniline in certain Fungi, which become blue in contact with the Air. By Dr T. L. Phipson.

On the Artificial Formation of Populine, and on a New Class of Organic Compounds. By Dr T. L. Phipson.

Analysis of the Diluvial Soil of Brabant, &c., known as the Limon de la Hesbaye. By Dr T. L. Phipson.

Notes on the Decomposition of the Organo-Metallic Radicles. By Mr G. B. Buckton.

On the Mode of preparing Carbonic Acid Vacua. By Mr J. P. Gassiot.

On the Synthesis of some Hydro-Carbons. By Mr W. Odling.

Modification temporaire et permanente apportée par la Chaleur à certaines Propriétés Optiques du Feldspath orthose, de la Cymophane et de la Brookite. By M. A. Des Cloizeau.

On the Adulteration of Linseed Cake with Nut Cake. By Mr W. H. Harris.

On a Photolithographic Process adopted by the Government of Victoria for the Publication of Maps. By Mr J. W. Osborne.—The process was first adopted by the Government in September 1859, and has since been extensively used, and many hundreds of maps and plans produced by its means. The object of the process was the reproduction of drawings and engravings in black and white, without the gradations known as half-tone. For this purpose a perfect negative must first be obtained by the ordinary methods. From this a photographic positive is printed by the agency of light on paper, which has received a coating of a mixture of gelatine, albumen, and bichromate of potash. The action of light on this compound is to render such parts as are subjected to its action insoluble in water. The positive so obtained is covered entirely by lithographic transfer ink. This done, the paper is floated, with its inked side upwards, upon a tray of boiling water. By this process the ink is fused, the albumen is coagulated, and the gelatine, not rendered insoluble by the action of light, is softened. When these effects are completed, gentle friction with a sponge removes the ink and the gelatine from all parts of the paper, except those which form the image to be produced. The resulting picture is a positive transfer, which is transferred to the stone in the usual manner employed by lithographic printers. The result is an image on stone, from which any number of copies may be produced by the ordinary process of lithographic printing.

On the Principles upon which Atomic Weights should be determined. By Mr G. C. Foster.

On the Nomenclature of Organic Compounds. By Mr W. Odling.

On Schönbein's Antozone. By Dr G. Harley.

On the Action of Nitric Acid upon Pyrophosphate of Magnesia. By Mr D. Campbell.

On the Manufacture of Hydro-carbon Oils, Paraffin, &c., from Peat. By Dr B. H. Paul.—The author described the results that had been obtained at some works lately erected under his direction in the island of Lewis, N.B. The peat of that locality was described as a peculiarly rich bituminous variety of mountain peat, yielding from five to ten gallons of refined oils and paraffin from the ton.

On a Particular Case of Induced Chemical Action. By Mr A. Vernon Harcourt.

On the Nature of Nitrogen, and the Theory of Nitrification. By Mr T. Sterry Hunt.

On some Principles to be considered in Mineralogical Classification. By Mr T. Sterry Hunt.

On Hypobromous Acid. By Professor H. E. Roscoe.

On the Essential Oils and Resins from the Indigenous Vegetation of Victoria. By Mr J. W. Osborne.—Mr Osborne drew the attention of the Section to the abundance of essential oils of indigenous growth in the colony of Victoria. The vegetation yielding them was to be found everywhere, forming in many instances large forests of miles in extent. Mr Osborne stated that the yield was in most cases exceedingly large; for instance, the *Eucalyptus amygadalina*, a very large forest tree, bore leaves which, with the twigs to which they were attached, gave, in the green state, as much as three pints of the oil from 100 lb. of the fresh material. Thirty-five specimens of oils were exhibited, all of which were possessed of valuable properties; some were of value as medicines, others as perfumes, and the great majority would be serviceable in the arts as solvents for resins used in the manufacture of varnishes, and also for illuminating purposes, for which they were well adapted, as they burnt with a very white and clear light in lamps adapted for the consumption of paraffin oil, and were safe, inasmuch as they were ignited with great difficulty. The trees yielding these valuable products covered an area of the colony equal to 12,000,000 acres. Mr Osborne next referred to the resins of the colony from the gum-trees or species of Eucalyptus, the *Callitris verrucosa* and *cupressiformis*, from the *Xanthorrhœa australis* and the various species of the Acacia, and described some of their properties and the purposes for which they were adapted.

On the Effects of Different Manures on the Mixed Herbage of Grass Land. By Mr J. B. Lawes and Mr J. H. Gilbert.

On some of the Difficulties arising in the Practice of Photography, and the Means of Removing them. By Mr M. Lyte.

On a Simple Method of taking Stereomicro-photographs. By Mr C. Heisch.

On Ferrous Acid. By Dr W. Odling.

On the Means of observing the Lines of the Solar Spectrum due to the Terrestrial Atmosphere. By Dr J. H. Gladstone.

On the Decay and Preservation of Stone employed in Building. By Dr B. H. Paul.

On Aërolites from India. By Professor N. S. Maskelyne.

On Columbite from Monte Video. By Professor N. S. Maskeylne.

Section C.—(*Geology.*)

On a Whittled Bone from the Barnwell Gravel. By Mr H. Seeley.

On a Deep Well at Norwich. By J. Crompton, Esq.

On a Tertiary Bituminous Coal in Transylvania, with some Notice of the Brown Coals of the Danube. By Professor Ansted.

On the Alluvial Deposits of the Rhine. By Mr R. A. C. Godwin-Austen.

On an Ancient Sea Beach and Bed at Fort-William. By Mr J. G. Jeffreys.

On the Wokey Hole Hyæna-Den. By Mr W. Boyd Dawkins.—Mr Dawkins described the peculiar features of the den—its accidental discovery, it being filled up to the roof with *debris*, stones, and organic remains—and showed the evidence of human occupation. In three areas in the cave he found ashes of bone, and especially of the *Rhinoceros tichorhinus*, associated with flint and chert implements of the same type as those of Amiens and Abbeville, and to those of the south-west of England. They were, however, of ruder workmanship, and possibly are of an earlier date. They were found underlying lines of peroxide of manganese, and of comminuted bone, and overlying in one of the three areas remains of the hyena, which mark the old floors of the cave. From this he inferred that man, in one of the earlier, if not the earliest, stages of his being, dwelt in this cave, as some of the most degraded of our race do at present; that he manufactured his implements and his weapons out of flint brought from the chalk downs of Wilts, the least fragile chert of the greensand of the Black-down hills, and arrow heads out of the more easily-fashioned bone. Fire-using, indeed, and acquainted with the use of the bow, he was far worse armed with his puny weapons of flint and bone than his contemporaries with their sharp claws and strong teeth. The very fact that he held his ground against them shows that cunning and craft more than compensated for the deficiency of his armament. Secondly, that as he was preceded in his occupation, so was he succeeded by the hyena. He then gave a brief summary of the organic remains found, comprising upwards of 1000 bones, 1015 teeth, and 156 jaws belonging to the lion, wolf, fox, bear of two species, badger, *Hyæna spelæa*, ox, deer of six species, Irish elk, horse, and rhinoceros of two species. One of the latter, *Rhinoceros hemitœchus*, stamps the date of the cave as belonging to the preglacial; while the rest of the organic remains belong to the Fauna, typical of the postglacial period.

On the Last Eruption of Vesuvius. By Dr Daubeny.

(This paper appears in the present number of this Journal.)

On an Extinct Volcano in Upper Burma. By Mr W. T. Blanford.

On the Comparative Structure of Artificial and Natural Igneous Rocks. By Mr H. C. Sorby.

On the Skiddaw Slate Series. By Professor Harkness.

Contributions to Australian Mesozoic Geology. By Mr C. Moore.

On the Co-relation of the Slates and Limestones of Devon and Cornwall with the Old Red Sandstone of Scotland. By Mr W. Pengelly.

On the Gold-fields of Auckland, New Zealand. By Dr W. L. Lindsay.

On the Gold-fields of Otago, New Zealand. By Dr W. L. Lindsay.

On the Tooth of a Mastodon, from Tertiary Marls near Shanghai, China. By Professor Owen.

On the Cause of the Difference in the State of Preservation of different kinds of Fossil Shells. By Mr H. C. Sorby.

On the Identity of the Upper Old Red Sandstone with the Uppermost Devonian (the Marwood Beds of Murchison and Sedgwick), and of the Middle and Lower Old Red with the Middle and Lower Devonian. By Mr J. W. Salter.

On a Skull of the Rhinoceros tichorhinus. By Mr S. P. Saville.

Supplementary Report on Slaty Cleavage—Theoretical Considerations. By Professor Phillips.

Preliminary Report of the Committee for Investigating the Chemical and Mineralogical Composition of the Granite of Donegal, and the Associated Rocks. By Dr T. Sterry Hunt.

On Ossiferous Caves in Malta, explored by Capt. Spratt, R.N., with an Account of Elephas Melitensis, *a pigmy species of Fossil Elephant, and other Remains found in them.* By Dr Falconer.

On the Glacier Phenomena of the Valley of the Upper Indus. By Capt. Godwin-Austen.

On the Diluvial and Alluvial Deposits of Central Germany, and on the Climate of the Period. By Dr K. von Seebach.

On the Fossils of the Boulder-clay in Caithness. By Mr C. W. Peach.

Notice of some Mammalian Remains from the Bed of the German Ocean. By Mr C. B. Rose.

On Specimens of Flint Implements from North Devon. By Rev. J. Dingle.

Exhibited, Flint Implements from Abbeville and Amiens. By Dr Daubeny.

Exhibited, some Flint Implements from Amiens. By the Rev. G. T Bonney.

Exhibited, Flint Implements from Hoxne. By Mr Doughty.

Exhibited, some Models of Foraminifera. By Dr Fritsch.

On Bituminous Schists and their Relation to Coal. By Professor Ansted.

On the Palæontology of Mineral Veins and the Oolitic Age of some of the Mineral Veins in the Carboniferous Limestone. By Mr C. Moore.

On the Fossil Feathered Animal (Griphosaurus of Wagner, Palæopteryx of Von Meyer) found in the Lithographic Slate of Pappenheim. By Professor Owen.

On an Early Stage in the Development of Comatula, *and its Palæontological Relations.* By Professor Allman.—The subject of this communication was a small Echinodermatous animal, a single specimen of which was obtained by the author on the south coast of Devon, where it was found attached to one of the larger sertularidæ, dredged from about four fathoms depth. The author regarded it as one of the early stages in the development of Comatula, and believed that it had been witnessed both by Thompson and Dujardin, though not correctly described or figured by either of these naturalists. It consisted of a body borne upon the summit of a long jointed stem. The body had the form of two pyramids placed base to base. The upper pyramid is formed of five triangular valve-like plates, moveably articulated upon the upper side of the lower pyramid, and capable of being separated from one another at the will of the animal, so as to present the appearance of an expanding flower-bud, and again approximated till their edges are in contact, and the original pyramidal form restored. From between the edges of these plates, long flexile spiniferous arms, which must not be confounded with the permanent arms of Comatula, are protruded in the expanded state of the animal, and within these is a circle of shorter, more rigid, rod-like appendages, which seem to be moveably articulated to the upper side of the calyx, immediately round the centre, where it is almost certain that the mouth is placed. The lower pyramid or proper calyx is mainly formed of five large hexagonal plates, separated from the summit of the stem by a zone, whose composition out of distinct plates could not be demonstrated, and having five small tetragonal plates intercalated between their upper angles. In assigning their proper value to the several plates thus entering into the body, the author regarded the lower zone, which rests immediately on the stem, as simply a metamorphosed joint of the stem itself, while the verticil of plates, situated immediately above this, is the true basilar portion of the calyx. The five small intercalated plates are the equivalents of the *radialia*, and destined to carry afterwards the true arms of the crinoid; while the five triangular plates which constitute the sides of the upper pyramid are *interradialia*. Professor Allman considered the little animal described in this communication as of special interest, in the light which it seemed capable of throwing on the real nature of certain aberrant groups of *Crinoidea*, such as *Haplocrinus*, *Coccocrinus*, &c., in which the calyx supports a more or less elevated pyramidal roof, composed entirely or in great part of five triangular plates, which find their homologues in the five sides of the pyramidal roof of the little crinoid, which formed the subject of his paper.

On the Origin and Mode of Occurrence of the Petroleum of North America. By Dr T. S. Hunt.

On the Structure and Origin of certain Limestones and Dolomites. By Dr T. S. Hunt.

On the Gold-bearing Strata of Merionethshire. By Mr T. A. Readwin.

On the Geology of a Part of Sligo. By Mr A. B. Wynne.

Exhibited, some of the Six-inch Geological Maps of the Burren District, County Clare, Ireland, by Mr F. J. Foot.

On a Plesiosaurus from the Lias of Whitby. By Dr A. Carte and Mr W. N. Baily.

Report of a successful Search for Flint Implements in a Cave called "The Oyle," near Tenby, South Wales. By Mr G. N. Smith.

Exhibited, some Scutes of the Labyrinthodon, from the Keuper Bone-Breccia of Pendock, Worcestershire, by the Rev. W. S. Symonds.

On New Fossil Fishes from the Old Red Sandstone of Caithness. By Mr C. W. Peach.

Section D.—(*Zoology and Botany, including Physiology*).

On the Infloresence of Plants. By Mr J. Gibbs.

On two Aquatic Species of Hymenoptera, one of which swims with its wings. By Mr J. Lubbock.

Exhibition of a Specimen of Astarte compressa, *having its hinge-teeth reversed.* By Mr J. Jeffreys.

On the Toot-poison of New Zealand. By Dr W. Lauder Lindsay.

On the Influence of the Conditions of Existence in modifying the Characters of Species and Varieties. By the Rev. W. N. Molesworth.

Experiments with the Seed of Malformed Roots, and on the Ennobling of Roots, with particular reference to the Parsnip. By Mr J. Buckman.

Recent Experiments on Heterogenesis, or Spontaneous Generation. By Mr J. Samuelson.

On the Zoological Significance of the Brain and Limb Characters of Man, with Remarks on the Cast of the Brain of the Gorilla. By Professor Owen.—Professor Owen exhibited two casts, one of the human brain, which had been hardened in spirits, and had therefore not preserved its exact form; but to all intents and purposes it would serve as an illustration of the human brain. The other cast was taken from the interior of the cranium of the gorilla. From an examination of these, the difference between the brain of man and that of monkeys was at once perceptible. In the brain of man, the posterior lobes of the cerebrum overlapped, to a considerable extent, the small brain or cerebellum; whereas in the gorilla, the posterior lobes of the cerebrum did not project beyond the lobes of the cerebellum. The posterior lobes in the one were prominent and well marked; in the other, deficient. These peculiarities had been referred to by Todd and Bowman. From a very prolonged investigation into the characters of animals, he felt persuaded that the characters of the brain were the most stedfast; and he was thus induced, after many years of study, to propose his classification of the mammalia, based upon the differences in the development of their brain structure. He had placed man —owing to the prominence of the posterior lobes of his brain, the existence of a posterior cornu in the lateral ventricles, and the presence of a hippocampus minor in the posterior cornu—in a distinct sub-kingdom, which he had called Archancephala, between which and the other members of the mammalia the distinctions were very marked, and the rise was a very abrupt one. The brain, in his estimation, was a far better guide in classifying animals than the foot; but the same difference that existed between their brains was also observable between their feet. The lecturer referred to a diagram which represented the feet of the aye-aye, the gorilla, and man, pointing out the chief differences in the structure of the skeleton. These differences he considered sufficiently great to elevate man from the sub-kingdom to which the monkeys belonged, and to place him in a distinct sub-kingdom by himself.

Professor Huxley observed that the paper just laid before the Section appeared to him in no way to represent the real nature of the problem under discussion. He would therefore put that problem in another way. The question was partly one of facts, and partly one of reasoning. The question of fact was, What are the structural differences between man and the highest apes?—the question of reasoning, What is the systematic value of those differences? Several years ago, Professor Owen had made three distinct assertions respecting the differences which obtained between the brain of man and that of the highest apes. He asserted that three structures were "peculiar to and characteristic" of man's brain—these being the "posterior lobe," the "posterior cornu," and the "hippocampus minor." In a controversy which had lasted for some years, Professor Owen had not qualified these assertions, but had repeatedly reiterated them. He (Professor Huxley), on the other hand, had controverted these statements, and affirmed, on the contrary, that the three structures mentioned not only exist, but are often better developed than in man, in all the higher apes. He (Professor Huxley) now appealed to the anatomists present in the Section, whether the universal voice of Continental and British anatomists had not entirely borne out his statements and refuted those of Professor Owen. Professor Huxley discussed the relations of the foot of man with those of the apes, and showed that the same argument could be based upon them as on the brain,—that argument being, that the structural differences between man and the highest ape are of the same order and only slightly different in degree from those which separate the apes one from another. In conclusion, he expressed his opinion of the futility of discussions like the present. In his opinion, the differences between man and the lower animals are not to be expressed by his toes or his brain, but are moral and intellectual.—Professor Rolleston said he would try and supply the members of the Association with the points of positive difference between the human and the ape brain. For doing this we had been abundantly shown that the hippocampus minor and the posterior lobe were insufficient. As differentive, they must be given up at last. But as much had recently been done for the descriptive anatomy of the brain by Gratiolet and others, as had been done for astronomy by Stokes and Adams, for language by Max Müller, and that this had been ignored in this discussion, was little creditable to British science. This analysis of the brain's structure had established as differentive between man and the ape four great differences—two morphological, two quantitative. The two quantitative are the great absolute weight and the great height of the human brain; the two morphological, the multifidity of the frontal lobes corresponding to the forehead, usually, popularly, and, as this analysis shows, correctly, taken as a fair exponent of man's intelligence, and the absence of the external perpendicular figure. This had been abundantly shown by Gratiolet. No reference to these most important matters had been made by Professor Owen; and this omission could not fail to put the British Association's repute for acquaintance with the works of foreign fellow-labourers at great disadvantage in the eyes of such foreigners as might be present. Professor Rolleston concluded by saying that if he had expressed himself with any unnecessary vehemence, he was sorry for it; but that he felt there were things less excusable than vehemence, and that the laws of ethics and love of truth were things higher and better than were the rules of etiquette or decorous reticence.—Mr W. H. Flower, looking at the subject solely in the anatomical view and as a question of fact, stated that the result of a considerable number of dissections of brains of various monkeys was that the distinction between the brain of man and monkeys did not lie in the posterior lobe or the hippocampus minor, which parts were proportionately more largely developed in many monkeys than in man, and that if these parts were used in the classification of man and the monkeys the series would be,—first, the little South American marmosets; then would follow the baboons, the cercopithea, macaque; then man must be placed, followed by the anthropoid apes, the orang-outang, chimpanzee, and gorilla; and last, the American howling monkey.—Dr Humphry thought that slight differences of structure might lead to vast functional results, and that a moral hiatus might be greatly out of proportion to any mere physical distinction.—Professor Owen replied that Professor Rolleston had led the meeting to conclude that he had not paid any attention to the convolutions of the brain of mammals, and that the investigation of this subject was the exclusive property of the German anatomists, whereas he might be permitted to state, that almost at the very time that Leuret wrote his memoir on this subject, he had delivered a course of lectures on the convolutions of the brain, which he regretted had not been published, owing to the pressure of other labours; but the diagrams were still in existence, as his successor could testify, in the Museum of the Royal College of Surgeons.

On the Homologies of the Bones of the Head of the Polypterus niloticus. By Professor R. Owen.

On the Characters of the Aye-aye, as a test of the Lamarckian and Darwinian Hypothesis of the Transmutation and Origin of Species. By Professor R. Owen.

Observations of the Habits of the Aye-aye living in the Gardens of the Zoological Society, Regent's Park, London. By Mr A. D. Bartlett.

On Ribs and Transverse Processes, with special relation to the Theory of the Vertebrate Skeleton. By Dr Cleland.

On the Structure of Corymorpha Nutans. By Professor Allman.—The body of the polype was described as presenting a continuous cavity, as far back as the zone of posterior tentacula. From the floor of this cavity a large conical mass of vacuolated endoderm projects forwards, and nearly fills the posterior wider part of the cavity, whose extension backwards seems at first sight not to be continued beyond the zone of posterior tentacula. There is here, however, in reality, no interruption of the general body-cavity, for the axis of the conical projecting mass of endoderm is perforated by a channel, which thus continues the cavity backwards to the summit of the stem.

A system of inosculating longitudinal tubular vacuolæ was described as existing in the stem; they are indicated externally by the longitudinal coloured lines visible even by the naked eye. At the summit of the stem they coalesce, and become continuous with the cavity of the body. In these tubes, distinct currents similar to those so long known in the stem of *Tubularia indivisa*, were occasionally very perceptible under the microscope.

Under a high power of the microscope, delicate parallel longitudinal striæ may be detected, lying externally to the tubular vacuolæ; they are situated between the ectoderm and endoderm, and may be traced upwards on the body of the polype, as far at least as the zone of posterior tentacula; they seem to consist of fine tubular fibres, and are apparently the equivalent of the fibres (muscular?) visible beneath the ectoderm of *Clava*, *Coryne*, &c. Still finer circular striæ may also be occasionally witnessed under a high power running transversely round the stem; but the author could not determine whether these represent fibres or mere rugæ in the ectoderm.

The gonophores are medusiform, and were described as belonging to the generic type of *Steenstrupia* (Forbes). They were liberated in abundance from the specimens examined. The generative elements were not visible in any of the medusoids at the time of their liberation; but the author obtained from the same part of the sea where the Corymorpha occurred, a free *Steenstrupia* a little larger than the medusoids of the present species, at the time when they become detached, but which he did not hesitate to consider as identical with them, and in this the generative elements were quite distinct between the ectoderm and endoderm of the manubrium.

The species of Corymorpha which constituted the subject of this communication was considered by the author as identical with *C. nutans* (Sars), though it does not entirely agree with the diagnosis of this species as given by Sars. It was discovered in the Firth of Forth last summer.

On the Change of the Form of the Head of Crocodiles; and on the Crocodiles of India and Africa. By Dr Gray.—Dr Gray stated that the crocodile, when first hatched, has the front of the face short and rounded, even in those that have an elongated beak in the adult state. The nose of the different species lengthens and gradually assumes the form which is the character of the kind; and it is at this age that the peculiar form of the different kinds are best examined and compared. After the animal has assumed its adult size, the bones of the head dilate on the side, and the forehead and nose become more swollen. The change of form thus produced is so great, that some naturalists have regarded them as distinct species. This dilation of the sides and increase in thickness of the bones of the head are doubtless produced to support the large teeth which are developed as these animals attain their adult age. The author observed that this was a good instance, as showing the necessity of studying all kinds of animals in all their stages of growth, and under different circumstances. He stated that no species could be said to have been properly observed until all these circumstances had been examined and noted; and that though the notice of a single individual or state of an animal was useful, it could only be regarded as a sign-post, indicating the existence of an animal which required further study and examination. Dr Gray then proceeded to speak of the African crocodile. He observed that Adanson mentioned three crocodiles as found in the Senegal. Cuvier, in his monograph, thought that Adanson had made some mistake, and makes some very severe remarks on the inaccuracies of travellers; but more recent researches had shown that in this case the traveller was correct, and the philosopher at fault. Adanson mentions the green and the black crocodile and the gavial of Senegal. There can be no doubt, from the specimens which are in the British Museum from West Africa, that Cuvier was right in regarding the green crocodile as the crocodile also found in the rivers on the north and southern parts of Africa. Cuvier, on the other hand, considered the black crocodile of Adanson was identical with the alligator with bony eyebrows found in South America. This is not the case; for there is a black crocodile found in West Africa, which is often imported into Liverpool; and there are specimens in the British and Liverpool Museums, and some young ones living in the Zoological Gardens in the Regent's Park: it is a true crocodile, but peculiar from having three long plates in the eyelids, and it is probably this peculiarity that misled Cuvier. It is to be observed that the French naturalists have not yet discovered this fact; for Dr Gray stated that he had recently purchased from the French Museum the skeleton of this African black crocodile under the name of *Alligator pulpebrosus* from the Brazils, and there is little doubt that it must have been the examination of the skull of this animal that induced some zoologists to believe that some specimens of alligators had the teeth sometimes fitted into notches in the margin, as in the crocodiles, while in fact they were observing the skull of a true crocodile, and not an alligator. The gavial of Senegal of Adanson is most like the *Crocodilus cataphractus* of Cuvier, which has a long nose like a gavial, but is a crocodile; this animal has been re-described under various names. Dr Gray stated that the crocodiles of India had been much misunderstood: some authors said the common crocodile of Africa was found in India, others confused more than one species under the name of *C. palustris*. There are four species found in India: two are confined to the estuaries or the mouth of rivers where the water is brackish, as *Crocodilus porosus* or *biporcatus*, which is found on all parts of the coast, and also in the islands of Java and Borneo, and even on the north coast of Australia; and the other is a new species confined, as far as we at present know, to the coast of Pondicherry. The latter is only known, from a specimen lately received (French), as *Crocodilus biporcatus*. The other two are confined to the inland rivers; and they are sometimes found high up in the mountains where the water of the river is frozen. It is to be observed that these river-crocodiles, which have been confounded with the African kinds, are known from them by the short, broad shape of the intermaxillary bone, which is separated from the maxilla by a straight suture; while in the crocodiles of the African rivers the intermaxillary bone is produced behind and between the edge of the maxilla. One species is generally distributed over distant parts of India; the other is confined to Siam, and is probably the animal described by the French missionaries, though the specimen in the British Museum has no crest on the occiput; but Dr Gray believes that this might be either an effect of age, or an individual peculiarity.

Report on the Mercantile Marine. By Dr Collingwood.

On Geoffrey St.-Hilaire's Distinction between Catarrhine and Platyrrhine Quadrumana. By Dr Collingwood.

A Suggestion for the Physiological Classification of Animals. By Mr J. Hinton.

On a New Form of Echinodermata. By Professor Allman.

On Zoological Provinces. By Sir J. Richardson.

On Marriages of Consanguinity. By Dr G. Child.

On the Production of similar Medusoids by certain Hydroid Polypes belonging to different Genera. By the Rev. T. Hincks.

On the Generative Zooid of Clavatella. By Professor Allman.

On New Species of Tubularidæ. By Professor Allman.—The author gave the following diagnoses of new species of *Tubularidæ*, which he had obtained during the autumn of 1862 on the coasts of Shetland and Devonshire.

Clava diffusa (Mihi).—*Polypes* about ¼ of an inch in height, light rose colour, developed at intervals upon a creeping reticulated stolon;

tentacula about twenty. *Gonophores* scattered, commencing just behind the posterior tentacula, and thence extending singly, or in small clusters, for some distance backwards upon the body of the polype. In rock pools at low water spring tides. Out Skerries, Shetland Isles.

Tubiclava (Mihi, Nov. Gen.)—*Polype* claviform, supported on the summit of free stems, which rise at intervals from a creeping stolon, and are invested by a chitinous polypary ; tentacula filiform, scattered. *Gonophores*, dense clusters of sporosacs aggregated immediately behind the posterior tentacula.

T. lucerna (Mihi).—*Zoophytes* about two lines in height ; stems quite simple, or rarely with a short lateral branch ; polypary clothing the stem, corrugated, dilated at the base of the polype ; pale yellowish brown. *Polype*, when extended, about equal to the stem in height ; white, with pale ochreous centre ; tentacula about twenty, confined to the anterior third of the polype. Creeping over the surface of loose stones in the bottom of a rock pool, Torquay. On stones between tide marks, Dublin Bay.

Eudendrium humile (Mihi).—*Zoophyte* delicate, rising to about $\frac{3}{4}$ths of an inch in height, much and irregularly branched ; main stems and branches distinctly annulated throughout. *Polype* yellowish vermilion, vase-shaped, with a circular groove near its base and a trumpet-shaped proboscis ; tentacula twenty or twenty-three, with the alternate ones elevated and depressed in extension. *Gonophores* (male) surrounding the body of the polype, and springing each by a short stalk from the circular groove, which passes round the polype near its base, each gonophore consisting of two super-imposed chambers. Female gonophores borne both by the base of the polype and by the cœnosarc immediately behind it. Rooted to the bottom of rock pools near low-water spring-tides, Torquay.

Eudendrium vaginatum (Mihi).—*Zoophyte* much branched, rising to about an inch and quarter in height, polypary deeply and regularly annulated throughout. *Polypes* vermilion, with about eighteen tentacula, and having the body, as far as the origin of the tentacula, enveloped in a loose, corrugated membranous sheath, which loses itself posteriorly upon the polypary. *Gonophores* not known. In rock pools at extreme low-water spring-tides, Shetland.

Perigonymus serpens (Mihi).—*Zoophyte* consisting of short, simple, erect stems, about two lines in height, terminated by the polypes, and rising at short intervals from a creeping stolon, which forms an irregular net-work upon the surface of other bodies, the whole of the stems and stolon occupied by a reddish orange cœnosarc, and clothed with a delicate transparent polypary, which does not form a cup-like dilatation at the base of the polypes. *Polypes* reddish orange, with about twelve or fourteen tentacula, so disposed that in complete extension they are held with alternate tentacula elevated and depressed ; body of polype oval, with proboscis conical. *Gonophores* medusiferous, borne by the creeping stolon, and elevated each upon a rather long peduncle. *Medusoids* dome-shaped, with the vertical slightly exceeding the transverse diameter. Manubrium reaching to about one half the depth of the bell, with a simple mouth destitute of tentacula ; marginal tentacula two, opposite, very extensile, and with large reddish orange bulbous bases, without evident ocelli ; the intermediate radiating canals terminating each in a very small bulbous dilatation. Growing over the stems of *Plumularia setacea ;* dredged from about 12 fathoms, Torbay.

Perigonymus minutus (Mihi).—*Zoophyte* very minute, consisting of simple stems rising to the height of about a line and half from a creeping stolon, and bearing the polypes upon their summit ; polypary dilated round the base of the polype. *Polypes* ash-brown, with seven or eight, rarely twelve, tentacula, held irregularly during extension, and with little or no curvature. *Gonophores* piriform, medusiferous, borne at various heights upon the stem, and supported on rather long peduncles. *Medusoid* with the summit suddenly contracted so as to give a somewhat conical form to the umbrella; two opposite radiating canals terminating each in a pale-brown bulb which is continued into a very extensile filiform tentaculum, the alternate two canals terminating each in a much smaller bulb without tentacle; no evident ocellus; manubrium short, with a four lobed lip, but without oral tentacula. Forming a fringe round the edge of the operculum of *Turitella communis* dredged in Busta Voe, Shetland. Out of between twenty and thirty specimens of living Turitella examined, not one was free from this remarkable little zoophyte.

Perigonymus Muscus (Mihi).—*Zoophyte* consisting of numerous erect stems about ½ an inch in height, not composed of coalesced tubes, springing at intervals from a creeping stolon, and sending off short branches, which are themselves, for the most part, without further ramification; polypary light brown, slightly corrugated, and with a well-marked cup-like dilatation at the base of the polype. *Polypes* semi-retractile, light reddish-brown, with about sixteen tentacula directed in extension alternately backwards and forwards. *Gonophores* medusiferous, borne upon a rather long peduncle, and springing from the branches at a short distance behind the polype. *Medusoid* dome-shaped, with the four radiating canals terminating below each in a large reddish bulb, which sends off two very extensile filiform tentacula, having an ocellus at the base of each; manubrium extending to about a third of the entire depth of the umbrella, and with four short oral tentacula. The medusoid is thus, in all points, undistinguishable from that of *Perigonymus ramosa*, Van Beneden. In a rock pool, Torquay, where it occurred abundantly, creeping over the bottom in small moss-like tufts.

Tubularia Bellis (Mihi.)—Basal portion of *Cœnosarc* prostrate, creeping and sending up short, free, sparingly branched stems, which rise to three-fourths of an inch or one inch in height; polypary where it covers the lower part of the stems and the whole of the prostrate portion marked by wide but distinct annulations; cœnosarc orange, deepening in tint towards the base, expanding into a collar immediately below the polypes. *Polypes* measuring in full-sized specimens about five lines from tip to tip of the extended tentacula; body of polype scarlet. *Gonophores* borne upon short erect branched peduncles, each gonophore with four well-marked tentaculoid tubercles on its summits, peduncles and spadis scarlet. A beautiful little zoophyte conspicuous by the bright colour and large size of its polypes. It occurs attached to the bottom of rock pools at extreme low-water spring tides, Shetland.

Report on the Reproduction of the Hydroida. By Professor Allman.

Report of the Dogger-Bank Dredging Expedition. By Mr H. T. Mennell.

Report of the Committee for Dredging on the North and East Coasts of Scotland. By Mr J. G. Jeffreys.

On a Species of Limopsis now living in the British Seas, with Remarks on the Genus. By Mr J. G. Jeffreys.

On the Cultivation of the Salmon Fisheries. By Dr Davy.

On the Occurrence of Asplenium viride *on an Isolated Travertine Rock among the Black Mountains of Monmouthshire.* By the Rev. W. S. Symonds.

Notice of some Objects of Natural History lately obtained from the Bottom of the Atlantic. By Professor W. King.

Exhibited, a Botanical Chart of the Barony of Burren, County Clare, by Mr F. J. Foot.

Remarks upon the Natural History of the Herring. By Professor Huxley.

Notes on Sphærularia Bombi. By Mr J. Lubbock.

Reply to the Remarks of Mr F. Marcett on the Power of Selection ascribed to the Roots of Plants. By Dr Daubeny.

(This Paper appears in the present number of this Journal.)

Sub-Section D.—(*Physiology.*)

On the Study of the Circulation of the Blood. By Dr G. Robinson.

On Simple Syncope as a Coincidence in Chloroform Accidents. By Dr C. Kidd.

On the Physiological Effects of the Bromide of Ammonium. By Dr G. D. Gibb.

Observations on the Earth-Worm. By Dr J. Davy.

Remarks on all the known Forms of Human Entozoa. By Dr T. Spencer Cobbold, F.L.S. This paper was accompanied by an extensive series of highly finished and original drawings, as well as by a tabulated record of the various species, arranged in the following manner:—

Trematoda.	1. *Fasciola hepatica*, Linnæus.
	2. *Distoma crassum*, Busk.
	3. *Distoma lanceolatum*, Mehlis.
	4. *Distoma ophthalmobium*, Diesing.
	5. *Distoma heterophyes*, Siebold.
	6. *Bilharzia hæmatobia*, Cobbold.
	7. *Tetrastoma renale*, Chiaje.
	8. *Hexathyridium Pinguicola*, Trentler.
	9. *Hexathyridium venarum*, Trentler.
Nematoda.	10. *Ascaris lumbricoides*, Linnæus.
	11. *Ascaris mystax*, Rudolphi.
	12. *Trichocephalus dispar*, Rudolphi.
	13. *Trichina spiralis*, Owen.
	14. *Filaria medinensis*, Gmelin.
	15. *Filaria lentis*, Diesing.
	16. *Strongylus bronchialis*, Cobbold.
	17. *Eustrongylus gigas*, Diesing.
	18. *Sclerostoma duodenale*, Cobbold.
	19. *Spiroptera hominis*, Rudolphi.
	20. *Oxyuris vermicularis*, Bremser.
Cestoda.	21. *Tænia solium*, Linnæus.
	22. *Tænia mediocanellata*, Kuchenmeister.
	23. *Tænia acanthotrias*, Weinland.
	24. *Tænia flavopuncta*, Weinland.
	25. *Tænia marginata*, Batsch.
	26. *Tænia echinococcus*, Siebold.
	27. *Tænia nana*, Siebold.
	28. *Tænia elliptica*, Batsch.
	29. *Bothryocephalus latus*, Bremser.
	30. *Bothryocephalus cordatus*, Leuckart.

As will be seen by this list, the author finds that the Cestodes, Nematodes, and Trematodes are pretty equally divided as regards the number of species respectively liable to invade the human body; and although he has thus furnished a total of no less than thirty distinct forms, yet he has considerably reduced the number of presumed species by including all the larval *Cysticerci* under the adult titles to which they are severally referable. Dr Cobbold brought forward a number of novel views respecting the structure, habits, mode of development, and production of particular species, and he gave the results of several experiments which he had conducted with the purpose of establishing their genetic relations. He especially remarked upon the fearful destruction of human life which the larvæ of *Tænia echinococcus* occasion in Iceland, and he suggested certain precautionary measures calculated to check the progress of this endemic. Since the reading of the paper, the author has added other details, and has thus expanded the communication into a considerable memoir, which will shortly be published, *in extenso*, in the 3d part of the "Proceedings of the Zoological Society of London" for 1862.

On Tobacco Smoking: its Effect upon the Pulsation. By Dr Smith.—Dr Smith had ascertained that tobacco-smoking causes a large increase in the rate of pulsation in some persons, while in others no increase occurs, and hence that there is a diversity in the mode of action of this substance as there is in the admitted good or evil effects upon the body.

On the Question whether Arsenic taken for lengthened Periods in very minute Quantities is Injurious. By Dr J. Davy.

On Secret Poisoning. By Professor Harley.—Professor Harley stated that although he had no wish to engender groundless suspicions, or excite unnecessary alarms, yet he was sorry to say he could not but repeat the statement he made last year in a paper on slow poisoning, read before the Royal Medico-Chirurgical Society of London,—namely, that he believed the cases of secret poisoning that are discovered form but a small per-centage of those that actually occur. Nay, more, he even went a step farther, and declared that he not only believed that we magnified the difficulty of perpetrating the crime, but that we were also inclined to exaggerate the facility of its detection. No doubt, modern discoveries in physiology and chemistry had enabled us not only to distinguish between the effects of poison and natural disease during life, but likewise to detect and extract the poison from the tissues after death. But modern discoveries had also made known to us many poisons with which we were hitherto unacquainted. It was in toxicology as in naval warfare, no sooner was a projectile discovered that is considered irresistible, than our engineers set about discovering armour-plates more invulnerable than their predecessors. So, no sooner does the criminal find a new poison that he can use with impunity than the experts set about discovering a means for its detection. Dr Harley remarked that the great desire of the poisoner was to get hold of a poison the effect of which would so closely resemble that of natural disease as to be mistaken for it. Fortunately, however, this was attended with extreme difficulty, as the effects of poison were generally sudden in their onset and rapid in their termination; for the poisoner seldom had time or opportunity of administering the poisonous agent in so small a quantity and for such a length of time as is requisite to produce an artificial state of disease, which may be mistaken at least by the accomplished physician for real disease. It had been asserted that in all cases of poisoning where death occurred, the poison ought to be found in the tissues after death. Professor Harley, however, pointed out that this was not strictly true; for even in the case of arsenic, which was supposed to be the most persistent of all poisons, if the patient only lived along enough the mineral might be entirely eliminated by the excretions before death, and afterwards not a trace remain to be detected in the body. Such occurred in Alexander's case, when, although it was known that arsenic was the poison which caused the death, none was found in the body. Alexander, however, did not die till the sixteenth day. For this and other reasons the author then said, "that as the not finding poison in the system after death is no absolute proof that the patient did not die from its effects, the symptoms observed during life, in conjunction with the morbid appearances observed after death, even when no poison is discovered by chemical analysis, ought to be sufficient to convict the poisoner; and even the symptoms alone, if there be good circumstantial evidence, especially if combined with proof of a motive, ought to convict, just as was done at Palmer's trial."

On the Difference of Behaviour exhibited by Inuline and ordinary Starch when treated with Salivary Diastase and other converting Agents. By Professor Rolleston.

Observations made at Sea on the Motions of Vessels, with reference to their Effects in producing Sea-Sickness. By Mr J. W. Osborne.

On the Function of the Auricular Appendix of the Heart. By Mr I. Ashe.

On the Functions of the Oblique Muscles of the Orbit. By Mr I. Ashe.

On the Normal Position of the Epiglottis as determined by the Laryngoscope. By Dr G. D. Gibb.

Remarks on the Loss of Muscular Power arising from the ordinary Foot-clothing now worn, and on the means required to obviate this loss. By Mr J. Dowie.

An Attempt to show that every living Structure consists of Matter which is the Seat of Vital Actions, and Matter in which Physical and Chemical Changes alone take place. By Professor Beale.

A Tabular View of the Relation which subsists between the Three Kingdoms of Nature with regard to Organization. By Mr H. Freke.

On an Albino Variety of Crab; with some Observations on Crustaceans, and on the Effect of Light. By Mr R. Garner.

On the Termination of Motor Nerves, and their connection with Muscular Contractions. By Professor W. Köhne.

Some Observations on the Vitality of Fishes as tested by Increase of Temperature. By Dr J. Davy.

Some Observations on the Coagulation of the Blood in relation to its Cause. By Dr J. Davy.

On Pearls: their Parasitic Origin. By Mr R. Garner.

On Tobacco in relation to Physiology. By Mr T. Reynolds.

On the Skull Sutures, and their relation to the Brain. By Mr R. Garner.

Section E.—(*Geography and Ethnology.*)

Ascent of the Cameroons Mountain, West Africa. By Captain R. Burton.

On Colour as a Test of the Races of Man. By J. Crawfurd, Esq.—Colour in different races appears to be a character imprinted upon them from the beginning, because, as far as our experience goes, neither time, climate, nor locality has produced any change. Egyptian paintings 4000 years old represent the people as they are now. The Parsees in India who went from Persia are now the same as when they emigrated a thousand years ago. African negroes that have for three centuries been transported to the New World remain unchanged. The Spaniards settled in tropical America remain as fair as the people of Arragon and Andalusia. He contended that climate had no influence in determining colour in different races. Fins and Laps, though farther north, are darker than the Swedes; and within the Arctic circle we find Esquimaux of the same colour and complexion as the Malays under the Equator. Yellow Hottentots and Bushmen live in the immediate neighbourhood of Black Caffres and negroes. There is as wide a difference between the colour of an African negro and a European, between a Hindoo and a Chinese, and between an Australian and a Red American, as there is between the species of wolves, jackals, and foxes. The arguments for the unity of the human race, drawn from anatomical reasoning, would also prove that there was no difference between hogs and bears, the bovine and equine, and the canine families.—Sir C. Nicholson said that, notwithstanding the ingenuity displayed in Mr Crawfurd's paper, he could not agree in his conclusions. The variety of the human races, as they now are, had doubtless existed for a long time. Tombs of very great antiquity showed this. But there is now in India a race of Jews perfectly black; and in China the Jews had long become the same in physiognomy as the Chinese, and the Jews never intermarry. Among the natives of America there was an evident approximation to the Red Indian in physiognomy; they were assuming the hatchet face and losing the beard. The same effect could be discerned among the European population of Australia; and Sir Charles stated his opinion that the question was to be settled on philological rather than ethnological grounds.

Letter from Eastern Africa. By Dr LIVINGSTONE.

On the Proceedings of the United University Missions. By the Rev. H. C. SCUDAMORE.

Voyage on the Lake Nyassa, Eastern Africa. By the Rev. Mr STEWART.

On the Trans-Indus Frontier of British India. By Major WALKER.

On the Climate of Guernsey. By Professor ANSTED.

On Vancouver's Island. By Commander MAYNE.

An Account of the Veddahs of Ceylon. By Mr J. BAILEY.

A Journey to Harran in Padan-Aram, and thence over Mount Gilead into the Promised Land. By Dr C. T. BEKE.—In December 1861, Dr Beke, accompanied by his wife, undertook a journey to Harran, the residence of the Patriarch Terah and his descendants, and thence over Mount Gilead into the Promised Land, by the road taken by the patriarch Jacob, in his flight from his father-in-law Laban. Harran is a village situate at the eastern extremity of the plain of Damascus,—the land of Uz of the Book of Job. At the entrance from the west is a draw-well of great antiquity, which Dr Beke identifies with the well at which Abraham's steward, Eliezer of Damascus, met Rebekah. Some of the water has been analysed at the Royal School of Mines, by direction of Sir Roderick I. Murchison, and found to contain upwards of 100 grains of solid matter in the gallon. The water of a second well near the former is so impure as to be no longer fit for use; and at the present day the inhabitants obtain their chief supply of water through an artificial canal from the river Barada—the Abana of Scripture. On the first day of the present year, the travellers left Harran on their way to Mount Gilead. They first came to the river Awaj, the ancient Pharpar, forming with the Barada or Abana, the two "Rivers of Damascus," the capital of Aram or Syria; which rivers gave to *Aram Naharam*, or "Aram of the Two Rivers," its distinguishing appellation. This district, though not incorrectly called "Mesopotamia of Syria," has been supposed to be the *Mesopotamia of Assyria*, between the two rivers Euphrates and Tigris, whence have arisen considerable errors in Scripture geography and history. When, according to the Scripture narrative, Laban set "three days' journey" between his flocks and those of his son-in-law Jacob, it is reasonable to infer that the latter led his flocks in the direction best adapted for his contemplated flight from Padan-Aram, that is to say, up the left bank of the Awaj. The spot where he so crossed the river would consequently have been at or near Kiswe, a town on the great pilgrim road between Damascus and Mekka; and thence he would have proceeded south over the plains of Hauran. This is the road taken by Dr Beke; and certainly nothing could so graphically describe it as the few simple words of Scripture:—"He passed over the river, and set his face towards the Mount Gilead." A traveller, however much unacquainted with the country, has only to proceed along the high road, running straight from north to south over an almost level plain, without a mountain intervening to lead him astray, and he soon sees before him the summit of Gilead, standing out separately and distinctly, and towards it he "sets his face." The distance travelled by Jacob before Laban "overtook him in the Mount Gilead" is stated to have been "seven days' journey." Travelling much quicker than the Patriarch could have done, it was on their fifth day from Harran that Dr and Mrs Beke ascended the side of Gilead, where they soon came to some delicious springs of water in the midst of luxuriant pasturage. At such a spot the Patriarch Jacob, with his wearied flocks and herds, would naturally have stopped and pitched his "tent in the Mount," where he was overtaken by Laban. A few minutes more brought the travellers to the summit of Gilead, where they enjoyed an extensive view over the Promised Land, embracing Mount Tabor, Nazareth, Cana, Tiberias, and other places rendered ever memorable by our Lord's ministry and miracles. After the reconciliation between Laban and Jacob, it is said that "Jacob went on his way, and the angels of God met him, ... and he called the name of the place Mahanaim." Close to where Dr Beke crossed the summit of Gilead is a ruin called Mahneh, which may be looked on as representing the spot where the patriarch, on his first coming within sight of his native country after an absence of twenty years, was favoured with this manifestation of the Divine presence. Shortly after leaving the pass of the mountain Dr and Mrs Beke came to a *cromlech;* in form and appearance it is almost identical with Kits-Coty House, in Kent. Thence proceeding down Wady Ajlun, they reached the *Ghor*, or plain of the Jordan, not far to the north of Wady-Zerka, the river Jabbok of Scripture, over which the patriarch Jacob crossed before meeting his brother Esau, and where "there wrestled a man with him until the breaking of the day; . . . . and Jacob called the name of the place Peniel." After his meeting with his brother, Jacob, professing to accompany him, journeyed to Succoth, "leading on softly;" and there stopped to "build him an house, and make booths for his cattle;" whilst "Esau returned that day on his way unto Seir." Succoth is generally supposed to be on the west side of Jordan, a few miles to the north of the Jabbok; but the whole context shows that the patriarch, in order to get free from his brother, pretended to be going on with him towards Seir, but stopped all at once, as if weary, at Succoth, whilst Esau unsuspectingly continued his journey. Succoth is accordingly placed by Dr Beke at a short distance to the south of the Jabbok, on the east side of Jordan, and most probably near the ford of that river, on the high-road between Es-Salt and Nablûs, where is now the ruined bridge known as *Gisr Damieh.* Crossing here the Jordan, the patriarch would have entered the mouth of Wady Fār'a, where it joins the Jordan from the west, and continuing up the valley, he at length "came to Shalem, a city of Shechem, which is in the land of Canaan, when he came from Padan-Aram, and pitched his tent before the city."

Ascent of Um Shaumur in the Peninsula of Sinai. By the Rev. G. Prout.

On the Middle Island of New Zealand. By Mr J. Rochfort.

On the Civilization of Japan. By Sir R. Alcock.

On serious Inaccuracies in the Great Survey of the Alps, south of Mont Blanc, as issued by the Government of Sardinia. By Mr W. Mathews.

On the Yang-tze-Kiang River, China. By Lieut.-Col. Sarel.

On the Eastern Archipelago and New Guinea. By Mr A. R Wallace.

On Terrestrial Planispheres. By the Chevalier Ignazio Villa.

Decipherment of the Phœnician Inscription on the Newton Stone, Aberdeenshire. By the Rev. Dr Mill.

Recent Letter on the Death of his Wife. By Dr Livingstone.

On Language as a Test of the Races of Man. By Mr J. Crawfurd.

Report on the Human Remains found in the course of the Excavations at Wroxeter. By Mr T. Wright.—Mr Wright stated that human remains had been found in the excavations at Uriconium, under three different classes of circumstances:—First, were the ancient Roman cemeteries outside the town, which had been partially explored last autumn, and which were now under a course of further exploration. In an ethnological point of view, the discoveries here were of comparatively little use, because, as all the interments hitherto discovered were by cremation, no skulls or other perfect bones were found among the remains of the dead; but we derived from them the knowledge of the important fact, that the inhabitants of Uriconium continued to burn their dead, and, in fact, seem to have had no other mode of burial until the latest period of the existence of the city, that is, after the Roman government had been withdrawn from the island. Secondly, there were the remains of the inhabitants of the town,—men, women, and children,—who had been massacred by the savage barbarians, when the city was taken and destroyed. In the third place came the deformed skulls, which had been the subject of so much discussion,—a discussion which seemed not yet to have led to any satisfactory result.

On the Geography of Bread Plants. By M. Michelsen.

On the late Explorations in Australia by Burke and Wills, Gregory, &c. By Sir C. Nicholson.

Some Observations on the Psychological Differences that exist among the Typical Races of Man. By Mr R. Dunn.

Exploration dans l'Afrique centrale, de Serre-Leone à Alger, par Timbuctu. By M. J. Gérard.

Section F.—(*Economic Science and Statistics.*)

Report of the Committee on Technical and Scientific Evidence in Courts of Law. By the Rev. V. Harcourt.

On Expectation of Life. By Mr C. M. Willich.

On the Numerical Mode of estimating Educational Qualifications, as pursued at the Greenwich Hospital School. By the Rev. G. Fisher.

On the Economic Effects of Recent Gold Discoveries. By Mr H. Fawcett.

On Local Taxation and Real Property. By Mr F. Purdy.

On the Income Tax. By Mr W. T. Thornton.

The Tariffs and Trade of various Countries during the last Ten Years. By Mr R. Valpy.

On the Practicability of a Division of the Employer's Profits amongst the Work-people. By Dr Watts.

On the Pauperism and Mortality of Lancashire. By Mr F. Purdy.—The object of this paper was to direct attention to the connection of distress in Lancashire, as indicated by the pauperism with the mortality. During the last fifteen years the cotton-manufacturing unions of Lancashire and the adjoining districts have been thrice visited with distress. In the year 1846–47 the relief to the poor in that county rose 83 per cent. above the average expenditure of the three preceding years. The deaths at the same time, on a similar comparison, increased 18,181, or 36 per cent. In the autumn of 1857, distress, consequent upon what was then termed the "American Crisis," again fell upon the cotton trade. In respect to this and the present period, Mr Purdy's statistics applied to the twenty-one unions of Lancashire and Cheshire, which contain the principal seats of cotton manufacture in this country. During the nine months ended with Midsummer 1858, the deaths were 4786 in excess of the corresponding period of 1857, or 11·9 per cent. In the same comparative terms the pauperism was increased by 20,756 recipients of relief, —*i.e.*, by 45 per cent. These twenty-one unions, including the town of Liverpool as one of the number, had an aggregate population in 1861 of 2,067,000 persons. The present is the third visitation alluded to. Its first symptoms were appreciable in the pauper returns of November last; the statistics are here carried up to Midsummer of the present year, no returns of deaths having been published for any subsequent date. The pauper lists have swollen greatly since that time, and at present there are many signs of still greater augmentations. The deaths in the March quarter of the present year had increased by 1671, or 10·9 per cent. over the average of the corresponding quarters of the three preceding years. In the June quarter, the increase was only 545, or 4·0 per cent.; the increase in the six months 7·7 per cent. The number of paupers in the first quarter had increased by 39,847, or 65·3 per cent.; in the second quarter the increase was 50,793, or 89·7 per cent. Mr Purdy drew attention to the remarkable circumstance of the increase of pauperism in the second quarter being accompanied with a diminished rate of increase in the mortality. For the better exemplification of the distress in the various unions as measured by the pauperism, the rise in the number of paupers relieved in the six months was computed on every 100 of the population for each of the principal unions, and the difference in the rate of mortality placed in jaxtaposition with the results. Many and considerable disparities were pointed out in these tables.

On the Progress of Instruction in Elementary Science among the Industrial Classes under the Science Minutes of the Department of Science and Art. By Mr J. C. Buckmaster.

On Endowed Education and Oxford and Cambridge Fellowships. By Mr J. Heywood.—Mr Heywood defined an endowment to be a charity, and explained that the charities of the country were under the control of a Commission which sat in St James' Square. He therefore thought it advisable that the Universities should be also controlled, either by the Charity Commissioners or by some other Board, such as the Committee of the Privy Council. He next referred to what he considered to be the prejudicial influence which he thought was often exerted upon the education of the country by the course of study pursued at the University, and he quoted the instance of a school containing eighty boys, in which scarcely anything was taught but classics and mathematics, simply because a certain number of these boys were prepared for the Universities. He thought that such an evil would be remedied if the course of study were more extended, and if other more practically useful subjects—such as the modern languages, natural and moral sciences—were more encouraged in the University. He also thought that the students of the University ought to be instructed in subjects which would be more practically useful to them in after life. He did not propose to discourage classics and mathematics; but desired that scholarships and fellowships should be given to those who passed a successful examination, either in modern languages, or in the moral or natural sciences. He explained the subjects of the Trinity Fellowship Examination, and read various extracts from the examination papers, apparently to prove that the questions set required knowledge which could be of little practical use in after life. He concluding by insisting on the importance of more largely endowing the scientific professors.

On the Definition and Nature of the Science of Political Economy. By Mr H. D. Macleod.

On the Utility of Colonization. By Mr H. Merivale.

A Statistical Inquiry into the Prevalence of numerous Conditions affecting the Constitution of 1000 *Consumptive Persons when in Health.* By Dr Smith.

On the Subject-matters and Methods of Competitive Examinations for the Public Service. By the President.

On the Expenses and Social Condition of University Education. By the Rev. W. Emery.

Statistics which show the increasing Circulation of a Pure and Instructive Literature, adapted to the Capacities and the Means of the Labouring Population. By Mr H. Roberts.

On the Instruction and Training of the Unemployed in the Manufacturing Districts during the present Crisis. By the Rev. W. N. Molesworth.

Notice of a General Mathematical Theory of Political Economy. By Mr W. S. Jevons.

On the Study of Periodic Commercial Fluctuations. By Mr W. S. Jevons.

On the Prevention of Crime. By Mr E. Hill.

On the Cotton Famine and Substitutes for Cotton. By Mr D. Chadwick.

Some Statistics of Zostera marina *as a Substitute for Cotton.* By Mr H. Harben.

Section G.—(*Mechanical Science.*)

Mr J. Nasmyth described his *Improved Form of Link Motion.*

Mr E. E. Allen read a paper *On the Importance of Economising Fuel in Iron-plated Ships.*

Dr F. Grimaldi read a paper descriptive of a New Marine Boiler for generating steam of high pressure.

Mr W. Thorold read a paper *On the Failure of the Sluice in Fens, and on the Means of securing such Sluices against a similar Contingency.*

Mr J. Oldham read the Report of the Committee appointed last year to make *Tidal Observations in the Humber.*

On the Strains in the Interior of Beams and Tubular Bridges. By the Astronomer Royal.

Prof. D. T. Ansted, M.A., read a paper *On Artificial Stones.*—In this paper the author alluded to experiments made in the laboratory, on the various methods suggested for preserving stone, by a Section of the Committee recently appointed by the Board of Works in reference to the Palace of Westminster,—Dr Hoffmann, Dr Frankland, Mr Abel, and the Author being members of it. During their investigations, a remarkable material was submitted by Mr Ransome for their consideration; and its discovery arose out of Ransome's method of preserving stone, by effecting a deposit of silicate of lime within the substances of the absorbent stone, by saturating the surface with a solution of silicate of soda, and then applying a solution of chloride of calcium,—thus producing a rapid double decomposition, leaving an insoluble silicate of lime within the stone, and a soluble chloride of sodium, which could afterwards be removed by washing. To prove this, Mr Ransome made small blocks of sand in moulds, by means of silicate of soda, and then dipped them in chloride of calcium. The result was the formation, almost instantaneously, of a perfectly compact, hard, and, to all appearance, a perfectly durable solid.

Mr W. Smith read, in abstract, the Report of the Steamship Performance Committee.

The Secretary read a paper by Mr C. Atherton, late Engineer of the Royal Dockyard, Woolwich,—*On Unsinkable Ships.*

Dr Fairbairn, the President of the Section, read a paper *On the Results of some Experiments on the Mechanial Properties of Projectiles.*—He commenced by stating that, in the investigations which had taken place with regard to projectiles and armour-plated ships, one great difficulty that had arisen was to get good plates of sufficient thickness, and vessels of sufficient tonnage to carry those plates. It appeared that they were limited to plates of five inches in thickness; with plates heavier than that, a ship would not be what was technically called "lively." He had attended the experiments at Shoeburyness from the commencement, and they had reference to the force of impact. He would state the results of the more recent experiments, which had not yet been published. The first series of experiments had reference to the quality of the plates and the properties of the iron best calculated to resist impact. There were three qualities required: first, that the iron should not be crystalline; but, secondly, that it should be of great tenacity and ductility; and thirdly, that it should be very fibrous. The mean statical resistance to crushing of the two flat-ended specimens of cast-iron is 55·32 tons per square inch. The mean resistance of the two round-ended specimens is 26·87 tons per square inch. The ratio of resistance, therefore, of short columns of cast-iron with two flat ends, to that of columns with one flat and one round end, is as 55·32 to 26·87, or as 2·05 to 1,—an extremely close confirmation of Professor Hodgkinson's law. Applying this same rule to the steel specimens, it would appear that the flat-ended shot should have sustained a pressure of 180 tons per square inch before fracture. In the experiment it actually sustained 120 tons per square inch without injury, excepting a small permanent set. In the experiments with cast-iron, the mean compression per unit of length of the flat-ended specimens was ·0665, and of the round-ended ·1305. The ratio of the compression of the round-ended to the flat-ended shot was therefore as 1·96 : 1, or nearly in the inverse ratio of the statical crushing pressures. Applying this law to the case of the steel flat-ended specimen, it may be concluded that the compression before fracture would have been only ·058 per unit of length. The determination of the statical crushing pressure of the flat-ended steel shot as 180 tons per square inch and its compression as ·058 is important, on account of the extensive employment of shot of this material, size, and form in the experiments at Shoeburyness. In the case of the lead specimens, the compression with equal weights was the same whether the specimen were at first round-ended or flat-ended. This is accounted for by the extreme ductility of the metal and the great amount of compression sustained. In regard to the wrought-iron specimens, it may be observed that no definite result is arrived at, except the enormous statical pressure they sustain, equivalent to 78 tons per square inch of sectional area, and the large permanent set they then exhibit:—

	Statical Resistance in Tons per Square Inch.	Dynamical Resistance in Foot lb. per Square Inch.
Cast-iron, flat-ended ...	55·32 ...	... 776·8
Cast-iron, round-ended ...	26·87 ...	... 821·9
Steel, round-ended, ...	90·46 ...	... 2515·0

In the experiments on the wrought-iron specimens, the flat-ended steel specimens, and the lead specimens, no definite termination was arrived at, the material being more or less compressed without any fracture ensuing. The mean resistance of the specimens of cast-iron is 800 foot lb. per square inch ; that of the specimen of steel is 2515, or rather more than three times as much. The conditions which would appear to be desirable in projectiles, in order that the greatest amount of work may be expended on the armour-plate, are—1. Very high statical resistance to rupture by compression. In this respect, wrought-iron and steel are both superior to cast-iron; in fact, the statical resistance of steel is more than three times, and that of wrought-iron more than two-and-a-half times, that of cast-iron. Lead is inferior to all the other materials experimented on. 2. Resistance to change of form under great pressures. In this respect hardened steel is superior to wrought-iron. Cast-iron is inferior to both. The shot which would effect the greatest damage to a plate would be one of adamant, incapable of change of form. Such a shot would yield up the whole of its *vis viva* to the plate struck; and, so far as experiment yet proves, those projectiles which approach nearest to this condition are the most effective. The President stated that steel shots might be made at a comparatively small cost. M. Bessemer had told him, that if he had a large order he could produce steel shots at a little more than the price of iron ; but if the ingots as cast had to be rolled or hammered to give them fibre, they would cost near L.30 a ton, instead of L.8 or L.10 a ton.

Mr T. Ashton read a paper *On Projectiles with regard to their Power of Penetration.*

Mr W. Smith read the Report of the Committee appointed at the last Meeting of the Association to inquire into the Causes of Railway Accidents.

Messrs Williamson of Liverpool made a communication relative to the *Merits of Wooden and Iron Ships*, with regard to cost of repairs and security for life, and in the event of accidents at sea,—calling attention, in particular, to an iron ship of their own, the Santiago, which met with a collision, the consequences of which would have been absolute destruction of the vessel had she been of wood; whereas, being of iron and having water-tight compartments, the vessel was able to pursue her voyage, and was repaired at the cost of a few hundred pounds, instead of several thousands, which would have been necessary had she been made of wood, and could have been preserved from foundering.

Professor W. J. M. Rankine read a paper *On the Form and Motion of Waves at and near the Surface of Deep Waters.*—This paper was a summary of the nature and results of a mathematical investigation, the details of which have been communicated to the Royal Society.

A paper was brought before the Section by Mr C. Vignoles, *On the Practice and Principles of Diverting Rivers, and the Stoppage of Breaches in Embankments.*—The author proceeded to describe a method successfully adopted by him in dealing with the River Ebro. The plan he pursued was one very generally adopted at the present day by the Dutch engineers, —namely, gradually shallowing the river throughout at the required spot by means of fascine work. It consists in forming large rafts of fascines, and floating them down to the desired place ; loading them evenly with stones, and thus sinking them down to the bottom ; and repeating the operation till they rise above the surface of the water. This, he contended, was a more judicious plan than that of piling from the sides to the centre, the result of which was the continual narrowing of the waterway, which caused the tide or stream to rush through with such accelerated violence so as frequently to destroy the works before they were completed; whilst, by the use of fascines, the water was gradually shallowed all over and its force checked by degrees. The Dutch engineers had long since given up the piling system for such purposes.

A paper, by Mr J. Sewell, was read, *On the Prevention of Railway Accidents.*—The author considered that the main cause of accidents was the want of punctuality in the trains; and that this arose mainly from the overloading of them, which rendered it impossible that they could keep time. Engines were made to perform certain work and draw certain loads, and if these were exceeded it was impossible that time could be kept. This was a matter that the public could not ascertain for themselves, and he therefore advocated the importance of having engines licensed like boats, omnibuses, &c., by Government, to draw certain loads; and a statement giving that information should be placed conspicuously on the engine. This would prevent the overloading, as it would be in the power of every passenger to see whether the power of the engine was duly apportioned to the carriages it had to draw.

On an Improved Painting Telegraph Apparatus. By Mr T. Sortain.

On the Manufacture of Armour Plates. By Mr A. C. Tylor.

On Instruments for observing the Motion of Vessels at Sea, with reference to Sea-Sickness. By Mr J. W. Osborne.

SCIENTIFIC INTELLIGENCE.

BOTANY.

Ozone Exhaled by Plants.—M. Kosmann has made experiments on this subject at Strasburg. His conclusions are:—

1. Plants disengage ozonised oxygen from their leaves and green parts.
2. The leaves of plants disengage during the day ozonised oxygen in ponderable quantity greater than that which exists in the ambient air.
3. During the night, in the case of plants growing separate from each other, there is no difference between the ozone disengaged by the plant and the atmospheric ozone; but when the plants are crowded together and grow vigorously, the ozone, during night, observed in the plant, is more abundant than in the air, which is explained by admitting that the ozone disengaged during the day continues to surround the plants during the night, when the weather is calm.
4. Plants in the country give out more ozone than those in the town during the day; this ought to be the case, since their vegetative life is more active, and they reduce more carbonic acid.
5. From the last observation, we may infer that the air of the country, of houses surrounded by large gardens, of lucerne and clover fields, and of forests, is more vivifying than that of towns.
6. In the heart of cities and of a concentrated population, the ozone is in larger quantity in the air during the night than during the day; if we pass from such an assemblage of human beings, and enter a crowded collection of plants, the excess of the ozone at night over that during the day diminishes; if we go still more into the country where plants are more numerous than men, the ozone of the air in the day becomes larger than that during night.
7. The interior of corollas does not set free any ozonised oxygen.
8. In inhabited rooms the oxygen does not exist generally in an ozonised condition.—*Comptes Rendus*, *Nov.* 10, 1862.

Hybrid Ranunculus.—M. Alfred Wesmael, of Vilvorde, has noticed a hybrid between *Ranunculus acris* and *R. bulbosus*. It was found in the meadows at Tournay. It has characters intermediate between the two species, and its organs of reproduction are abortive. The andrœcium is not developed, and the carpels are represented by a small wrinkled projection.—*Bulletin Acad. Roy. de Scien. de Belgique*, 1862.

Indigenous Fibres in Australia fitted for Manufactures. By Ferdinand Mueller, Government Botanist.—The two varieties of New Zealand flax (*Phormium tenax*) are deserving of especial attention, as likely to supply the wanting material to British weavers, the strength of the phormium fibre being almost equal to that of silk, and little doubt being entertained that finally the genius of invention will overcome the hitherto experienced difficulty of separating by an easy method, without sacrifice of the material's strength, the fibre from the leaves.

I beg further to draw attention to the extreme facility with which this plant might be reared on places not available for any other cultivation (such as margins of swamps, periodically inundated banks of lakes, &c.); further, to its great vigour of growth, to the probability of its proving quite hardy in the southern parts of England and Ireland, and to the certainty of its cultivation being attended with full success in South Europe, and therefore in proximity to the British market, and under the advantage of cheap labour.

Specimens for experiment on this promising, and moreover highly ornamental plant will be readily available in Europe, where the plant was introduced in the beginning of the year 1788.

The fibre of the less prolific *Doryanthes excelsa*, or Giant Lily, of New South Wales, greatly resembles that of the phormium.

The fibre of various of our native plants is employed by the aborigines for making their nets and fishing lines, and indiscriminately called by them "Curryong." It remains yet a subject of inquiry whether the products of these plants can be brought into qualitative competition with other textile fibres hitherto universally used.

The *Pimelea axiflora* (Ferd. Mueller) was recently observed in great frequency near Twofold Bay, whence it extends to Port Philip, and I can have no difficulty, therefore, in obtaining samples of its tough bark, and of that of the allied *Pimelea ligustrina*, *pauciflora*, and *microcephala*.

Sida pulchella (Bonpl.), *Brachychiton populneum* (Rob. Brown), and *Commersonia Fraseri* (Gay), are the other native plants known to be principally employed by the aborigines for obtaining cordage. Considerable quantity of the bark of the former might be gathered in the forests of this colony and of Tasmania; the two other species occupy scattered outposts on the eastern frontiers of Gipps Land, the main body of plants extending through New South Wales and Queensland.

We possess in Victoria a few species of Asclepiadaceous plants, which yield a kind of cotton similar to that once used by the ancients for ropes, as demonstrated from Pompeiian relics.

A perennial flax (*Linum marginale*, All. Cunn.) is by no means rare in this colony, but it is not likely to possess any advantages over the common flax.

The Tasmanian stringy bark tree, which, as I anticipated, has been by comparison with original specimens in Sir Joseph Banks's herbarium, identified by Mr Richard Kippist with the original *Eucalyptus obliqua* of L'Heritier (having been collected during Cook's third voyage at Adventure Bay, by David Nelson), yields, as well as an allied species, which bears amongst the colonists the name of "Mountain Ash," a fibrous, but not tenacious bark. It is therefore not available for textile fibre, although, perhaps, it may be used for the manufacture of a coarse paper.

Attention may also be directed to the fibre of some species of Stipa, common in this colony, and more particularly to the fibre yielded by a sedge, *Cyperus vaginatus*, which occurs in the greatest abundance on the River Murray and its tributaries, and in many other parts of Victoria. The aborigines form very durable and tenacious cordage from this sedge, and employ it extensively for fishing nets.

The useful fibrous properties of the *Lepidosperma gladiatum*, and another plant, the *Lavatera plebeja*, were brought into notice by Mr Alexander Tolmer, of South Australia, who had observed the natives use them for the purpose of making baskets and fishing nets. This circumstance induced him to attempt to turn them to account for the purpose of making paper. Accordingly, to test them, he sent a quantity to England, where it was made into a useful paper. The *Lepidosperma* is perennial, and has been found in large quantities growing most luxuriantly on the banks of the Murray and several other parts of the Australian continent. The manufacturer in England who tried its paper-making qualities reported "that there is no doubt whatever of its making good paper; but that the price, exact loss of weight, &c., can only be determined by a continuous working of a large quantity." To prepare it for the market, it may be cut down close to the roots, the root being left to spring again. It is then left exposed to the action of the night dews, and the hot sun in the day, and occasionally turned over, until by this exposure the plant becomes partially bleached. It is then cut up into short lengths in any suitable machine, such as a chaff-cutter, and afterwards bleached by chloride of lime or any other of the well-known bleaching processes. It contains a gummy matter, which it is of importance to get rid of. The material will then be in a fit state to be manufactured in the same manner as any other fibrous material is converted into paper. The *Lavatera plebeja* is also an indigenous perennial plant, and grows freely throughout South Australia, Victoria, and New South Wales. It may be obtained in considerable quantities along the banks of the Murray and many of its tributaries, and is also found scattered over various parts of the colony. The fact of its abounding along the banks and in the marshes of a navigable river, such as the Murray, renders it highly probable that it may be made an article of commerce. The surveyor of the Victorian Expedition reported that "it clothes the banks of the Moriaminta Creek, and grows to an immense size on nearly all the creeks beyond the Darling." The treatment of this plant for the purpose of paper-making corresponds with that applied to the *Lepidosperma gladiatum.—Trans. Royal Soc. of Victoria.*

GEOLOGY.

Glaciers in Turkistan.—Captain Montgomerie read to the Asiatic Society some notes on the Brahma, Kun and Nun, Zanskar, Mustak, and other glaciers. He pointed out that these glaciers have proved to be of the most gigantic size, so large, indeed, that compared with them the glaciers of the Alps must be reckoned as of the second order. The glaciers surveyed by Captain Montgomerie's party may be divided into those of the Himalayan and Mustak water-sheds. The glaciers of the Himalayan water-shed are very numerous, varying in length from five to fifteen miles, the largest being the Drung Drung glacier of fifteen miles, and there are others over eleven miles in Zanskar, the Brahma glacier of eleven and a half miles in Wurdwun, and the Purkutsi glacier of seven and a half miles in Sooroo, besides a multitude of minor glaciers. The Purkutsi gunri or glacier is perhaps the most remarkable of the whole of this group, as it comes tumbling down in a torrent of broken and pinnacled ice from near the summit of the Kún peak, which rises upwards of 23,000 feet above the sea, a sight well worth looking at, though in actual length the glacier is somewhat inferior to others in the neighbourhood; it makes up for the want of length by the large mass of ice that is visible from one spot. The next group of glaciers referred to by Captain Montgomerie was that of the Mustak, consisting of those in the Saltoro and Hushe valley around the splendid peaks of Mashabrum, and others in its vicinity, which rise to upwards of 26,000 feet above the sea. The most remarkable glaciers in the

Saltoro valley, taking them from east to west, are the Sherpogong glacier, 16 miles, and the Koondoos, 24 miles in length; in the Hushe valley the Nang glacier, 14 miles in length, and the Atosir glaciers, 13 and 11 miles in length.

The next group referred to was that of the Mustak on the Bráldo and Báshá branches of the Shigar River. The Bráldo boasting of the Baltoro glacier, no less than 36 miles in length, with a breadth of from 1 to 2½ miles; the Punmah and Nobundi Sobundi glaciers, the longest of which is 28 miles in length, and the Biafo gáusè or glacier with a direct length of 33 miles without reckoning its upper branches. The Biafo gáusè forms, with a glacier on the opposite slope towards Maggair, a continuous river of ice of 64 miles running in an almost straight line, and without any break in its continuity beyond those of the ordinary crevices of glaciers. The Biafo glacier is supplied in a great measure from a vast dome of ice and snow about 180 square miles in area, in the whole of which only a few projecting points of wall are visible. Farther west the Hoh valley produces a fine glacier 16 miles in length. The Báshá valley contains the Kero glacier, 11 miles in length, the Chogo glacier, 29 miles in length, besides many branches and minor glaciers. The Bráldo and Báshá, in fact, contain such a galaxy of glaciers as can be shown in no other part of the globe, except it be within the Arctic circle.

Captain Montgomerie pointed out that the Baltoro has a main glacier 36 miles in length, and 14 large tributary glaciers of from 3 to 10 miles in length. The Baltoro glacier exhibits a wonderful number of gigantic moraines which streak it with 15 lines of various kinds of rock,—viz., gray, yellow, brown, blue, and red, with variations of the same, all in the upper part, quite separate from one another, but at the end of the glacier covering its whole surface, so as to hide the upper part of the ice entirely. In the centre of these moraines there was a line of huge blocks of ice which had not been observed on other glaciers, and which it is difficult to account for. The Baltoro glacier takes its rise from underneath a peak 28,287 feet high. Captain Montgomerie was in a considerable state of alarm at one time lest this noble peak should turn out to be in Turkistan. Captain Austen has, however, removed all anxiety on that score, as one side of the peak, at any rate, is in Her Majesty's dominions.

Captain Montgomerie noticed that all glacier phenomena were to be found on a gigantic scale in the Shigar valley. The crevices in the ice were of great breadth, and of the most formidable description. An attempt was made to measure the thickness of the ice by sounding one of these yawning chasms, but a line of 160 feet in length failed to reach the bottom of it. Observations made at the end of the glaciers gave a thickness of 300 or 400 feet, but doubtless higher up a still greater thickness of ice will be found. The surface ice was regularly drained by streamers with large lakes of a half to two miles in length, the whole water occasionally disappearing down great holes or "moulins" in the ice with a loud, intermittent roaring noise. The glaciers being on such a gigantic scale, it of course took days and days to explore one of them. In the smaller glaciers no particular precautions had to be taken, but in the Shigar valley it was absolutely necessary to tie all the men of the party together with rope, giving about ten yards between each, so as to save any one who might slip into a crevasse. Implements for cutting ice were in constant requisition, and altogether it was a service of considerable danger exploring the larger glaciers.—*Journal of Asiatic Society, Bengal.*

On Celts from Bundelkund, and some Chert Implements from the Andamans. By W. Theobold, jun.—During the past cold season I had the opportunity of examining a portion of the country in which Mr Le Mesurier first discovered celts (Journ. Asiat. Soc., 1861), and I was so fortunate as not only to collect, but also to ascertain their extension, upwards of 2000 miles east of the Tons River, which Mr Le Mesurier in his Memoir considered as their boundary in that quarter. In other directions I had not the opportunity of tracing them, but that their range extends over a much larger area than is at present assigned them in Bundelkund is almost a certainty. Of the most marked varieties of these implements I shall give a short description, that any one so minded may satisfy himself of the precise identity of these celts with those found in Europe, in confirmation of which I may quote Mr Oldham, whose acquaintance with stone weapons from Irish and European localities is very extensive. There is something, however, very peculiar in the mode of occurrence of these weapons, which must be cleared up hereafter, for though they may be traced as far into Behar, it is only west of the Tons that they are plentiful; for (rejecting a dubious case) I have not as yet obtained a single *perfect one* east of that river. The most natural explanation of this appears to be some superstition which induced men of old time to collect these relics of a still older age and convey them to the shrines and localities where they are now so abundant, so that celts collected over thousands of square miles are now accumulated about Karoi (Tirhowan or Kirwee) and its environs. This is, of course, a mere hypothesis, but agrees well with the scarcity of other stone weapons compared with the multitude of celts, one *stone hammer* and a single *arrow head* only as recorded by Mr Le Mesurier in addition to the numbers of celts scattered by threes and fours under pipul trees and in temples about Karoi. In the same neighbourhood a stone *punch* or *chisel* was procured by me, and at Powari, *east of the Tons River, a stone hammer*, which should encourage us to search more diligently for other relics of this most interesting *stone period.*

Very few of the celts in this collection offer any evidence of their ever having been fixed in handles, and where such has been the case, it was probably by a race of far more recent date than the original fabricators, for it is difficult to conceive a form less adapted for such a purpose than the typical celt, or more liable to be always falling out; this difficulty is greatest in the case of the smallest celts, and when we consider that a little flattening or notching the sides could have enormously facilitated their retention in any handle, it seems difficult to suppose that their original makers ever so used them. No. 4, though merely chipped, and not smoothed at the sides, presents the most perfect cutting edge of any in the collection, and what could have been easier than to fashion its sides if ever intended for a handle, or what form can possibly be suggested as *less applicable* for firm retention in a socket than that given to it, carefully wrought though it be? Some celts, perhaps, may have been fitted to handles, but hardly, I think, by their original makers, for reasons above stated, unless No. 6 is an exception. This celt presents a curious pit or depression on one side, which might have been intended to receive the head of a handle, and could certainly have contributed to its firm retention, though but slightly, and the general form is, as in all celts, singularly ill-adapted for such an application. The only other possible use I can suggest for this depression is, that of breaking nuts or fruit stones, which would not be so likely to fly off or slip aside if struck with the cupped side of this celt.

Celt No. 14 is the only one in the collection which exhibits any traces of an adaptation fitting it for a handle, and it only differs from others in certain rude notches cut in the side, which certainly suggest the probability of their having been made to receive some sort of lashing. Their rough finish, however, suggests doubts of their being as old as the original date of the weapon. The several typical forms of European celts may be recognised in our Bundelkund ones, though, in the illustrated catalogue of Irish antiquities in the Dublin Museum, there is nothing figured like the stone-hammer or mallet found by me at Powari. The most probable use for which this article was designed was probably pounding, but it is doubtful if it was not furnished with a high celt-shaped handle, as just above the neck it has suffered fracture. It is also fractured at the base, seemingly from accidental usage, but enough remains of the smooth basal surface to indicate its form beneath, and show the purposes to which it was probably applied. The neck or shoulder is very smoothly finished, but more specimens are required to indicate the normal shape of the perfect instrument. Weight 1 lb. $9\frac{3}{4}$ oz. Only one other blunt weapon was found, which, though perhaps used for similar purposes, is much lighter, and very different in shape, which is much that of a common native wrought-iron pestle. It has a flat top at one end, and probably had a blunt edge at the other, though now much worn down. It was never very highly finished, and weighs only $9\frac{1}{2}$ ounces. One of the most interesting celts in the collection is the very rude one which exhibits scarcely any signs of manufacture, and might readily enough be mistaken for an accidental fragment of rock. The natives, however, about Karoi possessed sufficient archæological acumen to perceive its nature, and have adorned it with a daub of red paint as Mahadeo, together with others of greater pretensions to divine honours than it. Whether accidentally or not, it exhibits the inæquilateral outline observable in many finished celts, and which was, for some cause or other, intentionally produced. The most curious point, however, about it is the presence of a few notches in the edge, which, as the stone is much decayed, may have originally been more conspicuous. That they are notches there is no doubt; but to have served any purpose, they must once have been much deeper, when they might have acted as a rude saw, the only instance of such a tool in stone I am acquainted with. Of many scores of celts, this is the only one of this rude type I have seen. The one marked from Debru ghat on the Soane is, perhaps, as unfinished, but it may once have had a finer edge, and its claims to be considered a celt are not conclusive.

The small fragment from Sibdilla is interesting, as showing how certainly the merest portion of a celt may be recognised, as regarding this fragment, small as it is, there can be no doubt; and as proving incontestably the former extension of these relics, on a very large area, —Sibdilla being a town of Behar not far from the hills, but 200 miles east of the Tons and the celt district proper about Karoi or Tirhowan.

Most of the celts once possessed a very sharp edge, but there are some in the collection, as Nos. 12, 13, 17, which, though well-finished, never seem to have been ground down to a cutting edge, and were probably used for other purposes than the sharp-edged ones, though what precise use that was can scarcely be guessed at. For comparison with these implements, I have laid on the table a few stone chips, for which I am indebted to Major Haughton, from the Andamans, the most finished of which might have been intended for arrow-heads, but the majority of which chips seem merely intended to be used with the fingers in dividing fish or flesh. The round stone is also from the same quarter, and seems to have been used for much the same purposes as the stone hammer from Powari. The four chips marked with a cross may have very well been intended for tipping arrows, to be used only against fish, but none of them would have been very effective against the Andaman pig, or, indeed, any land animal. As, however, the Andamenese chiefly depend on fish, which they shoot with arrows for their food, Major Haughton is probably correct in regarding many of these chips as arrow-heads, though of a far slighter character than the arrow-heads which are usually found accompanying celts. The small agate fragment from Behar bears the appearance of being the remnant of a larger shear, and whether intended as an arrow-point or not, is, there is little doubt, an artificially formed piece of stone. —*Journal of Asiatic Society of Bengal.*

PALÆONTOLOGY.

Palæontology of Malta.—A. L. Adams, M.D., now quartered in Malta with his regiment, the 22d, has been devoting his leisure time to the exploration of its caverns and palæontological deposits there, and a paper on the "Fossiliferous Caves" has lately been published. The Maghlah cave Dr Adams considers as the "fragment or extremity of what had doubtless been a large cave."

The strata or accumulations on its floor were thus arranged :—"Observations showed, that its vault and sides were thickly incrusted with stalactite and calc spar; the latter was of a yellowish-brown colour and tinged with oxide of iron; the thickness of the calc spar must have been considerable, as several masses in the side of the cliff measured from 1½ to 2 feet. The more recent stalagmite on the floor contained no organic remains, at least none have been discovered to my knowledge; it generally became looser in texture and passed into a calcareous gray earth, more or less tinged with iron, and mixed with nodules or masses of dark-brown loam. In some situations the stalagmite resolved itself into a compact reddish limestone. Both the last-named varieties contained abundance of land shells, belonging to the genera *Helix* and *Clausilia*; there were but few remains of rodents, but several fragments of the wing bones of large birds were found with that of a quadruped. The organic remains were most plentiful in the deeper portions and gray-coloured deposit, showing evident lines of stratification. In some situations teeth and bones of the rodents were so abundant, that I counted upwards of twenty incisor teeth on a surface of not more than one foot in circumference. Complete casts of *Helix* and of *Clausilia* were plentiful. The fragments of birds were numerous, especially their long and slender wing-bones; an entire scapula of a bird, about the size of a woodcock, was found. Several masses of this deposit, showing its connection with the surface, and of subjacent formations, gave a thickness of from two to three feet. I particularly noted that for upwards of a foot immediately over the latter, there was no trace of any organic remains, as if a long interval had elapsed between the deposition of the hippopotamus and rodent. The rodent is *Myoxus melitensis* (Adams); while at the same time he thinks the remains may belong to two species, and if so, he dedicates the second to a friend, and calls it *M. Cartei.* Many figures of the remains accompany the paper, both of the natural size and magnified. Of the hippopotamus he remarks, "On comparing the remains from the Maghlah with descriptions of *H. major*, by Cuvier and later authorities, I find the same discrepancies with reference to size, as are met with in Sicilian specimens and elsewhere along the Mediterranean; thus furnishing additional proof that the hippopotamus of the south was either distinct, or belonged to a smaller race than that of the north of Europe."

The Maltese beds are known to be very rich in *Echinodermata*, and his collections of these forms Dr Adams has sent to Dr Wright, in Cheltenham, a gentleman well qualified to work them out, and who is now preparing a work for their description and illustration.

ZOOLOGY.

*Archæopteryx lithographica, Meyer.**—This very remarkable fossil

* We retain the first name given by Meyer, September 1861. Synonyms should not be multiplied without cause, and there is none here.—Ed.

from the lithographic limestone of Solenhofen, has been lately acquired by the British Museum It has been described by three scientific men, the last of whom, Professor Owen, advocates the Ornithic character of the remains, and has made it the subject of a paper read before a very full assemblage of the members of the Royal Society of London upon the evening of the 20th November last

The British Museum fortunately possesses both sides of the slab, just as opened, and revealing the animal, and they mutually assist each other. That half in which the bones are really imbedded has had the stone partially removed from several parts, so as better to exhibit their form, and the impressions of the supposed feathers have been freed from some thin layers that covered them. On first reading a description, or seeing a drawing of the fossil, one is tempted to ask, Do all the parts belong to one animal? but an examination of the specimen itself tends in a great degree to remove that impression, and to make the observer conscious that he is looking at the most remarkable and anomalous form yet discovered. There are certainly strong ornithic characters in the skeleton. The bones of the foot and leg, and of the wings are so, but the elongation of the vertebral column into a long and slender tail is at variance with all known forms of birds, and cannot be sustained as analogous to the heterocercal tail of ancient fishes, while the small bones and hooks referred to as attached to the bend of the wing, if correctly so, would militate against the bird-form. The small bone and hook, or claw, seen upon the left side of the crack in the slab, resembles rather the first phalanx of the inner toe of the foot and its claw. The *Os furcatorius*, or merry thought, may belong to either bird or reptile, while the ribs are exceedingly reptilian in appearance, not ornithic. The idea of a bird is suggested by the leg and foot; and it is evident that whatever the animal may turn out to be, the structure of this limb, if connected with a reptile form, is different from all yet known, as the long, slender tail is in relation to a bird. The so-called feathers are impressions only, and show shafts with diverging rays or vanes; but it is quite possible that these may be appendages analogous to those of many-crested and tail-fringed lizards, or where the extremities and body are connected by membranes generally clothed with scales, but the structure of which has never been minutely examined. The discovery of the head will most probably reveal characters as different from bird-forms as the tail, the whole forming beautiful links so difficult to understand when seen imperfect or alone.—W. J. Edit.

On some Burmese Animals, by W. T. Blandford.—Lower Pegu is distinguished from Upper Burmah, as regards climate, pretty much as Lower Bengal differs from the Upper Gangetic plains; but in a much greater degree: Pegu being damper than Bengal; Upper Burmah drier than the N. W. provinces. The great change takes place above our territories, and is most strongly marked after passing Mendha. But a very considerable alteration in the vegetation, and a corresponding one in the Fauna, take place at a much lower point, and are, perhaps, first to be noticed about Akouk-toung, a rocky promontory on the banks of the Irawadi, about 30 miles below Prome. A comparatively dry region, however, stretches down the eastern flank of the Arakan hills, so far as they form a high connected range, that is—to a little below the parallel of Henzada; and of this the Fauna of the range of hills stretching to Cape Negrais is, in its principal features, essentially Arakanese, the hills being covered with dark evergreen jungle. My experience of both regions is mainly confined to the west side of the Irawadi river.

Of the upper dry region, the most characteristic animal is, perhaps, a ground Thrush (*Chatarrhœa gularis*, Blyth). I have never met with this bird below Prome; nor have I ever seen it in thick or high jungle.

It is entirely an inhabitant of bushes. It is common at Thayet Myo; and higher up, about Yenan-phyoung, it far exceeds any other bird in its numbers. *Lepus peguensis* is also, so far as I know, confined to this dry region;* as are also the few jackals which occur in Burmah. I have not heard of them, however, above the frontier, but suspect they will be found there, as well as at Meaday and Prome.

Dr Jerdon's new species of Magpie (*Crypsirina cucullata*), and his new *Pericrocotus*,† and probably his new *Maina*,‡ are other species peculiar to the dry region; none of them appearing to occur below: *Urocissa magnirostris* I met with, near the base of the Arakan hills, as far south as the neighbourhood of Gnathem-phyoung, but no further.

Of the damper climate of Lower Pegu, one of the most typical birds, so far, at least, as abundance is concerned, is the large *Buceros plicatus* (*ruficollis* (Blyth), the species with deep notches on the sides of the bill), of Arakan.§ *Sciurus Keraudrenii* I have seen near Myansoing; but it is far more common to the south; where, also, a peculiar variety of *S. bicolor*, with a light patch or band on the back, is tolerably abundant. If *S. bicolor* exists in Upper Burmah, it must be excessively scarce.‖ *S. assamensis* (?) is common throughout the Bassein district; and another species (*Sc.* —— ? is said to occur above; but of this I am far from certain.

I pointed out when in Calcutta the distinction between the three Kingfishers of salt-water and those of fresh-water streams and pools.¶

The Irawadi Porpoise abounds in many parts of the river. I saw them in great numbers above Ava in the gorge below Malé, and from their extreme scarcity in Pegu during the rains, I think it by no means improbable that they migrate up the river at that season. I believe something similar has been observed in respect to the "Susu" of the Ganges.**

* * * * *

"Of the new birds in my collection, the Maina (*Temenuchus burmesianus*, Jerdon), is from Thayet Myo, and will doubtless prove another of the peculiar species of the dry region. The little black and white bird

* I was assured of the existence of hares on the left bank of the Salwaen, above the junction of the Yunzalin river.—*Cur. As. Soc.*

† *P. albifrons*, Jerdon.—*Ibis*, 1860.

‡ Major Tickell called my attention to a white-headed Maina, which, he remarked, he had only seen about Rangoon, where I sought for it in vain. It is, doubtless, the *Temenuchus burmesianus*, Jerdon (*loc. cit.*), obtained by him at Thayet Myo, and by Mr Blandford in various parts of Upper Burmah. I observed, however, in Col. Phayre's compound in Rangoon, a flock of the beautiful *Ploceus hypoxanthus* (Daudin); Dr Jerdon obtained this bird at Thayet Myo; and Sir R. H. Schomburgk in Siam (*P. Z. S.* 1859, p. 151); it having previously been only known from Java and other islands of the great Eastern Archipelago.—*Cur. As. Soc.*

§ The most characteristic bird of the Martaban and Tenasserim jungles is certainly *Garrulax Belangeri*, at all elevations. The Shama (*Kittacincla macroura*) is also very abundant.—*Cur. As. Soc.*

‖ It is not likely to occur in Upper Burmah, to judge from the analogy of *S. purpureus* of Central India, the range of which does not extend to Upper Hindustan.—*Cur. As. Soc.*

¶ *Halcyon amauropterus*, *H. atricopillus*, and *Alcedo meningting*, being the salt-water species noticed by Mr Blandford, which are replaced higher up the rivers by *H. leucocephalus*, *H. fuscus*, and *A. bengalensis*. The little *Ceyx*, also appears to be peculiar to brackish water; but I observed *H. atricapillus* about 100 miles up the river Salween.—*Cur. As. Soc.*

** The Porpoise of the Irawadi has not yet been scientifically examined.—*Cur. As. Soc.*

(*Rhodophila melanoleuca*, Jerdon), is from the same place. Of *Mulleripicus Heddeni*, I believe that I obtained one specimen at Thayet Myo, and subsequently I again shot it S. of Bassein. It is a very wary bird. The rare Bunting (*Emberiza rutila*, Pallas), I found in grass on a stream, at the base of the Arakan hills near Gnathim-phyoung. The *Rhodophila* was shot in elephant-grass in the plains near Henzada.—*Journal of Asiatic Society of Bengal.*

CHEMISTRY.

Phosphatic Guano Islands of the Pacific Ocean.—These are chiefly Baker's, Howland's, and Jarvis's Islands. They are all of coral formation. They are situated near the equator, and between the meridians of about 155° and 180° longitude west from Greenwich. They are without fresh water, and almost entirely destitute of vegetation, and are the resort of countless thousands of birds, whose accumulated ordure and dead bodies have formed extensive deposits. "Much light may be thrown on the formation of these deposits on Baker's Island by the analysis, (I.) which follows, showing the composition of recently deposited guano. The sample itself does not represent any considerable part of the existing deposit, but was taken from a locality where large numbers of birds are still accustomed to congregate. It is the dung of the *Pelicanus aquilus*, commonly called the frigate bird, which of all the birds frequenting the island is the only one whose recent evacuations are of such a consistency that they may conveniently be collected. They contain a large proportion of solid matter, while the evacuations of nearly all the other birds are very thin and watery. It is found in their favourite roosting-places, and shows the character of guano before it has long been subjected to the influence of the weather. It is a light and dry substance, consisting of friable grains or fine powder, of a brown colour, smelling strongly of ammonia. Of the three following analyses No. I. is this freshly deposited guano; No. II. is of the light coloured guano from the deeper part of the deposit; and No. III. of the dark guano from the shallow part,—

	I.	II.	III.
Moisture expelled at 212° Fahr.,	10·40	2·92	1·82
Loss by ignition,	36·88	8·32	8·50
Insol. in HCl (unconsumed by ignition),	·78	...	...
Lime,	22·41	42·74	42·34
Magnesia,	1·46	2·54	2·75
Sulphuric acid,	2·36	1·30	1·24
Phosphoric acid,	21·27	39·70	40·14
Carbonic acid, chlorine and alkalies, undet.,	4·44	2·48	3·21
	100 00	100·00	100·00
Sol. in water remaining after ignition,	3·63		

No. I. contained 3·82 per cent. of actual ammonia, and all contain traces of iron.

Birds and other Animals in these Islands.—From fifteen to twenty varieties of birds may be distinguished among those frequenting the island, of which the principal are Gannets and Boobies, Frigate Birds, Tropic Birds, Tern, Noddies, Petrels, and some game birds, as the Curlew, Snipe and Plover. Of terns there are several varieties. The most numerously represented is what I believe to be the *Sterna hirundo*. These frequent the island twice in the year for the purpose of breeding. They rest on the ground, making no nests but selecting tufts of grass, where such may be found, under which to lay their eggs. I have seen acres of ground thus thickly covered by these birds, whose numbers might be told by millions. Between the breeding seasons they diminish considerably in numbers, though they never entirely desert the island. They are expert fishers, and venture far out to sea in quest of prey. The Noddies (*Sterna stolida*) are also very numerous. They are black birds, somewhat larger than pigeons, with much longer wings. They are very simple and stupid. They burrow holes in the guano in which they live and raise their young, generally inhabiting that part of the deposit which is shallowest and driest. Their numbers seem to be about the same throughout the year. The Gannet and Booby, two closely allied species (of the genus Sula) are represented by two or three varieties. They are large birds, and great devourers of fish, which they take very expertly, not only catching those that leap out of water, but diving beneath the surface for them. They are very awkward and unwieldy on land, and may be easily overtaken and captured, if, indeed, they attempt to escape at all on the approach of man. They rest on the trees wherever there is opportunity, but on these islands they collect in great groups on the ground, where they lay their eggs and raise their young. One variety, not very numerous, has the habit of building up a pile of twigs and sticks, 20 or 30 inches in height, particularly on Howland's, where more material of that sort is at hand, on which they make their nest. When frightened, these birds disgorge the contents of their stomachs, the capacity of which is sometimes very astonishing. They are gross feeders, and I have often seen one disgorge three or four large flying fish 15 or 18 inches in length.

The Frigate Bird (*Tachypetes aquilus*) I have already alluded to. It is a large rapacious bird, the tyrant of the feathered community. It lives almost entirely by piracy, forcing other birds to contribute to its support. These frigate birds hover over the island constantly, lying in wait for fishing birds returning from sea, to whom they give chase, and the pursued bird only escapes by disgorging its prey, which the pursuer very adroitly catches in the air. They also prey upon flying fish and others that leap from sea to sea, but never dive for fish, and rarely even approach the water.

The above are the kinds of birds most numerously represented, and to which we owe the existing deposits. When the islands were first occupied they were very numerous, but have since been perceptibly decreasing.

Besides these are the Tropic Birds, which are found in considerable numbers on Howland's Island, but seldom on Jarvis's or Baker's. They prefer the former, because there are large blocks or fragments of beach rock, scattered over the island's surface, under which they burrow out nests for themselves. A service is sometimes required of this bird which may, perhaps, be worthy of notice. A setting bird was taken from her nest and carried to sea by a vessel just leaving the island. On the second day, at sea, a rag, on which was written a message, was attached to the bird's feet, who returned to the nest, bringing with it the intelligence from the departed vessel. This experiment succeeded so well, that, subsequently, these birds were carried from Howland's to Baker's Island (forty miles distant), and, on being liberated there, one after the other, as occasion demanded, brought back messages, proving themselves useful in the absence of other means of communication.

There are several varieties of Tern; those described above, however, being the only kinds that are found in very considerable numbers. The game birds, snipe, plover, and curlew, frequent the islands in the fall and winter, but I never found any evidence of their breeding there.

They do not leave the island in quest of prey, but may be seen at low tide picking up their food on the reef, which is then almost dry.

Some of the social habits of these birds are worthy of remark. The gannets and boobies usually crowd together in a very exclusive manner; the frigate birds likewise keep themselves distinct from other kinds; the tern appropriate to themselves a certain portion of the island; each family collects in its accustomed roosting-place, but all in peace and harmony. The feud between the fishing birds and their oppressors, the frigate birds, is only active in the air; if the gannet or booby can but reach the land and plant its feet on the ground, the pursuer gives up the chase immediately.

Besides the birds there were but few original inhabitants found upon the islands. Among those I observe several varieties of spiders, at least two of ants, a peculiar species of fly that attaches itself to the larger birds and the common house fly, which latter, however, may have been recently introduced. They, as well as common red ants, are exceedingly abundant.

Rats were found on all these islands, especially on Howland's, where they had become astonishingly numerous. It would seem that they had been carried there long ago, as there are no traces of recent shipwreck on the island, and had multiplied extensively. On Jarvis's Island they were much less numerous, and were probably brought by a ship that was wrecked there thirty years since. They subsist on eggs, and also, as I observed on Baker's Island, by sucking the blood of the smaller birds—the tern and noddies; and in this connection I may observe that these smaller kinds of birds, described above, are almost entirely wanting on Howland's, and their absence, I think, may be attributed to the depredations of the rats. These rats of Howland's Island were almost as numerous as the birds. They are of very small size, being hardly larger than a large mouse, and, I think, must have degenerated from their original state in consequence of the change of climate, food, and condition of life. They had completely overrun the island, and on its first occupation by men were a great annoyance. For many nights in succession a barrel containing a few oats caught over 100, and I have known over 3300 to have been killed in one day by a few men employed for the purpose.

A species of small lizard was also found in great numbers on Howland's Island, some specimens of which I had preserved in spirit, but the package containing them was lost on the voyage home.—*Silliman's Journal, September* 1862.

MISCELLANEOUS.

Distinctions between Man and Monkeys.—Wagner, in his paper on the structure of the brain in man and monkeys,* though always remarking that man is distinct from the Quadrumana, has not met the objections of Huxley; nor are we aware that Gratiolet has given any data for clearing up the apparent inconsistency in separating man as a sub-class, upon the structure of his brain, from the quadrumanes, while as great or greater differences exist among the genera of that order. But while it would be interesting to know how far the brains of the Prosimiæ are essentially identical with those of the true Simiæ, the formation of the sub-class, Archencephala, as co-ordinate to that of the Gyrencephala, does not seem to depend on such an identity. For man may be so separated on other grounds. On the distinction of mind, as is well known, he has already been removed by some zoologists to a separate sub-kingdom, or even declared not to be the subject of zoologic classification. There being

* Archiv. fur Naturgeschichte, 1861.

such strongly-marked distinctions then, and these—the faculties of mind —being so closely related to the cerebrum as their organ, a uniform variation existing in this remarkably human organ would be sufficient, were there no other external distinctions to characterise man from the most anthropoid apes, or really from the whole of the Gyrencephala; though the same amount of variation could not be used for separating the genera of an order in which this organ and its function are not a characteristic feature. Not that this organ is peculiar to man, but that it is emphasized in him, and that the high exercise of its function is one of his most marked traits. As such, a variation, and especially a variation in the method of development, as shown by Gratiolet, is really of great force: granting, however, that if the distinctive faculties of mind did not follow this variation as a normal result, the mere variation in itself could not have such weight. Hence we think Huxley's objections are rather against the separation of man as *Archencephala*, than against the separation itself; and as such more specious than real, for it would be of equal force in logic to object against it that the ruminant or cetacean brain differs more from the quadrumane than that of man does from the chimpanzee's.

But the brain, however important in function, is really an obscure internal organ; and since there is so complete a relation between the external form and the mind, even some external feature would better have been chosen as characteristic of the sub-class. It has long been observed, that man is more justly characterised by his great toe than by his thumb, by his foot than by his hand, since the former imply the erect attitude. When we see how the gradual elevation of the brain-end of the body runs parallel with an elevation of zoologic grade, as shown by C. G. Carus and others, we see one mark of high rank in this striking external trait. When we further consider that the locomotive function as performed by the spine and mesial fins in lower vertebrate forms is gradually shared by members not on the mesial line, and becomes more and more exclusively the work of these members, while the spine is successively shortened, until in man we have only the posterior pair of members applied to locomotion, we find another character of elevation in this posture. Carus has remarked, that in using only one pair of members for locomotion, and leaving the other pair free to sensation and esthetic uses, man stands alone among animals. More recently Professor Dana has mentioned the same idea to the writer, and has further emphasized it, by observing that this application of members to the uses of the head in man is analogous to that cephalization, which he has long ago shown to be a principle of elevation in the Crustacea.

To sum up, then, in regard to the other Bimana. The thumb and hands of the gorilla are far more powerful than those of man. But they are really organs of locomotion in these arboreal animals. Man alone has a foot with toe and heel that plants itself firmly; he alone stands erect among beasts; he alone, having four well-developed members, uses only two for progression. With him the hand is an organ of sensation, and belongs to the head, the central organ of the senses. This, and all other marked features, point to the human head as dominant over the whole body, and to the subjection of all other functions to its functions of sensation, perception, and thought.

These striking features are peculiar to man among the vertebrates, and thus on merely zoologic grounds he is clearly separated from other mammals, and justly forms a sub-class by himself, even without regard to his mental phenomena, if it were possible to conceive of their absence in such a structure.

The significance of the other sub-classes also is more evident, when we consider their size and organic development rather than their mere brain structure. Hence Professor Dana has suggested to the writer the terms Macrencephala and Micrencephala for Gyrencephala and Lissencephala, the one being principally of large forms, and the other—with the exception of the Edentata, which, however, show a sluggish overgrowth—of corresponding small forms.

The Lyencephala would seem also to be better characterised by the short gestation and the premature birth of their young, than by the greater or less development of their *corpus callosum ;* though such indications of an unfinished structure are interesting confirmations of their premature condition. It might also be objected that the term is too much like Lissencephala to be a really good one.

It is interesting to observe, in the phenomena presented by microcephals, that the typic development may be arrested, while a vegetative growth or mere increase in size may still continue in the part so arrested ; indicating two kinds of forces, typic or formative, and nutritive. The former of these is essentially hereditary, governs the embryonic life and form, and gives rise more especially to the varieties of a species ; the latter productive of growth and health, is rather influenced by the conditions of life, food, &c.—*Silliman's Journal, September* 1862.

Compressed Crania of Europe.—A curious and unexpected confirmation of the Asiatic source of the compressed crania of Europe is furnished by a discovery made at Jerusalem in 1856, by Mr J. Judson Barclay, an American traveller. The circumstances are sufficiently remarkable to merit detail. Mr Barclay having received information of an extensive cave near the Damascus Gate, entirely unknown to Franks, he resolved to explore it, in conjunction with his father and brother. The requisite permission was obtained without difficulty from the Nazir Effendi ; and they repaired to the cave, the mouth of which is situated directly below the city wall and the houses on Bezetha. Through a narrow serpentine passage which traverses it, they gained an entrance into the cavern, the roof of which is supported by numerous regular pillars hewn out of the solid limestone rock. Many crosses on the wall indicated that the devout pilgrim or crusader had been there ; and a few Arabic and Hebrew inscriptions, too much effaced to be deciphered, proved that the place was not unknown to the Jew and the Saracen. About one hundred feet from the entrance, a deep and precipitous pit was discovered containing a human skeleton. The bones were of unusually large proportions, and gave evidence, from their decayed state, of having long remained in their strange sepulchre. But the skull, though imperfect, was in good preservation ; and this the explorers brought to America, and presented to the Academy of Natural Sciences of Philadelphia, where it attracted the attention of Dr J. Aitken Meigs, and was made the subject of an elaborate communication, printed in the Academy's Transactions.

Placed in the same cabinet with the American crania collected by Dr Morton, this skull, recovered from beneath the rocky foundations of Jerusalem, presents some of the most striking characteristics of the artificially modified crania of the New World. Seen by Dr Morton, without any clue to the circumstances of its discovery, it would have been pronounced, in all probability, a Natchez skull ; shown to Dr Tschudi, even in a European collection, it would be assigned unhesitatingly as the spoil of a Peruvian grave ; but the widely-extended empire of the grandson of Ferdinand and Isabella fails to account for the discovery of such a skull, with all the remains of the skeleton, in an ancient quarry-cavern of Jerusalem. The most remarkable feature is, that the occipital bone rises vertically from the posterior margin of the foramen magnum to meet the parietal bones, which bend abruptly downward between their lateral protuberances. After minutely describing the appearance which the several bones present, Dr Meigs expresses his conviction that the head has been artificially deformed, by pressure applied to the occipital region during early youth; and thus recognises in it an indisputable proof of the practice in ancient Asia of the same custom of distorting the human head, which was long regarded as peculiar to America."—*D. Wilson, "Prehistoric Man."*

Guesses at the Age of Man are summed up as follows:—"Here it is obvious we are dealing with no incomprehensible series of cycles of time. There are, indeed, difficult questions still requiring the illumination which farther observation and discovery may be expected to supply; nor have such been evaded in these researches; but the present tendency is greatly to exaggerate such difficulties. The first few steps in the progress thus indicated cannot be reduced to a precise chronology. The needful compass of their duration may be subject to dispute; and the precise number of centuries that shall be allowed for their evolution may vary according to the estimated progress of infantile human reason; but I venture to believe, that to many reflecting minds it will appear that by such a process of inquiry we do in reality make so near an approach to a beginning, in relation to man's intellectual progress, that we can form no uncertain guess as to the duration of the race, and find, in this respect, a welcome evidence of harmony between the disclosures of science and the dictates of Revelation."—*D. Wilson, "Prehistoric Man."*

Saltness of the Ocean.—The mean of 140 complete analyses gives 34·304 of salt in one thousand parts of water, unequally distributed over 16 regions. But the specimens being principally taken at lower latitudes, this mean is too high. If we take 34 in one thousand parts as the mean saltness of the sea at the mean atmospheric pressure, and give the results in differences of ten thousandths from this mean, they will become more perspicuous.

Thus the mean saltness of the Atlantic (35·77 thousandth) is expressed by + 17·7; of the Californian Pacific + 12·2, Japanese Pacific + 4·3, Indian Ocean + 1·3. These numbers confirm the conclusion of *Lenz* (Pogg. Ann. xx, 73). The Atlantic system of rivers drains by far the greater portion of the continents, and has the same position in latitude; thus the evaporation in the Atlantic must be greater than in any other part of the Ocean.

The Atlantic is divided into five regions, viz.:—

Reg.	III, Arctic region,	mean of 16	analyses.	+ 15·6
,,	II, North temperate,	,, ,, 24	,,	+ 19.5
,,	I, ,, tropical,	,, ,, 14	,,	+ 21·7
,,	X, South ,,	,, ,, 6	,,	+ 24·7
,,	XI, ,, temperate,	,, ,, 6	,,	+ 10·4
,,	XVI, Antarctic Ocean,	,, ,, 1	,,	− 54·4

Thus the tropical part of the Atlantic is the saltest, and the amount of salt regularly decreases toward the poles; yet the Northern Atlantic is more salt than the Southern (an influence of the Gulf-stream).

The first great circulation of terrestrial water is represented in these numbers: only a part of the water evaporated between the tropics directly returns to land and sea in form of rain; another part is carried to the polar regions here condensed to snow and ice, returning toward the equatorial belt either in great fresh-water currents or in veritable ice-streams, thus re-establishing the equilibrium.

Twenty-five different elements have been observed in the salt of the ocean or in plants and animals of the sea: *O*, *H*, *Cl*, *Br*, I, Fl, *S*, P, *C*, N, Si, Fe, Mn, *Mg*, *Ca*, Sr, Ba, *Na*, *Ka*: Ag, Cu, Pb, Zn, Co, Ni; but only those printed in *italics* are predominant. Of these, chlorine, sulphuric acid, lime, and magnesia, may be determined with great exactitude. Comparing all analyses of *ocean water* (including the North Sea), it is found that the relative proportion of the components is nearly constant, being,—

Chlorine 100, sulphuric acid 11·91, lime 2·95, magnesia 11·08. Total, 181·1 (for each 100 of chlorine).—*Silliman's Journal*, Sept. 1862.

PUBLICATIONS RECEIVED.

1. On the Foot-Prints of Limulus as Compared with the Protichnites of the Potsdam Sandstone. By J. D. Dawson, LL.D.—*From the Author.*

2. Journal of the Asiatic Society of Bengal. Nos. 2 and 3 for 1862. —*From the Editors.*

3. American Journal of Science and Arts, for September 1862.—*From the Editors.*

4. The Mechanics of the Heavens, and the New Theories of the Sun's Electro-Magnetic and Repulsive Influence. By James Reddie.—*From the Author.*

5. On Revolving Bodies and Centrifugal Force. By James Reddie. —*From the Author.*

6. An Appeal to Physiologists and the Press. By H. Freke, A.B., M.D.—*From the Author.*

7. Journal of the Chemical Society, for October, November, and December, 1862.—*From the Society.*

8. Proceedings of the Literary and Philosophical Society of Manchester, Nos. 1–3, for Session 1862–63.—*From the Society.*

9. The Earth and its Mechanism; being an Account of the Various Proofs of the Rotation of the Earth. By Henry Worms, F.R.A.S., F.G.S.—*From the Author.*

10. The Temperance Congress for 1862.—*From the National Temperance League.*

11. On Our Waters, their Impurities and Purification. By H. B. Condy.—*From the Author.*

12. Proceedings of the Literary and Philosophical Society of Liverpool, No. 6, Session 1861–62.—*From the Society.*

13. Bulletin de l'Academie Royale des Sciences de Belgique. 1862. Nos. 9, 10, and 11.—*From the Academy.*

14. Canadian Naturalist and Geologist, for October 1862.—*From the Editors.*

15. Annual Report of the Board of Regents of the Smithsonian Institution for the year 1860.—*From the Institution.*

16. Catalogue of Publications of the Smithsonian Institution to June 1862.—*From the Institution.*

17. Report upon the Physics and Hydraulics of the Mississippi River. Prepared by Captain A. A. Humphreys, and Lieut. H. L. Abbot.— —*From the Smithsonian Institution.*

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On the Organic Contents of the Older Metamorphic Rocks: a Review and a Classification. By John J. Bigsby, M.D., F.G.S., &c.

While engaged in the study of the regional affinities of the Silurian system, it soon became evident that several preliminary inquiries were indispensable; and among these the subject of the present essay.*

In the following pages it is proposed to treat of the circumstances under which numerous organic remains have been preserved in the metamorphosed deposits of the Carboniferous, Devonian, and Silurian formations successively.

As the general result of this inquiry, I hope to show, 1*st*, Considerable variation in the metamorphic forces; 2*d*, The not unusual mildness of their operation, often transforming instead of destroying; 3*d*, The unexpected frequency of the vestiges of life in these rocks; and, 4*th*, The conditions of their occurrence, not forgetting the injuries they have suffered.

We shall see that metamorphism has not obliterated the evidences of organic existence so completely and universally as once thought; and that the other destructive agencies, such

* It became necessary to take into account the whole series of formations as far as practicable; to ascertain the nature and value of the evidences of synchronism among strata lying apart; to examine into the doctrine of Universalism, rising anew into notice—with collateral subjects of great importance, such as the effects of oscillation, the relations of fossils (native, foreign, recurrent) to their sediments, and the circumstances connected with the intervals of rest between deposits, besides several other uncultivated but productive wastes in geological science.

as the violence of catastrophes, the slower action of oscillation, the many solvents, fluid and gaseous, and animal voracity,—the last no idle nor mean instrument,—have all been so measured out as to leave in numberless places plentiful traces of life.

Besides pointing out new and important data for the geological annalist, this paper may not be without another use; for a geologist of the highest rank declares in the "Cambridge Essays" (1857, p. 214), that "by metamorphism is meant the obliteration of organic remains; while another great authority, in his Presidential Address (1861) before the Geological Society of London, quoting from Sir Charles Lyell's "Elements of Geology" (1853), says, that metamorphic rocks, in their most normal and characteristic state, are wholly devoid of organic remains; whereas it is believed that our reader will soon see very many examples of fossils in completely altered rocks.

On Metamorphism in General.

It is desirable to premise a few words on metamorphism in general; chiefly, however, as it bears on organic remains.

Metamorphism results from very complex causes; such as, in the first place, the mechanical and chemical action of the two rocks, plutonic and sedimentary, at the moment of eruption; together with the play of molecular action. Afterwards comes the solvent power of water, heat and compression, accompanied with a very minute quantity of potash (Quart. Jour. Geol. Soc. Lond., xvii., xlviii., Horner).

Delesse describes metamorphism thus:—"I call limestone, or any rock whatever, metamorphic, which, at a date posterior to its formation, has undergone notable modifications in its chemical or physical properties; these modifications are shown by the development of different minerals, by changes in its structure of aggregation, or in its structure of separation, as well as in its chemical composition" (Bull. Soc. Geol. de France, n. s., ix. 133).* In relation, however, to the last point,

* M. Delesse (Bull. Soc. Geol. de France, n. s., xi. 567) gives another and more comprehensive definition of metamorphism in the following words:—Metamorphic rocks are Neptunian rocks, simple or mixed, which heat has modified physically and mineralogically much more than chemically; for it has only produced a crystallization, and a new association of the pre-existing elements—not a radical change of the elementary composition.

T. Sterry Hunt, F.R.S., has ascertained from numerous experiments (Hall, Palæontology of New York, iii. 16, 75), that the mineral constitution of normal and metamorphic rocks is identical; nothing is gained, nothing is lost, except form. Mr Sterry Hunt showed, by chemical examination, that the chromium, titanium, and iron, whose compounds in a crystalline form were regarded as characteristic of some of these altered rocks, exist already in an amorphous condition in the unaltered state (Canadian Journal, 1855, p. 255). Hence they are one rock; and each deposit, arenaceous, calcareous, argillaceous, &c., has its own prescribed form of alteration, but modified by proportion and variety in the earths concerned; and also by the agents in exercise at the time (Delesse, Bull. Soc. Geol. de Fr., n. s., xv. 751).

The sedimentary rocks of every period are liable to this process, from the earliest palæozoic to the tertiary; each having a few fossils spared.

The action of metamorphism upon the traces of life may be modified in amount only; or chemically, by the introduction of some foreign substance. Its tendency is not always, but usually, to injure or destroy organic structure, and this over large areas; the mode of escape open to the dead organism being either through a diminution of the metamorphic force or a certain substitution of matter; or, again, by means of a preserving agent, such as carbon or alumina.

M. Delesse gives us an instructive paragraph on the changes which take place in organic matter, when buried in silt, or left uncovered, in page 166 of his Memoir on Azote, but it is too long for quotation. He unites also with Daubree and Sterry Hunt in showing that the degree of metamorphism is greatly influenced by mineral composition, a fact well known to De la Beche and Murchison twenty-five years ago (Geol. of Russia, i. 23); but it occasionally happens that a given bed changes into some unexpected form. In this case the cause lies in its compound nature, or in a difference in permeability, or in a deficiency of alkaline carbonates. Thus, Delesse has met with a set of beds which are altered and not altered alternately, their mineral constitution not being the same. Sterry Hunt (Quart. Jour. Geol. Soc. Lond., 1859) frequently finds common limestones interstratified with crystalline schists. Striking examples of this on a large scale are minutely described by Kœchlin-Schlumberger, at Thann, Bitchweller, and near Overbach (Bull. Soc. Geol. de Fr., n. s., xvi. 681). Grüner (Bull. Soc. Geol. de Fr., n. s., xvi. 1138) presents us with similar appearance in the Department of the Loire.

In the North-West Highlands of Scotland, according to Sir R. Murchison, crystalline schists and flag-like gneiss overlie Silurian beds, only mildly affected. A similar fact is mentioned by M. Durocher as occurring in Finmark (Norway). Here a granular red sandstone, evidently sedimentary, is shut up in two beds of gneiss, above and below (Geology of Scandinavia, Mem. Soc. Geol. de Fr., vi. 98). Facts like these have hitherto received little attention. How all this takes place, chemistry goes far to explain. We will take the case of siliceous sandstone, one of the most refractory of minerals. In order to change it into quartzite, silica must become soluble, or fuse. Now, Daubree (Horner, Quart. Jour. Geol. Soc. Lond., xvii., p. 48) has shown that water, aided by moderate heat, by compression, and a very minute quantity of potash, has a solvent power over a wide range of substances, and on silica among the rest; but as M. Delesse states (Bull., n. s., xvi.), these alkalies may and do vary in quantity, and may even be absolutely wanting in places; so that the metamorphosing power acts unequally in different beds, or in different parts of the same bed. In this way, sandstones occasionally show themselves among quartzites in Nova Scotia (Dawson, Geol. of N. S.), and at Framont (Vosges), where the felspathic and petrosiliceous metamorphics were found by M. Delesse (Bull. Soc. Geol. de Fr., n. s., xvi. 248) to retain here and there both their arenaceous structure and their stratification. When sandstones contain much clay they cease to be converted into quartzite, and even continue to exhibit well defined fossils (Durocher).

It is mostly, but only mostly, from these parcels of imperfectly changed strata, in the midst of the fully metamorphosed, or about their boundaries, that we procure the vestiges of life which reveal the age of the unfossiliferous rocks around them—often a most important revelation. In becoming metamorphosed, siliceous rock (and argillaceous often) assumes a structure more compact, scaly, and conchoidal. Its density, cohesion, and hardness augment. The lines of stratification are preserved, and are coloured in different shades; the rock passing into a jasper, porcellanite, or petrosilex (Delesse). Calcareous beds, even perhaps when containing magnesia, are more easily reduced. They may probably contain their own flux.

Normal limestones alter into white, granular, and crystalline, and then develop mica, garnet, hornblende, pyroxene, spinelle, &c.; or, in union with magnesia, they give us serpentine or dolomite. The argillaceous strata are rather difficult of change. When this has been effected, the segregation of macle, staurotide, disthene, dypire, mica, garnet, hornblende, &c., takes place.*

Argillaceous shale turns into Lydian stone, as near Petrozavod on Lake Onega.† A soft foliated clay becomes a hard roofing-slate, with or without talc, chlorite, or silex. In a large area of clay slate, also undoubtedly metamorphosed, parts may be left untouched, and there retain its fossils, because, as Sterry Hunt tells us,‡ the alkaline salt being in insufficient quantity for the conversion of the whole bed, metamorphism has found its limit. With this Fournet§ agrees. For want of the alkaline base no felspar is developed, which in most cases constitutes (Delesse) the act of true metamorphism.

At Braintree (Massach.), the clay-slates yielding the *Paradoxides Harlani* are less metamorphosed than the surrounding rocks, which are syenite without a fossil.‖

The Silurian schists of Deville,¶ near Mezières (Ardennes), in places have undergone no change, except a superficial satiny glazing; but close by these beds, the same almost, in outward

* Delesse, Bull. Soc. Geol. de Fr., n. s., xvi. 224–228.

† Murchison, Sir R., MM. De Verneuil and Keyserling, Geol. of Russia, i. 23.

‡ Sterry Hunt, Geol. Reports of Canada, 1853–56, p. 169.

§ Fournet, Bull. Soc. Geol. de Fr., n. s., xvi. 241.

‖ W. B. Rogers, Proc. Amer. Acad. Arts, &c., vol. iii. p. 315.

¶ Virlet d'Aoust, Bull Soc. Geol. de Fr., n. s., xvi. 422.

appearance, are true porphyries, with large crystals of felspar imbedded. Doubtless, in the great field of nature, instances of these variations in the intensity of metamorphosis are numerous; but as this is not generally thought of, it is desirable to bring forward a few indisputable examples.

Sir H. De la Beche* observed, that in gneiss, mica, slate, and some other rocks, these variations take place along the strike as well as the dip. It is as well to observe, that mere consolidation is not metamorphism, and proceeds from different causes, such as infiltrations of water charged with silica, lime, magnesia, or of carbon.†

A kind of series may be observed in metamorphism, with local arrests at some one of the stages. Thus, shale and mudstone pass into hard slate, and so remain. This slate elsewhere passes into mica-slate; the latter into gneiss; and the gneiss into granite in innumerable instances.

A curious series of such mutations exists at Gargantua (N.E. shore of Lake Superior), and is worthy of notice as an example of mineral change. At the north end of this conspicuous headland, along the reefs on the beach, amygdaloid passes into granite, and the steps are these,—the amygdaloid first gradually loses its vesicular structure, and then for a few hundred yards becomes simply a trap, granular and tough; then slowly, bits of felspar and quartz are added, and the mass, lying east and west in thick leaves, soon takes the form of hornblendic gneiss, and is traversed by veins a foot thick of a red jaspery mineral. Finally, at a small rocky point, next to that of Gargantua proper, the rock is a true granite.‡ Here the same agencies are operating on different materials; the products therefore are different.

The State geologists of New York, and particularly Dr Emmons, twenty-three years ago, traced, near Lake Champlain, the passage of the ordinary fossiliferous rocks (Lower Silurian) into the highly inclined metamorphic strata of the State of Vermont. At a somewhat later date the same was done satisfactorily in Canadian beds of the same age, by Sir

* De la Beche, Geol. of Cornwall and Devon, p. 262.

† Ibid., Researches in Cornwall and Devon, p. 295.

‡ Quart. Jour. of Royal Institution, xviii. p. 230.

W. Logan and his able associates; but to the best of my recollection, the most graphic and precise details of the many and curious steps of this change have been furnished by James Hall, as it takes place on the north-west flank of the Appalachian Mountains.* Sir W. Logan's account of similar appearances on the south-east frontier of Canada is scarcely second to them.

Of course, it is about the line where metamorphosed strata, occupying at various inclinations elevated countries, meet the normal beds of the plains, that we find the largest areas of imperfectly altered rocks, with their organic remains and accidental minerals. This is general in Europe and America, as in Mount Paradis in Norway,† in Wales, in two known instances in France, namely, near Rieux and Limmerzel;‡ but in the Western Harz the reverse holds good (Murchison and Morris§).

The hypothesis of Sir John Herschel and of James Hall (Palæontology of New York, vol. iii.), of metamorphosis by great accumulation of sediment, does not conflict with any of the foregoing statements.

Carboniferous Formation.

It might be expected that the carboniferous strata would be greatly affected by this process, as they are commonly associated with eruptive rocks, and full of faults, but it is not so: we never see them changed into gneiss, mica-slate, hornblende-rock, &c.; and this for two reasons. The igneous rocks are there not often in such mass as to affect a considerable breadth of country; and most of the coal-measures are arenaceous or argillaceous, and thus consist of matters not easily fused; the limestones also being more mildly, or at least differently treated. The vast coal-fields of North America are in evidence of the first of these statements, for Professor H. D. Rogers observes, that no part of the United States of an equal area to Pennsylvania, full of carbonaceous deposits, has so small an

* Hall, Palæontology of New York, iii. 73.

† Durocher, Bull. Soc. Geol. de Fr., n. s., iii. 547.

‡ Elie de B. and Dufresnoy, Explic. de la Carte, &c., p. 204. 1841.

§ Murchison and Morris, Quart. Jour. Geol. Soc. Lond., xi. 441.

amount of igneous or crystalline rock.* And it is probably from the predominance of quartzose matter in the anthracite-basins of Rhode Island and of Bristol, Massachusetts, that the containing beds have suffered so little change. (Hitchcock.)†

In the anthracite region of Pennsylvania, all the substances concerned are moderately but distinctly metamorphosed. The anthracite speaks for itself. A mild graduated heat is sufficient for its formation.‡ The accompanying sandstones are micaceous and grey, resting on another sandstone which is bluish-grey and argillaceous. The shales are hard splintery slates, and a siliceous fire-clay floors the anthracite, in the form of a fine-grained blue shale. The connection between anthracite and heated igneous rocks is sufficiently plain, when it is found lying on a bed of these latter near Richmond in Virginia, as well as at Sincey, near Avallon in central France, and in Scandinavia. (W. C. Taylor.)§

Quartzose Rocks.—The sandstone overlying altered limestone in New Mexico is fine-grained, hard, light-yellow or grey, minutely laminated and highly micaceous; but it is by no means so completely changed, so dense, compact, and discoloured as the limestone on which it rests.‖ (Shumard.)

The Coal-measures of the government of Olonetz, and of the Valdai Hills in Russia, instead of having been hardened, have never been consolidated at all, perhaps from the abundance of carbon and clay disseminated throughout them;¶ for, as already referred to, the first of these substances in particular imparts to the substance it pervades, and especially to organic matters, a remarkable power of resistance to change.** We see this also in the Lower Silurian of St Petersburg, and in the black Tchernoizem-earth of Central Russia. The carboniferous sandstones in this empire are often as incoherent as the dunes of the sea-shore; *Stigmaria ficoides*, the only

* H. D. Rogers, Geol. of Pennsylvania, ii. 698.
† Hitchcock, Amer. Jour. of Science, xv. 327.
‡ De la Beche, Mem. Geol. Survey of Great Britain, i. 220.
§ Taylor, W. C., Statistics of Coal, p. 445.
‖ Shumard, G. G., M.D., Trans. Ac. Sciences, St Louis, i. 282.
¶ Murchison, &c., Geol. of Russia, i. 78.
** Delesse, Annales des Mines, 5 série, tom. xviii. p. 168.

plant they contain, representing the first and second stages of chemical changes.*

Sir R. Murchison † shows that at Tcherkask, at Popofskoe, and elsewhere, in Russia, the altered sandstones and shales of this formation take on the same appearances as in other parts of the world, as in North America, Wales, &c.,—that is, they become micaceous, hard, and dark-brown, and, like their anthracite, they resume their normal form as they continue in certain directions. We see this beautifully in South Wales, in Pennsylvania, &c.

The carboniferous sandstones of the Vosges (Delesse ‡), although entirely converted into felspathic or petrosiliceous strata, often contain well-preserved animal and vegetable remains.

In the coal-mines of Languin, near Niort (Loire Inferièure) we see vegetable impressions in sandstone, accompanied by talcose schist; and this is repeated in those of Bourgonnière, (Loire Inf.), and in Dauphiné. They are partially or wholly carbonised.§

The grits and sandstones of Thuringia, the Harz, Westphalia, and Saxony, are changed into flinty slate (the ordinary modification), not uniformly, but in patches.‖

Calcareous Rocks.—The effects of metamorphism on carboniferous limestone vary with its composition. In New Mexico, where it is magnificently developed, it is converted into a dusky-brown cellular rock, often amorphous. It is here highly inclined in most places, and has a quâquâversal dip around the granitic (Albite) mountain of the Cornudas¶ (Shumard). The usual fossils are here either obscured or obliterated; but whenever the metamorphism is moderate they appear. In the Organ Mountains of the same interesting region, this limestone is dingy brown-black, brittle and hard,** semicrystalline, highly inclined, and pronounced to be fully metamorphic by Dr Shumard, and abounding in *crinoids*,

* Murchison, Geol. of Russia, i. 77. † Ibid., i. 100.

‡ Delesse, Bull. Soc. Geol. de Fr., n. s., xi. 568.

§ Durocher, Bull. Soc. Geol. de Fr., n. s., iii. 547.

‖ Murchison and Morris, Quart. Jour. Geol. Soc. London, xi. 441.

¶ Shumard, Tr. Ac. Sc. St Louis, i. 282. ** Ibid., i. 345.

Productus cora, *Productus punctatus*, *Athyris sublilita* (Hall), *Spirifer hemiplicatus* (Hall), &c.

The limestones of the Carboniferous formation, which overspread much of Pennsylvania, Ohio, Missouri, Illinois, &c., are little affected by this species of change.

In the Oural Mountains, according to Sir R. Murchison, a coralline limestone (carboniferous) is altered into a green and white marble.

Being frequently either dolomitic or argillaceous, this limestone behaves differently under the modifying force. In the first case it may be fawn-coloured, tough, and hard, amorphous, and full of short confused cracks, as at Breedon Hill in Leicestershire, which has *orthoceratites* (some flattened and stretched), large *euomphali* and *producti*, all in fine casts. The greyish-blue and pale-grey limestones of Llangollen and Llandudno (Wales) are so tough, close-grained, and massive, as to be entitled to be considered moderately metamorphic, and yet various corals and *producti*, in the state of calcspar, are common in them.

Coquand* gives a succinct but sufficient account of Professor Henslow's striking example of change at Plas Newydd. (We have seen the original.)

Beds of clay-slate and argillaceous limestone are there traversed perpendicularly by a dyke of crystalline basalt 45 yards wide; and they are metamorphosed for 10 or 12 yards from either side of the dyke. In many places the clay-slate is converted into hard porcellanic jasper, and in the hardest part of the mass are impressions of fossil shells, *producti* especially, together with an abundance of analceine and garnets. That carboniferous limestone, as well as clay-slate, passes into flinty schist, is to be explained by its mineralogical impurity on such occasions. Alumina and silex must have been introduced by epigenesis. This occurs at Lauthenthal in Thuringia.† (Murchison and Morris).

Argillaceous Rocks.—Rocks consisting principally of clay, when altered, harden into a jasper. Thus at Kronack,‡ in

* Coquand, Traité des Roches, p. 318.

† Murchison and Morris, Quart. Jour. Geol. Soc. Lond., xi. 441.

‡ Ibid., p. 419.

Thuringerwald, the lowest carbonaceous rock, abutting against Upper Devonian and Lower Carboniferous, is a jaspidian clay-stone, followed upwards by a conglomerate containing fragments of an older porphyry. Here the coal-strata had been broken through by igneous rocks. Associated with the conglomerate, and forming its roof, is an indurated finely laminated shale, in parts resembling the "Black Bat" of Staffordshire.

We have little to say about the fossils in this portion of the metamorphic series. They often disappear by a substitution of the containing rock; a white layer of calcspar occupies the place of the shell; and even this disappears when the alteration is carried a little further. We have had reason to believe that the fossils are not so much damaged as in other epochs, and that, on the whole, they are not rare in these modified strata.

As must have already been seen, the traces of life can bear much. Where the metamorphic process is far advanced, and the rock very felspathic, coal-plants may be numerous and distinct, as at Thann (Delesse), and at Languin, as already cited.

"The effect of heat on plants," says Delesse, "when tolerably intense, is to drive off all the water and any volatile matters, leaving only a thin carbonaceous impression on the mineral substance; but since (Delesse*) the stability of organic matters is augmented by carbon and diminished by the presence of azote, we find vegetables more largely and more perfectly preserved in carboniferous strata than animal matters."

The Devonian Formation.

The nature of our materials compels us to treat this formation *en masse.*

The metamorphism of the Devonian rocks is more advanced, and wears more frequently and more completely the igneous aspect than that of any other epoch,—at least, so it seems. Examples are numerous and distinct.

Agassiz first suggested that the broad, irregularly shaped

* Delesse, Annales des Mines, 5 ser., xviii. 317.

hills of syenite, clay-slate, and white marble to the south-west of Boston (Massachusetts) are Devonian, in a paper announced, but not published; and the idea has been adopted by T. Sterry Hunt and others.* The district in question is large, and will, when properly examined, prove to contain the representatives of other periods. Among these the "primordial" has already been identified.

It is agreed that the White Mountains of New Hampshire owe a great share of their bulk to Middle Devonian strata;† now converted into gneiss, mica-slate, clay-slate, and quartzite.‡

In New Mexico, Dr G. G. Shumard has reported the presence of altered Devonian; but we have to wait for further information. D'Orbigny,§ in like manner, found in South America very large tracts of Devonian, and often in a state of intense metamorphism. Other examples (Cornwall, &c.) will appear as we proceed. Reasons founded on probability for a higher degree of change in this age are seldom of much value, and I have no other to offer.

Quartzose Rocks.—Alcide D'Orbigny informs us‖ that on the east side of the Bolivian Cordillera, and elsewhere in South America, are beds of compact quartzose sandstone, white and yellow, and passing downwards into very micaceous foliated sandstone, blackish or iron-red, and then containing fossils in thin, well-defined seams. They are impressions of *Terebratula antisiensis*, D'Orb.; *T. peruviana*, D'Orb.; *Spirifer boliviansis*, D'Orb.; *S. guicha*, D'Orb.; *Orthis Inca*, D'Orb.; *O. laticostata*, D'Orb.; *Actinocrinus?* We notice that in this sandstone the substance of the fossils is totally absorbed.

M. Grüner,¶ in his excellent paper on the Transition Formations of the Department of the Loire, describes a Devonian conglomerate as composed of the debris of previous formations,

* Hunt, American Jour. of Science, n. s., xiv. 54.

† Lyell, Second Visit to the United States, i. 84. Hall, Palæont. of New York, iii. 50.

‡ Hall, Palæontology of New York, iii. 50.

§ D'Orbigny, Travels in South America, iii. 221, 227.

‖ Ibid., Cours de Palæontologie, iii. 35.

¶ Grüner, Annales des Mines, 3d series, xix. 151.

as well as of fragments of a granitoid porphyry. Resting on this is a felspathic sandstone, whose beds, being greatly disturbed by quartziferous porphyry, have no constant direction. I refer to them because they contain organic matter in the shape of anthracite,—a substance frequently seen in the Devonian of France. We have no accounts of any interest respecting organisms possibly existing in the quartzose rocks (Devonian) of Russia, Britain, N. America, &c.

Calcareous Rocks.—Both Sir William Logan* and his friend, Mr Sterry Hunt, have struck upon Devonian fossils in the white crystalline limestone of Lake Memphragog and its vicinity (eastern Lower Canada), where a large mass of granite metamorphoses and penetrates that rock. This marble is almost certainly a northern prolongation of the fossiliferous limestone of Derby and Rutland in Vermont, sixty or eighty miles to the south (Hitchcock); and it has been frequently seen, as well as the wild forests will allow, to Gaspè, along a distance of 500 miles still farther north.

Sir R. Murchison,† or one of his distinguished companions, gives a beautiful description of the effects of metamorphism on fossiliferous limestone, in the following words:—"This descent of the Kakva (Ural) would satisfy any one, with its limestone undulations and trappose alternations, of the reality of metamorphism; the limestone being dark-grey, with white veins, but red and compact near the trap. In one place, where the limestone was in absolute contact with a dyke of greenstone porphyry, it had been converted into a pure white saccharoid granular marble.

"Near the eruptive rocks these Devonian limestones are crystalline, but at certain distances they are unaltered, and contain organic remains. For long spaces, where the limestone is not absolutely saccharoid or granular, it is often compact, amorphous, and without distinct trace of bedding. Among such strata we found fossils. Even in the associated trap (like schaalstein) we found corals like those in a similar rock on the Lahn in Nassau,—*i. e.*, *Favosites polymorpha*, *F. ramosa*, *Stromatopora concentrica* [possibly in Laurentian

* Sir W. Logan, Canadian Naturalist, iv. 298.

† Murchison, Geol. of Russia, i. 401.

also], *Terebratula reticularis.*" As we also see in the Trappean ash of East Ogwell in South Devon (Godwin-Austen); the *Ogygia* in the volcanic grits of Marrington Dingle, Wales;* and the *brachiopoda* in the trap of Montreal Trenton Limestone.

Delesse† finds well preserved Encrinites and Zoophytes in the Upper Devonian marbles of the Vosges (France). They are sheathed in leaflets of talc,—the production, our author thinks, of a period subsequent to the deposition of the limestone. Coquand‡ finds *Goniatites* imbedded in the marble of Campan in the Pyrenees. It is full of the same kind of talc which is found in rocks acknowledged to be highly modified.

Durocher§ mentions that the dolomite of Gerolstein in the Eifel contains numerous Zoophytes, themselves also dolomitic.

Dr Bureau‖ describes an interesting example of the existence of Lower Devonian fossils in a metamorphosed limestone at Ebray (Loire Inferièure). It is a narrow band of limestone, inclined nearly vertically, and runs east and west to a considerable distance probably. At its north border it presents some blackish or grey limestone, interstratified with thin layers of black schists. To these succeeds a compact mass of grey limestone without show of stratification. It is here that the fossils are most numerous, and they are all Lower Devonian, especially those collected in M. Porche's quarry.

Proceeding now into Devonshire, we find Sir H. De la Beche¶ stating that certain portions of the Plymouth limestones are so connected with trappean rocks, and so intruded on by porphyry, they are so hardened and jointed, that they are to a certain degree metamorphosed.

These grey and black marbles contain many Devonian remains, such as *spirifer*, *atrypa*, *productus*, *nerita*, *pileopsis*, collected by the Rev. R. Hennah.

* Sir R. Murchison, Silur., 3d edit., p. 85.

† Delesse, Bull. Soc. Geol. de Fr., n. s., vi. 528.

‡ Coquand, ibid., vi. 528.

§ Durocher, ibid., iii. 547.

‖ Dr Bureau, ibid., xviii. 337.

¶ Sir H. De la Beche. Rep. on Devon and Cornwall, p. 64.

In the Devonian limestone of Cornwall, as in that of all epochs, my friend, Mr S. Patterson, who is well acquainted with the geology of that county, informs me that the fossil often is replaced by the containing rock, and disappears without causing the slightest change in the form of the granulation. We have seen an *Orthis* from Newton Bushell, Devonshire, which, after having been broken into four unequal portions, had been re-cemented by white calcspar, with little injury to its shape (Cabinet Museum of Practical Geology, London). A *Septæna plicata* (Sowerby) has been singularly treated: the lower quarter of one valve has been doubled down under the other, and without other injury (same Cabinet, several specimens).

The septa of the *orthoceratites* in Lower Devonian, South Devonshire, are often missing by twos and threes. When this takes place, the remaining septa, or a few of them, hang down in a larger segment of a smaller circle. Casts of their partitions, in a series of rather thick discs, rest upon each other's edges in succession, as so many counters might. (S. Devon, and Breedon, Leicestershire.) In the Torquay collection is an *orthoceras* which has been broken in the middle, and restored. An angle has been formed at the spot. Broken apices are here, as in other formations, common among univalves.

Brachiopoda at this and other periods are greatly obscured by masses of crystallized quartz or lime forming within and about them.

We are not acquainted with any cases of stretching, flattening, in the modified limestones of the Devonian.

Argillaceous Rocks.—Near Nictau,* in Nova Scotia, on the river so called, a branch of the River Annapolis, is a bed of coarse slates dipping S. 30 E. It holds a band of highly fossiliferous peroxide of iron, whose organic remains James Hall finds to be much the same as those of the Oriskany Sandstone (Devonian base) in the State of New York. They are *Spirifer arenosus*, *Strophodonta magnifica*, *Atrypa unguiformis*, *Strophomena depressa*, *Avicula*, *Bellerophon*, *Favosites*,

* J. W. Dawson, F.R.S., Geol. of Acadia, supplementary chapter, p. 64.

Zaphrentis, &c. These fossiliferous ridges of partially altered slates run a considerable distance to the west, and are then interrupted by a region of white granite, which penetrates the slates, and converts them into gneiss with garnets. On the Moose and Bear Rivers, as well as in Annapolis basin, the iron-ore and its slates recur on the east side of this granite, interlaced also with greenstone and syenite-veins. Both are in a higher state of metamorphism than near Nictau; for the iron-ore is magnetic, but still full of the Devonian fossils of Nictau.

In a memoir on the Devonian Rocks of Cornwall, Professor Sedgwick* says that he found a highly fossiliferous group of clay-slates (as we understand) ranging from New Quay by Padstow to Tintagel. In some parts of this distance it approached a central boss of granite, and there became metamorphosed. Here the Devonian rock is changed into very crystalline chiastolite slate; yet in it were some distinct impressions of the long winged spirifers of Tintagel. The "schist ardoise" of the Ardennes† is a special condition of clay-slate. It is greenish, reddish, blue, or grey. With dividing planes peculiar to itself, it is extremely fissile, but presents neither wrinkles nor folds. As subordinate beds, roofing-slates contain micaceous sandstone, quartzite, lamellar limestone, and clay-slate; the last, according to M. Thirria, holding vegetable impressions and animal remains. At Rimogne in this district, the "schist ardoise" has a lustrous surface, and is interleaved, according to M. Rozet,‡ both with quartzite and limestone. The last contains crinoids, and at Mondrepuises, &c., as we are informed by Dumont,§ there are *Trilobites* and *Strophomena*.

The flinty clay-slate of this period presents us with by far the most numerous and striking instances of distortion, squeezing, and flattening. It is possible that these appearances only occur in laminated beds.

In the hardened flinty slate from Barnstaple (North Devon)

* Sedgwick, Quart. Jour. Geol. Soc. Lond., viii. 4.

† D'Omalius, d'Halloy, and M. Thirria, Explic. Carte Geol. de Fr., p. 251. Elie de B. et Dufresnoy.

‡ Rozet and Dumont, ibid.

§ Ibid.

the *spirifers* are occasionally stretched lengthwise, and more so on one side than on the other.

Suchlike is the occasional distortion of the *Spirifer extensus* of the hard greywacke of South Petherwin (Cornwall). The Aviculas from this latter neighbourhood are often flattened and misshapen. These instances are taken from the Sharpean Cabinet of the Geological Society of London.

A Lower Devonian *Rhynchonella*, very siliceous, of Looe, in Cornwall, has commonly a brown corroded appearance, from unequal weathering most frequently; and it looks ragged, and as if gnawed round the mouth of the valves. The *Orthis circularis* of Lower Devonian from Lynmouth and Woodabay in North Devon, is similarly marked, and is coated with red iron rust.

In ferruginous flinty slate from Padstow, in Cornwall, we have a Middle Devonian *Strophomena*, much distorted. These three specimens are in the Museum of Practical Geology, London. (*D'Orbigny, Cours de Palæont., passim, for more.*)

Upper Silurian Metamorphosis.

Throughout all the countries which have been looked into geologically, Silurian strata have been met with in the metamorphosed state, and under similar circumstances. North-east America, Russia, Scandinavia, Britain, France, Spain, &c., abound with them. Magnificent instances were seen by David Forbes, Esq., F.R.S.,* in the Bolivian Andes of South America.

The great chain of the Appalachians, with whose structure Professor H. D. Rogers has familiarised us, exhibits the same phenomena; but the very few geologists who have visited small portions of the Alpine ranges of India have not as yet met with them,—as probably they will do.

The Silurian rocks of every age are, in most countries, liable to penetration and dismemberment by plutonic forces, and in every variety of form and magnitude. Metamorphism, therefore, is pretty frequent among them.

Quartzose Rocks.—As rocks of this composition, tolerably pure, are not plentiful in the Upper Silurian, and, when they

* Forbes, Quart. Jour. Geol. Soc. Lond., xvii. 60.

do occur, are usually unfossiliferous, we are only in possession of one example of an arenaceous rock of this stage being at the same time metamorphosed and fossiliferous. It is furnished by Sir R. Murchison,* who says, that in Scania there is a red micaceous sandstone, connected with argillaceous beds and porphyry (as in Norway), in which forms of *modiola* and *avicula* are met with, as well as *Leptæna depressa*, *L. euglypha*, and a *Brontes*.

Calcareous Rocks.—The Upper Silurian strata of the Appalachian chain, as they go north into Vermont, and from thence, by Memphragog Lake, through much of the Eastern Province (so called) of Canada, and for several hundred miles north-east to Gaspé, chiefly belong to the Niagara group (Wenlock) of the New York State geologists. Large masses of these strata are altered, both in the State of Vermont on the south-east frontier of Canada, and in the Notre Dame Mountains, much farther north, as Sir William Logan has told us. The calcareous strata in these localities are changed into white crystalline marble, while the accompanying schists are converted into calcareo-micaceous schists and mica-slate (Canadian Reports). Therefore their organic contents are injured and obliterated; but, as in other places, the white marbles of the Niagara period at Dudsville and Georgeville, near Lake Memphragog, exhibit many discs of *Encrinites*, *Favosites Gothlandica*, *Porites*, and *Cyathophylli*. The only instances at present remembered by me of compressed fossils, whether in normal or altered rocks of Upper Silurian Limestone, are five in the Niagara formation, and one in the Clinton (New York). They are *Fenestella prisca* (Clinton). Hall, Palæont. of New York, ii. 96; *Orthoc. annulatum*, ii. 96; *O. undulatum*, ii. 293; *O. imbricatum*, ii. 291; *Cyrtoceras cancellatum*, ii. 290; *Spirifer bicostatus*, ii. 263.

In the Trenton limestone near Quebec in Canada, I met with a *Bellerophon* within a central partition belonging to a large orthoceratite.

The calcareous bands and coarse slates on the East river of

* Sir R. Murchison, &c., Geol. of Russia, i. 646.

Pictou (Nova Scotia) resemble those of Arisaig on the east coast of Nova Scotia, rendered so well known by the Rev. D. Honeyman. They hold many of the same species of fossils, and especially *Chonetes Nova Scotica;* but here the beds are vertical, much altered, and penetrated by igneous dykes. The condition of the fossils is not mentioned; but Dr Dawson considers them to be Upper Silurian or Lower Devonian. This set of beds, much metamorphosed, and having the same fossils, recur some miles off at the east end of the Cobequid Mountains.*

In the hills of Horton † and New Canaan, Nova Scotia, we have fossiliferous strata of the Silurian age under the following circumstances. The oldest beds with fossils are the fawn-coloured and grey clay-slates of Beech Hill, whose only organic remain is the beautiful *Dictyonema Websteri.* These Beech Hill slates are of great thickness, and are succeeded to the south by a great series of coarse slates, often micaceous and sometimes a slate-conglomerate, with fragments in it of still older slates. In some parts of this series are bands of coarse, laminated, magnesian, and ferruginous limestone, containing greatly distorted fossils, crinoid joints, casts of brachiopods, trilobites, and corals. Among the last are *Astrocerium pyriforme*, and *A. venustum*, with an *Heliolites* allied to *H. elegans.* The eminent palæontologist of Albany, James Hall, regards these beds as the equivalents of the Niagara formation (Wenlock).

Sir R. Murchison ‡ found near Kushvnick, in the Ural, *Favosites Gothlandica* in white granular marble; it is therefore probably Upper Silurian. As our author receded from the igneous zone on the Ural Mountains, the altered sedimentaries (Upper Silurian) parted with their talcose, quartzose, or chloritic character, and resumed their normal state. *Leptæna uralensis* and *Terebratula* (?) are here.

On the rivers Yega-Lagra and Jezem, are beds of fetid limestone, full of encrinites and no other organic remains. On them lie thick masses of grey crystalline limestone (marble) containing indeterminable fragments of *Murchisonia*,

* Dawson, Geol. of Acadia, suppl. chap., p. 59. † Ibid., p. 60.

‡ Sir R. Murchison, Geol. of Russia, i. 380.

specimens of *Pentamerus ostiacus*, and *Calamopora alveolaris*, indications of Upper Silurian, while the subjacent rock is Lower Silurian. (Murchison, Geol. of Russ., i. 408.) M. Scheerer,* of Freiburg, in his account of the gneiss, slates, and limestones of Norway, says that he met with large beds of granular crystalline marble in the Paradis Bakken, running up more or less closely to granite. Its age is sufficiently attested by some scattered and just recognisable fossils, the *Halysites*, *Catenipora*, *&c.*

Argillaceous Rocks.—We have no materials under this head.

Lower Silurian.

The recorded instances of organic remains existing in the altered rocks of the lower stage of the Silurian epoch are more abundant than in the upper; and this, not because of any unwonted opulence in its fauna, but because of its greater and more numerous exposures; of its great thickness, the almost countless varieties of its sediments, and the frequent invasions of plutonic rocks in most of their forms.

These remarks are of very general application.

Quartzose Rocks.—In 1856, Dr Emmons † met with his Taconic system ("primordial" of Barrande) in the centre of North Carolina, some hundreds of miles to the south of his first-discovered Taconic region. It is a series of schists, white and brown sandstones, quartzites, often vitrified, and granular limestones associated with the schists. The upper division contains green clay-slates, novaculite, argillaceous sandstone, sometimes chloritic, and brecciated conglomerates. Most of the above beds indicate the agency of metamorphic and physical disturbance. Some of them, however, are but little interfered with. Singular to say, the vitrified quartzites of the lower division of this very remote deposit, 1000 feet thick, are full of a rare zoophyte, the *Palæotrochus major* and *P. minor*. And there are some faint traces of *Bryozea*, or a coral, according to Dr Leidy of Philadelphia. This *palæotrochus* has been seen of large size from the copper-bearing rocks of Point

* Scheerer, Quart. Jour. Geol. Soc. Lond., ix. 5. Foreign Memoirs.

† Emmons, Bull. Soc. Geol. de France, xviii. 235, n. s.

Kewawoonan, on the south side of Lake Superior, by Dr Leconte, an able naturalist, who was persuaded of the organic nature of these numerous bodies.

It is almost certain, that they are also in the Potsdam sandstone ("primordial" of that region).

Professor H. D. Rogers* finds, in the primal white sandstone of Pennsylvania (Potsdam sandstone), its distinctive fossil, *Scolithus linearis*, although that rock is very vitreous, and has many crystalline segregated minerals,—conditions which are to be accepted as indications of true metamorphism.

M. Pouillon Boblaye† gives several instances of the presence of Caradoc fossils in the metamorphic rocks of France, as, for example, in the quartzite of D'Ecouves and St Aubin du Cormier, near Rennes; but there is some mistake about the exact place of this quartzite, for Durocher‡ calls it primordial.

M. Caillaud,§ in a very interesting paper on a bed of white marble, for the most part Devonian, in the department of Loire Inférieure, says that a quartzite underlies it at Sion, containing a layer of three or four species of *Lingula*, among which are *L. Brimonte* and *L. Hawkei* (Rouault), together with the Bilobite of Dekay (*Cruziana* of D'Orbigny and *Fræna* of Rouault).

Calcareous Rocks.—The Lower Silurian stage, metamorphosed and normal, in Canada, with their attendant auriferous rocks, talcose slates, and chroniferous serpentines, are simply the continuations northwardly of the crystalline limestones of Western New England. Thus the great calcareous bands of the Trenton and other limestones (Low Silurian), which are found on the river Yamaska, in the eastern province of Canada, enter the state of Vermont near Missisquoi Bay, at the head of Lake Champlain; but they are there changed into the white marble of Vermont and of Berkshire (Massach.) On the weathered surfaces of these marbles James Hall finds Trenton fossils. From thence, passing south-west, they cross the river Hudson near West Point Academy, ac-

* Rogers, H. D., Professor, Geol. of Pennsylvania, i. 224.

† M. Pouillon Boblaye, Comptes Rendus, vi. 168. 1838.

‡ Durocher, Memoir on the Geol. of Scandin., p. 158.

§ Caillaud, Bull. Geol. Soc. de France, n. s., xviii. 335.

cording to Mather;* and we have calciferous sandstone and Mohawk limestone highly metamorphosed in Orange and Rockland counties, New York, as well as in Sussex county, New Jersey. They very much resemble the white marble of the Laurentian series; but they hold an abundance of the fossils and accidental minerals of the same limestones in the north just mentioned.

The Chazy and Black River limestones (auroral of Pennsylvania), we learn from Professor Rogers,† exhibit in Montgomery, Chester, and Lancaster valleys, all the gradations of metamorphism, from the earthy to compact clouded marble, and so on to hard granular limestone, dolomite, and the most largely crystalline calcspar, with segregated graphite,—the occurrence of graphite being our chief reason for introducing this quotation. No other organic remain finds mention.

Ferdinand Roemer‡ discovered in the valley of the San Saba, in Texas, some very instructive rocks of the Silurian and Carboniferous epochs. They form a sort of ring around a granite knob. The Silurian rocks, and we have now to do with no others, are Potsdam and calciferous sandstones, together with a limestone, probably the Chazy, or Bird's Eye of New York. This limestone is fawn-coloured, pure, very fine-grained, splintery, and in places crystalline. F. Roemer pronounces this calcareous bed metamorphic; but certainly it is so only in a moderate degree. Many of its fossils, however, are mutilated and otherwise imperfect; but among the easily recognisable are many *Orthocerata*, all with their septa close together. One resembles *O. montrealensis*, Billings. There are likewise *Raphistoma*, *Pleurotomaria*, and *Bellerophon*. The Potsdam sandstone is not altered, and it rests upon a coarse conglomerate of the subjacent granite. This sandstone is here represented, as elsewhere in the north-west, by alternating beds of greenish sandstone and grey limestone, containing several genera of primordial Trilobites, and some Brachiopods.

* Mather, Geol. Report on the State of New York, p. 464.

† H D. Rogers, Geol. of Pennsylvania, i. 224.

‡ Roemer, Memoir on the Geol. of Texas, Amer. Jour. of Science, n. s., vol vi.

Dr G. G. Shumard has visited this dangerous locality, rendered so by hostile Indians, and has added much to our knowledge of its geology.

Sir Roderick Murchison* has left it doubtful whether the following examples of fossils in marble belong to Upper or Lower Silurian; but they are worthy of notice. "In the upland valley of the River Miass, in the Ural, fairly jammed in between two great parallel lines of eruptive rocks, we discovered Encrinites in pure white saccharoid limestone. So highly altered is the rock, that we could still less believe our eyes than when in the Austrian Alps, with Professor Sedgwick, we discovered similar organic remains in the chloritic primarised limestone in the Tauern Alps."† Encrinites,‡ in a highly saccharine white marble, were also met with by these gentlemen at Syrostan, in the Ural.

M. Durocher§ met with an altered limestone, near Brevig, in Norway, with organic remains of the Silurian period (whether Lower or Upper he does not say). It contained numerous crystals of paranthine, a double silicate of lime and alumina.

Mr Peach,‖ the very successful explorer of difficult localities, discovered, at Durness, in Ross-shire, in the limestone marked C^2 in Sir Roderick Murchison's section, page 370, vol. xvi. of the "London Geological Society's Journal," sixteen Lower Silurian fossils, remarkably like those of North-east America. They are *Murchisonia*, *Maclurea*, two *Orthocerata* specifically American, a *Raphistoma*, and other fossils, in a mottled, greyish-blue, or whitish limestone, highly siliceous, cherty in parts, and geodiferous. It is hard, marbled, veined, and occasionally jointed, and so is to be considered as moderately but truly metamorphosed. In describing the transition formations of the department of the Loire, M. Grüner¶ finds that the Silurian beds there consist of a

* Murchison, Geol. of Russia, i. 426.

† Ibid., Geol. Trans., iii. 306.

‡ Ibid., Geol. of Russia, i. 434.

§ Durocher, Bull. Soc. Geol. de France, n. s., iii. 547.

‖ Peach, Murchison, Quart. Jour. Geol. Soc. London, xv. 366.

¶ Grüner, Annales des Mines, 3d Series, xix. 151, 152.

series of sandstones, schists, and limestones, the last usually upon the others. The schists are tender, but at their upper limits become very tough, and pass into the form of a felspathic crystalline quartzite. When these friable clay-schists are near porphyry (which they often are), they become amphibolic and talcose, changing considerably in dip and direction. The limestone intercalated with these variable masses is full of encrinital columns, *Orthis*, &c. Whether *it* is altered, M. Grüner has omitted to say.*

The granitic hill called Mont Noire, near Sorreze (Central France), is flanked on both sides by Lower Silurian limestone, both crystalline and schistose strata, however, intervening. This limestone is very splintery (scaly?), and varies from red to spotted red and brown. In this altered condition it contains *Orthocerata*.

Argillaceous Rocks.—Dr C. J. Jackson,† an American geologist of great experience, thus describes the clay-slate of Braintree, ten miles south of Boston (Massachusetts), in which *Paradoxides Harlani* occurs. It is a grey or blue clay-schist, rather metamorphosed, divided into rhomboidal prisms by natural joints. It contains silicate, but not carbonate of lime. Near the line of junction between these schists and the syenite which has acted upon them, and which also borders them on the two sides, we find *in the slate* many masses and veins of epidote, a segregation produced by the syenite. With others, Dr Jackson considers this slate to be equivalent to the "primordial" of Bohemia.

The *Paradoxides Bennetti*‡ is from Branch in Newfoundland. It is from a siliceous schist, hard, fine grained, and associated with fossils at present unknown. The rock is modified.

M. Barrande§ quotes from Dr Emmons as follows :—" The schist in which I found the *Ellipsocephalus* and the *Atops* (new genera), is on the road near Mr Reynold's house (Ver-

* Elie de Beaumont and Dufrenoy, Explic. &c., p. 158, &c.

† Jackson, L'institute, xliii. 883. W. B. Rogers, Proc. Amer. Acad. Arts and Sciences, vol. iii.

‡ Salter, Quart. Jour. Geol. Soc. Lond., xv. 552.

§ Barrande, Bull. Soc. Geol. de France, n. s., xviii. 258.

mont). The rock is a deep green schist, whose surfaces are glazed, and sometimes look as if covered with a black varnish. This schist is imperfectly fissile, and the cracked surfaces are ferruginous." We take it to be metamorphosed, because we know of no fissile, glossy, chloritic rock which is not so.

Diplograpsus secalinus of Mr Eaton has been long known in the roofing slates of Hoosic Mountain (Massachusetts), but James Hall thinks it is *G. pristis* spread out and enlarged by pressure. The Hoosic schists are very old, almost certainly primordial, for in this mountain calciferous sandstone lies upon them.

M. de Verneuil * lately brought from Astorga, in the kingdom of Leon, some slabs of black satiny slates, which, although in an advanced stage of metamorphism, exhibit some determinable impressions of *Graptolites*. These clay-slates, then, belong to the Lower Silurian of Europe, a datum of importance in the geology of that part of Spain.

The Silurian formation, apparently wanting in Italy proper, is extensive in the Island of Sardinia, and principally in two masses,—a north-eastern and a south-western. General della Marmora, in his valuable work on the Geology of Sardinia,† gives a very useful section from Flumini Maggiore, on the south-west of this island. It displays a succession of Lower Silurian beds lying directly on granite. The lowest, representing Lingula Flags, or the Primordial of Barraude, is a leptinite, compact, dark-greenish, its base felspar with mica —in fact, a kind of hornstone. It contained two distinct casts of *Orthis* (and perhaps more). The calcareous talcose shales next succeeding are also changed for considerable thicknesses into argillaceous, talcose, and, though rarely, into micaceous *slates*, containing at the same time twelve species of zoophytes, identified by Professor Meninghini of Pavia. Now these metamorphosed beds, it is important to notice, are followed upwards, conformably by an unaltered limestone, richly fossiliferous at the summit of the Lower Silurian stage, or perhaps mid-Silurian. It has yielded sixteen species of Orthoceratites, one of them being very large: *Graptolites*

* De Verneuil, Coquand, Traité des Roches, p. 310, 1857.

† Della Marmora, Geol. of Sardinia, i. 55.

(*G. priodon*); *Cardiola interrupta*, &c. (also verified by Meninghini).

Near Villagrecca* (Sardinia), is another bed of highly metamorphosed hornstone, in contorted vertical beds, and macliferous. It is in contact with a trachyte at Nuraminis, and can be traced to St Pantaleo, a little beyond which place it turns into a black carburetted clay-slate with *Graptolites*. A short way to the south of this, at Mount Serpeddi, these black schists are overlaid by schistose micaceous greywacke, with impressions of crinoid joints, lined with leaves of mica larger than those which are sprinkled through the rock itself.

On the east slope of Mount Exi, hard by, certain limestones contain many fossils, principally Orthoceratites and Encrinites, but all crushed and deformed; so that we have in this interesting locality organic remains under various metamorphic treatment.

Proceeding now to France, we meet with useful matter. Pouillon Boblaye † discovered impressions of an Orthis and of Calymene trilobites in macliferous slate, 200 yards south-east of the pond at the Salles de Rohan, near Pontivy; but the macles were not well developed there. M. Dufrenoy, however, afterwards brought from this spot specimens of remarkable beauty, in which are to be seen at the same time macles fully developed, and perfectly characterised impressions of Spirifer, Orthis, and Trilobite. Coquand was equally successful in 1844.‡ He finds the Orthides to be identical with those of Brest. One of his specimens shows clearly an insensible passage from common to macliferous clay-slate. Good examples of these changes are placed in the Museum of the School of Mines at Paris.

The beds of Lower Silurian schist, near Christiania, sometimes exhibit impressions of animal remains, even in parts which are much hardened, and which have assumed a siliceous aspect in the vicinity of granite (Durocher).§ Mr Salter informs us, in Sir Roderick Murchison's paper on the Silurian

* Della Marmora, Geol. of Sardinia, ii. 88.

† Pouillon Boblaye, Comptes Rendus, 1838, p. 186.

‡ Coquand, Bull. Soc. Geol. de France, n. s., ii. 556.

§ Durocher, Bull. Soc. Geol. de France, n. s., iii. 547.

rocks of the south of Scotland (Quart. Jour. Geol. Soc., Lond., vii. 149), that the limestone of St Aldcans, Ayrshire, is generally thick bedded or amorphous; it is highly altered, and its chief mass very dark coloured, with white veins, and soapy serpentinous saalbands. This limestone has been contorted and wrenched from its strike. It nevertheless contains many individuals of the Maclurea, some Murchisoniæ, and a Cytheropsis.

We thus learn, from the details of sixty-four cases where organic remains have been found in altered rocks, that metamorphism has dealt with them more favourably than hitherto supposed, and it has been rendered probable that there are many cases of animal life, left by a diminished modifying energy, to reward a diligent search. We learn, too, that the great divisions of the palæozoic series, as well as the smaller mineralogical subdivisions, receive from this complex force a treatment differing somewhat both in kind and intensity, but always in accordance with the principles laid down by our great investigators.

The study of metamorphism is of high importance, for it is of very extensive application. It gives us the key to the history and relations of districts which are hopelessly unintelligible to the common inquirer. The want of this key has deprived more than one eminent geologist of the pleasure of announcing splendid discoveries—discoveries which remain to reward hopeful and diligent search.

Some Account of Plants collected in the Counties of Leeds and Grenville, Upper Canada, in July 1862. By George Lawson, LL.D., Professor of Chemistry and Natural History, Queen's College of Canada.*

Having accepted a kind invitation from an eminent Canadian judge to join him on one of his circuits, I arrived at Brockville, a comfortable county town on the north bank of the St Lawrence River, at the foot of the Thousand Islands, on Monday, 30th June. We started early on the following morning (1st July), drove rapidly, and soon reached Farmersville, a village in rear of Brockville, and distant from it about

* Read before the Botanical Society of Edinburgh, February 12th, 1863.

15 miles. The only unusual plant observed on the way was *Echium vulgare*, a native of Europe, long known in Virginia as a troublesome weed, and now making its way in Canada. One remarkable instance was mentioned to me of its introduction by a farmer, and its subsequent spread for miles along an adjoining road. The woods passed through presented no unusual features. Throughout Central Canada we have the same constant succession of beech and maple in good lands, with occasional overtopping basswood and elm trees, or widely spreading butternuts; and pines, white cedars, and hickories spread their roots over thinly covered rocks, whilst *Larix americana* forms a close and impenetrable thicket growth in the swamps, constituting those "tamarack swamps" that are the terror of Canadian travellers. At Farmersville, in addition to the ordinary forest trees, there were fine groves of *Carpinus americana* (Michx.), a small tree with fluted stem, ash-coloured bark, and hard, tough timber, like ironwood. As an undergrowth, there was an abundance of *Zanthoxylum americanum*, and several species of Ribes. *Viola canadensis* was still beautifully in flower, and with it *Stellaria longifolia*, *Oxalis stricta*, an upright form with perennial roots, *Geum album*, *Osmorhiza brevistylis*, *Cryptotænia canadensis*, *Tiarella cordifolia*, *Mitella diphylla*, *Circæa alpina*, the last clustering in patches around old stumps. Scattered through the woods there was a profusion of *Cornus canadensis*, a humble species nearly as small as *C. suecica*, and differing from it in the larger, broader leaves clustered almost into a verticil at the top of the short stem. In swampy and springy spots, there were fine beds of *Naumburgia thyrsiflora*, with *Chrysosplenium americanum*, *Carex intumescens*, *C. gracillima*, with the scales of the fertile spikelets hardly awned, *C. laxiflora*, normal form, *C. stellulata*, *C. scoparia*, *C. polytrichoides*, *C. teretiuscula*, and various other Cyperaceæ and Junci. *Lemna minor* mantled the pools, and *Linnæa borealis* garlanded the black old stumps that rose out of sphagnous swamps. In such humid places, *Bryum Wahlbergii* formed broad patches. *Hypnum nitens* was found, and *Bryum argenteum* was everywhere abundant on dry, rocky, and earthy spots. *Climacium dendroides* was also collected; it is a

common moss in Canada, more so than *C. americanum.* I have gathered it in almost every locality in Canada that I have hitherto visited, and a moss so prevalent on the north banks of the St Lawrence and Lake Ontario is likely not to be rare in New York State, yet the American botanists do not seem to be well acquainted with it. A rocky shaded bank furnished many other cryptogamic plants, and the ferns were especially fine; large tufts of *Aspidium Goldianum*, with its beautiful broad, regularly divided fronds, some three or four feet long. *Cystopteris fragilis* displayed itself in several forms. A few tufts of the slender green thread-like stems of *Equisetum scirpoides* were met with, and miniature forests of the more stately *E. sylvaticum;* and there was an abundance of *Polypodium vulgare*, *Lastrea spinulosa*, var., *Osmunda regalis*, var. *spectabilis*, *Lastrea marginalis*, *Adiantum pedatum*, and *Polystichum acrostichoides*. *Neckera pennata* is common, and frequently fertile, on the trunks of white cedar (*Thuja occidentalis*), at the edges of rocky swamps, and on beech and maple in drier woods. Dr T. F. Chamberlain collected for me, not far from Farmersville, fine tufts of *Barbula ruralis* and *Selaginella rupestris*.

In the afternoon (1st July), we proceeded to Delta, passing on the way some very large and fine butternut trees (*Juglans cinerea*). Delta is a village with water-power mills, an hotel, and a few stores; it is picturesquely, but rather uncomfortably situate on the banks of a short stream that connects Upper and Lower Beverley Lakes, and which occasionally overflows its banks when from any cause a sudden rise takes place in the upper lake. The afternoon was spent in examining the locality. The village street itself afforded a number of those plants which accompany the settler and spring up around his dwelling, and which Mr Watson has well named "colonists," to distinguish them from aboriginal plants. The prevalent species in Delta were *Leonurus Cardiaca*, *Nepeta Cataria*, *Cynoglossum officinale*, *Galeopsis Tetrahit*, *Cannabis sativa*, and *Datura Stramonium*. The last, from its almost constant occurrence in our village streets, gardens, and court-yards, is a frequent cause of poisoning. Cases have been lately referred to in the newspapers, and several medical men have spoken to me of others that occurred in their private practice. In early summer time, the leaves of the Datura are mistaken for "lambs' quarters," that is *Chenopodium album*, which is in common use as a kind of spinage, and later in the season the green fruit of the Datura attracts the attention of children, who are tempted to eat it in consequence of its resemblance to some kinds of cucumbers, &c. In the summer of 1861, I believe Daturas were exposed for sale in the Quebec market-place as "pickling cucumbers;" and the same summer, persons brought to me the prickly fruit of a cucurbit, *Echinocystis lobata* (Torr. and Gr.), and the fruit of *Datura Stramonium*, which had both grown together in their gardens, to ask which was the right kind to pickle. I need hardly add that a more dangerous mistake could not be made.

There being accumulations of vegetable soil in the Delta valley, overlying, in some parts, a fine blue clay, used extensively for bricks, the indigenous vegetation was luxuriant. Basswood trees (*Tilia americana*) were in flower; *Populus grandidentata* grew beside the stream; *Fraxinus pubescens, Prunus americana*, and *P. virginiana*, attracted attention; but the original forest had been pretty well cleared, and instead of timber trees there was an abundant and luxuriant undergrowth of shrubs, many of them covered with flowers. Among the more conspicuous were *Viburnum acerifolium; Cornus paniculata*, various forms, some in flower, some in fruit; *Celastrus scandens*, with its mellow-toned foliage, sparing flowers, and flexile woody stems, twisted into all conceivable contortions among the branches to which it clung for support, and intermixed, as it often is, with the poison ivy and the more abundant *Ampelopsis quinquefolia*, whose foliage acquires such bright tints in autumn. There were likewise along the river edge dense tangled thickets of *Corylus rostrata*, whose large closed involucre envelopes the fruit, and projects beyond its apex in the form of a long beak; this involucre is densely clothed with silky bristles, like cowitch hairs, which are curved at one end, and, being easily detached, pierce the skin of the fingers. Although *C. americana* is prevalent on the plains west of Canada, and, perhaps, also *in* the extreme western part of our province, and is likewise the common species apparently in the United States, yet the *common* nut of Central Canada is certainly *C. rostrata*, which, like its classical congener of Europe, usually grows on thinly covered rocks overlooking lakes and streams.

On sloping banks there were acres of *Rubus odoratus*, covered with its masses of large purple blossoms, each rocky knoll in the background crested with little clumps of the stag-horn sumach (*Rhus typhina*), its long pinnate fern-like leaves overtopped by purple plumes of flowers. Wild vines (*Vitis cordifolia*) hung in leafy wreaths from the branches of the trees, or were thrown in luxuriant festoons over masses of crumbling rock. *Apocynum androsæmifolium* showed itself from beneath the higher bushes, and formed a low hedge-like edging along the side of the path over which its slender stalks bent beneath its neat, trim foliage, and clusters of maiden-blush flowers. Of other herbaceous plants observed were *Ranunculus recurvatus*, *Desmodium canadense*, a fine plant, *Epilobium coloratum*, *Geum album*, *Osmorhiza brevistylis*, *Cryptotænia canadensis*, *Erigeron strigosum*, *Vaccinium corymbosum*, *Rumex verticillatus*, *Alopecurus aristulatus*, *Carex festucacea*, *C. stipata*, *C. stellulata*, and one belonging to the group *Vesicariæ*, which I have not been able to determine, *Sisyrinchium bermudiense*, *Orchis spectabilis*, *Geranium Robertianum*, in the woods, quite wild, carpels much wrinkled, glabrous; *Anemone virginiana*. Of the last I find, in different localities, forms with larger cylindrical heads of carpels, and secondary pedicels without involucels; but the sepals are usually obtuse, and I am doubtful whether we have the true *A. cylindrica* (Gray), in Canada. *Phlox divaricata* was abundant, but out of flower, and *Hydrophyllum virginicum* also bore its fruit heads, shaggy with bristles. *Asarum canadense* was observed in one or two spots. *Amphicarpæa monoica* showed its long trailing shoots in the herbage of the woods. Of ferns, *Dicksonia punctilobula* was the most striking, and a singular lax form of this species, with dark foliage, was observed. *Botrychium virginicum* was very fine in dense beechen shades; *Equisetum hyemale* and *E. limosum*, both simple and branched, grew on the banks of the stream, the last usually in water.

Wednesday, 2*d July* 1862.

On this the second day of our journey, the margins and islands of Upper Beverley Lake were explored in a boat, the river which passes down by the village, and the rocky, plantless islands in the Lower Lake. Of water-plants, the most conspicuous were the white and yellow water-lilies, *Nymphæa odorata* and *Nuphar advena*, the former exhaling a delicious but delicate perfume, and often bearing on the under surface of its old leaves the beautiful alga *Phyllactidium pulchellum*. *Anacharis Alsinastrum* formed green meadows in shallow parts of the lake, where the oar brought up masses of red ochre. *Myriophyllum heterophyllum* grew in shallow muddy places, the points of its shoots bearing lanceolate, oothed, undivided leaves, projecting above the surface of the water. *Najas flexilis* was in great quantity, and fertile. Of *Ranunculus aquatilis* there was an abundance of lax, flowerless plants in deep water, having slender unbranched stems several feet in length, with very long internodes, and leaves all capillary, the segments spread in all directions (not in one plane), collapsing when taken out of the water, leaf-stalks in the form of long close sheaths.* The species of Potamogeton collected were *P. prælongus*, *P. pectinatus*, *P. gramineus*, *P. heterophyllus*, *P. lucens*, various forms of *P. natans*, and apparently floating-leaved forms of *P. lucens* or *P. fluitans*; also *P. zosteræfolius*, Schum., which is apparently *P. compressus* of Gray's excellent Manual, although not *P. compressus*, Linn., whose stems are described (Bab. Man.) as *slightly* compressed; in our plant they are perfectly flattened, leaves linear, resembling the broad flat stems, and scarcely exceeding them in breadth, with apiculate tips, three principal

* We have various other forms of *Ranunculus aquatilis* in Canada. One of these, which I gathered at Yarker in 1861, appears to be referable to *R. trichophyllus*, Godr.; stem slender, thread-like, rooting at nearly all the joints; leaves all submerged, formed of capillary segments not all in one plane, sheaths inconspicuous, receptacle globose, hispid, petals small, narrowly elliptic-ovate, faintly veined, white, with yellow claw and yellow nectary; carpels inflated on the peripheral side, conspicuously rugose when dry, with recurved or hooked tips. We have *no* Batrachian Ranunculus with *floating* leaves in this country, except indeed *R. Purshii*, a very distinct species, with bright yellow petals, which hardly belongs to the group.

veins, and numerous parallel intermediate ones, sepals very short, broad, rounded; fruit obovate keeled. Hooker and Arnott unite *P. compressus*, L., with *P. pusillus*, L. (so also Chamisso and Schlechtendal). Around the margins of the lake were collected *Eleocharis obtusa*, *E. palustris*, *Scirpus sylvaticus*, *S. lacustris*, *Juncus tenuis*, *Phalaris arundinacea*, *Chara vulgaris*, *Fontinalis antipyretica*, var. Sunken logs were enveloped in great green masses of *Spongilla fluviatilis*, which no one is likely to mistake for a plant after smelling the atrocious animal odour which it gives out in drying. The swampy margins of the lake were fringed with *Myrica Gale* the sweet gale or bog myrtle, a most abundant shrub in Canada, which, mangrove-like, spreads over the mud, and by its close habit and neat foliage marks an apparently well-defined limit of land and water around all our lakes. The low thicket-growth which it thus forms is impenetrable to a skiff or canoe, and too weak to support the weight of a man. Woe to the boat that gets aground, nestling on a bank of bog-myrtle; woe to the man who seeks a footing on its treacherous verdure, for often it represents nothing more than a floating island of old logs, turf and swamp-muck, held together by creeping roots. *Nesæa verticillata* is often associated with the bog myrtle, its flexile willow-like shoots, often 6 or 8 feet long, thrown gracefully out from the bank, and dipping their tips in the water. In winter time, when the lakes become frozen, those arched shoots trip up snow-shoe pedestrians on the ice; hence the plant is here called hobble-bush.

The islands in the upper Beverley Lake furnished *Umbilicaria Dillenii*, *U. pustulata*, *U. pennsylvanica*, *Fissidens obtusifolius*, Wils., *Funaria hygrometrica*, one or two species of Orthotrichum, several Brya, and the cliffs were fringed with *Polypodium vulgare*. The flowering plants were mostly the same as those on the mainland. One may be noticed, *Nasturtium palustre*, the form with hirsute stem and leaves and long pods, which is the common kind in Canada; but farther north and west the glabrous long-podded plant apparently prevails, of which I have specimens from Fort Good Hope, Assiniboine River, and Fort Garry (M'Tavish and Schultze) very similar to some which I gathered on the banks of the Thames at Battersea in 1851. At Sloate's Lake, Sydenham (about 18 miles north of Kingston), we have a form with reflexed hairs and short, almost truly globular pods, which may be *N. hispidum*, DC.

Leaving Delta in the afternoon, we proceeded to the retired village of Newboro-on-the-Rideau. The Rideau Canal, which connects the two distant cities of Ottawa and Kingston, consists chiefly of a series of lakes, some of them of great extent; in fact, much of the country lying between Ottawa and Kingston, especially toward the latter, is interspersed with a perfect network of lakes. Newboro is located at that part of the canal known as the Isthmus, where the only great cutting occurs, and which being the highest point of the canal, forms the water-shed of the country between Kingston and Ottawa. The soil, where sandy, is poor, but there are also rich accumulations of vegetable soil in the valleys, and good oak timber is found. In the neighbourhood of Newboro, many of the plants noticed as occurring at Delta reappeared. In a marsh between Forfar and Newboro, some good aquatics were obtained, including algæ, &c. There were likewise several Glycerias, including *G. plicata*, *Lemna trisulca*, which grew not merely in pools, but mantled many broad acres of water, *Utricularia vulgaris*, *Veronica scutellata*, *Potamogeton pauciflorus*, *Typha latifolia*, *Sparganium eurycarpum* (Engelm.), our prevalent species; also a peculiar form of *Ranunculus Purshii*, with creeping stems rooted at each joint, all the leaves rounded and cleft into broad segments (none capillary). A very small Chara was likewise found, perhaps only a form of *C. vulgaris*.

Thursday, 3d July.

The immediate neighbourhood of Newboro is favourable for aquatics. In the canal cutting, and along the margins of the lakes, we obtained *Potamogeton natans*, *P. lucens*, *P. pectinatus*, *P. pauciflorus*, and another in a barren state that can only be referred to *P. Robbinsii* (Oakes); also *Anacharis*, *Naias*, *Charæ*, *Lysimachia stricta*, *Typha angustifolia*, *Acorus Calamus*, *Sparganium ramosum*, *Asclepias incarnata*, *Myrica Gale*, and *Epilobium palustre*, var. *lineare*. Here also we found *Carex pseudo-cyperus;* and on an island in Mud Lake, *C. comosa* (Boott), a species quite in the style of the former, and formerly confounded with it, but distinguished by its broader, more shortly pedicellate fertile spikes, and especially by the longer beak and two widely-spreading teeth into which it is divided.

The adjoining woods of maple, oaks, beech, and pines, yielded *Pyrolas*, *Goodyera pubescens*, *Shepherdia canadensis*, covered with beautiful scales like those of Elæagnus, *Vaccinium corymbosum*, *Mimulus ringens*, *Lycopus americana*, ferns and mosses. One of the commonest plants in the woods was *Galium triflorum*, a species which, in drying, gives out the odour of Asperula, the odour in this, as in other species, depending upon the secretion, apparently a volatile oil, of the glands at the bases of the leaves. *Cephalanthus occidentalis*, a cinchonaceous shrub common in our lake-swamps, has glands on its interpetiolar stipules precisely similar in form to those of *Cinchona Calisaya*, and it secretes also a "wax-like" matter, like the *Aceite Maria*. *Galium trifidum*, the ordinary state, and a very small one with linear leaves, were found in wet places. There were a few trees of *Prunus pennsylvanica*. In the village of Newboro, *Tragopogon pratensis* and *Rumex Patientia* were becoming naturalized, where *Solanum Dulcamara*, *Datura Stramonium*, and *Nepeta Cataria*, were already common. *Verbascum Thapsus* was abundant in the pastures, as everywhere else in Canada where I have been. The pastures around the lockmaster's house furnished an abundant supply of specimens of *Geaster*, also the more common *Bovista plumbea* and *Lycoperdon pyriforme*.

Near to Newboro there are extensive beds of magnetic oxide of iron, which are partially worked, and the ore is exported to Ohio for reduction. The ore being at the surface, the mining operation is a very simple one. The forest trees are cut down, the turfy herbage of *Adiantum pedatum*, *Polystichum acrostichoides*, *Vaccinia*, &c., is peeled of, and there lies the ore in a massive bed, requiring merely to be broken up and carted away.

Some time was spent in visiting the islands in Mud Lake, one of the numerous series of lakes of which the Rideau Canal chiefly consists. The islands are mostly bare masses of unstratified rock, covered with groves of sumach (*Rhus typhina*) and various creepers. In crevices on the bare slanting rocks, *Corydalis glauca, Danthonia spicata,* and *Silene antirrhina* were obtained, with an abundance of *Aralia hispida* and *Diervilla trifida. Polygonum cilinode,* a beautiful twining plant, was hanging in festoons from rock to rock, and running up the branches of shrubs and fallen trees, its stems often three or four yards long. This plant seems strictly to avoid limestone, our prevalent rock in the Kingston district. *Betula pumila* was also obtained, *Quercus alba,* and, in the water, *Potamogeton heterophyllus,* with various other aquatics already alluded to.

Friday, 4*th July*.

Leaving Newboro this morning, we passed through the rich farming country of Kitley. On the way a remarkable oak attracted attention, apparently a form of *Quercus macrocarpa*, with the lower half of the leaf-blade narrowed into a mere narrowly-winged petiole. In Kitley, several persons spoke of huge puff-balls having been found in the rich pastures, probably *Bovista gigantea.* Instructions were left to forward for identification any remarkable specimens of the kind that might in future appear. After a long drive over hard roads, we reached the village of Frankville in the afternoon. We found there extensive swamps and many good plants, such as *Vaccinium macrocarpum, Ledum palustre, Salix petiolaris,* Sm., *Alnus viridis, Iris versicolor, Linnæa borealis, Chiogenes hispidula, Aralia racemosa, Cornus canadensis, C. paniculata, Anemone pennsylvanica, Epilobium coloratum,* and a great number of cryptogamics. *Bryum roseum* was abundantly in fruit, and in fine condition; *Marchantia polymorpha* was in great quantity, covered with both antheridial and sporiferous receptacles; and many other musci, hepaticæ, lichenes, and fungi were collected. The following plants were also common:—*Triosteum perfoliatum, Galium trifidum, Circæa alpina, Epilobium angustifolium.* The last grows not on dry, sloping banks, like those of Glen Tilt, on which we used to gather it, but in the swampy woods, among fallen trees, often reddening the rank herbage for miles with its bright purple flowers.

In the fine beech and pine woods there was an abundant undergrowth of *Zanthoxylum americanum*, and other shrubs, such as *Ribes Cynosbati*, the prickly-fruited gooseberry; *R. rubrum*, with ripe fruit; *R. rotundifolium*, also abundantly fruited, which is the common smooth gooseberry of Central Canada. The common one in the New England States is *R. hirtellum*, according to Professor Asa Gray. *Dirca palustris* was in great quantity. This is the mousewood, a little shrub, with easily separable and remarkably tough flexible bark, which is commonly used by the farmers for thread and twine in tying up bundles of wool and other farm produce for market. It even comes into use for thongs in temporarily repairing harness, its strength is so great. I found it useful in tying up bundles of brambles and other shrubs that were too large to be placed in a vasculum. *Lonicera hirsuta* was trailing through the thickets, its long stems, with distant hirsute leaves (each more than four inches wide), throwing clusters of golden yellow flowers over the plain dull foliage of the Dirca bushes. Of brambles and raspberries there were several kinds. *Rubus strigosus*, our common red raspberry, and a near ally to the *R. Idæus* of Europe, is everywhere abundant in Canada, filling up the waste triangular spaces formed by snake fences, which, like the hedgerows of England, afford shelter to the perennial native plants long after the plough has eradicated them from the open fields. *R. occidentalis*, the black raspberry, or thimbleberry, was also abundant. It is a delicious wild fruit of peculiar flavour, and the foliage has the odour of sweet briar. I gathered one Rubus, having the habit, and with some indication of the fruit, of *R. occidentalis*, but clearly distinguished by want of the strong closely-set, hooked prickles of the pedicels which form so striking a character of that species. It may be distinct, or possibly a hybrid between *R. occidentalis* and *R. strigosus*, nearer the former. Meantime it may be characterised as *R. strigosus* var. *intermedius*, barren shoots pale purple, coated with a white glaucous bloom, not at all prickly, but with somewhat scattered, very slender, straight bristles, which are not bulbous at base; leaves pinnate on long petioles, the latter covered throughout with close-set setæ, which also extend along the midribs ; leaflets five, broadly ovate, pointed, dark-green and veiny above, whitened beneath, coarsely but regularly doubly serrate, each serrature ending in a small mucro ; terminal leaflet shortly petiolate, the others sessile, overlapping at base ; distance between the lower and upper pair of leaflets more than twice the length of the petiole of the terminal leaflet.

The only other Frankville plants that need be noticed here are *Carex gynocrates*, *C. filiformis*, *C. stellulata*, *C. aquatilis*, *Eriophorum latifolium*, *Amelanchier canadensis*, with its young shoots, leaves and fruit covered with a parasitical fungus, *Struthiopteris germanica*, *Cystopteris bulbifera*, *Onoclea sensibilis*, common in the swamps, *Pteris aquilina*, *Sphagna*, *Bovista plumbea*.

In the village street of Frankville, *Echinospermum Morisoni* and *Leonurus Cardiaca* were common, and the poisonous *Aconitum Napellus* luxuriated in flower plots in front of the houses as abundantly as it now does, or was wont to do, in the villa gardens of Newington, at Edinburgh.

On Saturday, 5th July, we returned to Brockville, in time for the afternoon train to Kingston.

Description of some New Forms of Photometer. By Thomas Stevenson, F.R.S.E., Civil Engineer. (Plate III.)

In 1850 I had constructed for me by the late Mr John Adie, a photometer, the framework of which consisted of the tubes of an old telescope, with the lenses removed, and closed at the ends by two plane discs of glass. The instrument was filled with a mixture of common writing ink and water, which acted as an absorbing medium for the rays of light in their passage from the object-glass to the eye-glass. The length of the absorbing column was varied as wanted, by the eye-glass tube sliding out or in, till the image just ceased to be visible. On the top of the telescope was fixed a cistern communicating with the interior by an orifice, and which served as a reservoir for receiving the surplus fluid, which was displaced by the sliding in of the eye-piece. The object proposed to be attained in the construction of this simple instrument was to eliminate some of the sources of error which exist in the photometers commonly used for comparing distant objects.

The photometers in general use are of two kinds. In one of these, lights are compared by increasing or diminishing the distances between them and the instrument; and in the other by increasing or diminishing the lengths of an artificial absorbing medium interposed between them and the eye. For experimenting on lights which are far removed from the observer, such as lighthouse apparatus, the latter form of instrument can, in most instances, alone be used. In such cases, a wedge-shaped prism of coloured glass is moved horizontally before the eye till the gradually increasing thickness of the interposed medium at last renders the object invisible. The intensity of the light is measured by the distance of the eye from either end of the prism, which is, of course, a direct measure of the thickness of the coloured glass at the point through which the axis of vision is directed. In this instrument there are three possible sources of error:—

1*st*, The want of homogeneity in the density of the glass itself, and the presence of striæ or other local imperfections.

2*d*, The want of uniformity in the distribution of the colouring matter throughout the whole extent of the prism.

3*d*, The variations that may exist in the polish and inclinations of the refracting surfaces as well as the risk of some parts of the surfaces being accidentally soiled by the hands of the observer while the experiments are being made.

The instrument which I had formerly constructed is obviously nearly wholly free from those sources of error; for the absorbing medium being a fluid, is uniform in its colour and density throughout the whole extent of the column, whether it be long or short, and the line of vision is in every observation restricted to the same two pieces of glass, which may be reduced to very small areas; so that all errors due to imperfection of form or deficiency of polish are manifestly constant, and therefore cease to be elements of error in determining valuations that are merely comparative. I found, however, that this instrument afforded little comfort in observation, as it was impossible to prevent leakage of the fluid between the sliding tubes.

Having had occasion, during the summer of 1860, to make some photometric observations, I was led to adopt the following improvements in the construction of photometers similar in principle to what has just been described, which it may be useful to record, as I have not anywhere seen an account of similar arrangements. Figs. 1 and 2 represent sections of an instrument similar in its construction to that already described, but which is free from the annoying leakage to which I have referred. GH in fig. 1 is the eye-piece, which, in order to shorten or lengthen the column, is thrust inwards or outwards, while J is the cistern for holding the excess of fluid, having a stop-cock at the top for allowing air to escape. EFDB is a stuffing-box filled with soft sponge, by which any leakage water is readily absorbed, and prevented from coming to the outside.

Another form of photometer is shown in figs. 3 and 4, where A is an India-rubber bag, filled with a coloured fluid, having two discs of plane glass, B and C, fixed in its sides. CD is a tube which presses against one of the sides of the India-rubber bag, and is steadied, so as to insure parallelism of the two discs, by passing through a collar, and by three small pins which fit into holes in the brass framing of the glass disc on which it abuts. F is the cistern or reservoir for holding the excess of fluid, with stop-cock attached. The length of the column of fluid is diminished or increased by compressing or expanding the sides of the India-rubber bag by means of the rack and pinion E, which moves the eye-tube out or in, and presses it against the bag. Figs. 5, 6, and 7 represent the last variety of the instrument. AGDB, fig. 5, is a brass box filled to a certain depth with coloured fluid. HIJK are two upright tubes, each having totally reflecting (45°) prisms fixed at top and bottom. The lower prisms which project into the fluid have their reflecting sides protected from contact with it, in order to insure total reflection. The two tubes work in converging slits cut in the top of the box so as to be moved from or towards the eye-glass E, which is placed in the centre of convergence of the two grooves.

Rays of light proceeding from two distant objects, and falling upon the upper prisms, are reflected down to the lower prisms, where they are again reflected, and finally pass through the column of fluid to the eye, which is placed at the glass E. By moving the prisms along the grooves, the lengths of fluid through which the rays proceeding from the two objects will pass may be varied, either until there is an equalisation in the intensity of the images, or until extinction has been effected, when the relative lengths of fluid are to be noted. In order to adapt the instrument for observing lights situated in different azimuths from the observer, and at different elevations from each other, the upper prisms are made capable of rotation round their vertical and horizontal axes, so as to present their immergent or first refracting surface in any required direction.

Figs. 8 and 9 show a method of arranging the photometers just described, which admits of the images being thrown on a piece of paper stretched over a triangular prism of wood or metal, as employed in Ritchie's Photometer, so that when both faces of the paper seem to be equally illuminated to an eye looking downwards, the tubes are then in the positions necessary for equalising the two lights. Instead of a prism covered with paper, a diaphragm of tissue paper, with a portion of it oiled, as recommended by Bunsen, may be placed vertically between the photometers.

I may mention that I have successfully used several of these forms of instrument when experimenting on the powers of different lighthouse apparatus; but I have found that, like other instruments of a similar kind, a good deal of practice is necessary before the eye becomes capable of estimating correctly the equality of any two lights.

I have now to describe a photometer of an entirely different kind from those already explained, and which, so far as I am aware, is new in principle. The more immediate object for which it was designed was to supply a meteorological rather than an optical want, though it also admits of adaptation to other photometric purposes. I have for some time back remarked that several very heavy westerly gales have been preceded, at greater or lesser intervals, by unusually dark, gloomy weather. In one case this diminution of daylight was so great as to produce a sort of noonday-twilight, and was the precursor of a heavy storm. A greater number of observations can alone determine whether the suspicion be well founded that these two atmospheric phenomena are really connected together. The prognostics of storms are of such great importance, tending as they do to the preservation of life and property, that I consider the subject worthy of being farther and more minutely investigated. The abnormal deficiency of daylight to which I have referred is so great as to admit of being readily detected by any instrument possessing only a moderate degree of sensibility. For such a purpose as that of measuring the varying amounts of daylight, it seemed necessary that the instrument should be portable and convenient for travellers. It seemed farther obvious, that to employ any absorbing medium was objectionable, for there is no known fluid which possesses a constant degree of transparency. Even though such a fluid could be found, it is still, I believe, an unsolved difficulty in physical optics to reduce the results to a numerical value; for the successive decrements of light produced by passing through equal successive lengths of fluid may not be equal. Supposing it has been found that one beam of light requires two inches of the medium to extinguish it, while another requires only one inch, we may still be unable, from such data, to arrive at accurate quantitative values. Could the amount of daylight be ascertained, as is done in experiments on the diverging rays of lamps or candles, by simply measuring the relative distances of the photometers from the radiants, the difficulty would disappear, and we should at once be enabled to arrive at numerical values, because the decreasing intensity of a diverging cone of light is in each case inversely proportional to the squares of the given distances from the radiant.

It occurred to me that this method of trial might be attained by allowing a minute portion of daylight to pass through a small hole pierced in a diaphragm, behind which the light, spreading into the dark chamber in concentric spherical shells, would diverge over nearly 180°. The intensity of this diverging light could then be ascertained by moving a transparent diaphragm near enough the aperture to allow the eye to decipher any characters that may be inscribed on it; and in all cases the distances of the diaphragm from the aperture necessary for producing distinct vision would at once represent, in the inverse duplicate ratio, the intensities of the rays. By arranging numbers in any order unknown to the observer, the possibility of mistake, arising from his fancying that he has distinct vision when he has not, might be prevented. The ability to decipher the symbols furnishes, in each case, a certain proof that distinct vision has been attained. In fig. 10, *a* represents the minute hole by which the light is admitted; *b c d e* and *f g h i* represent the outer and inner tubes, having numerous stops in their inner surfaces to prevent stray rays from being reflected to the eye; *h* is the transparent diaphragm, which may consist either of oiled paper or ground glass, and *k l* is the shield for the observer's eye.

In order to adapt this very simple instrument to the measurement of artificial parallelized light, or of direct sun light, a small piece of tube (fig. 11), having a lens of short focal distance fixed in it, is attached to the outer end of the large tube. Rays incident upon the lens will converge to a focus in the minute orifice *a*, after which the rays will pass in a diverging cone, and be thus made susceptible of having their intensities ascertained.

Other forms of this instrument, resembling the construction of those I have adopted for the photometers with absorbing media, might be employed. The best arrangement would be to mount two of the photometers on pivots fixed on a straight rod having a transparent screen attached to it, and fitted with a training apparatus similar to that employed in Mr P. Adie's patent sextant, so that in whatever direction the photometers were pointed, their axes would form equal angles with the screen.

The only instrument for measuring the intensity of direct solar light and diffuse daylight, with which I am acquainted, is that proposed by Mr M. Ponton in the Transactions of the Royal Society of Edinburgh; but the method employed by him is different in principle from that just described. He also separated minute portions of daylight by passing them through small orifices; but the method of valuation was the employment of orifices varying in diameter from $\frac{1}{10}$th to $\frac{1}{100}$th of an inch, the intensity of the light being in each case valued by the relative *areas* of the orifices required to produce the same effect. In the instrument now described a single orifice is sufficient, and all error due to irregularity of form is constant. The intensities are in each case valued, not by the *areas* of the orifices, as in Mr Ponton's instrument, but by the *distances of the screen from the centre of divergence.*

A Record of the Plants Collected by Mr Pemberton Walcott and Mr Maitland Brown, in the year 1861, *during Mr F. Gregory's Exploring Expedition into North-West Australia.* By FERDINAND MUELLER, M.D., Ph.D., F.R.S., Government Botanist for the Colony of Victoria.*

The despatch of an exploring party to Nickol Bay, on the north-west coast of Australia, during the year 1861, under the command of F. Gregory, Esq., offered a favourable opportunity of extending our very scanty knowledge of the vegetation of this part of the Australian continent. By the arrangements of the leader, his companion Mr Maitland Brown was enabled to secure a series of botanical specimens in the interior of the country explored, whilst Mr Pemberton Walcott, who had already distinguished himself by forming botanical collections at the Murchison River towards Shark's Bay, prepared collections of such plants as were found growing in the vicinity of the landing-place. These plants were obligingly placed at my disposal for examination, and I beg to submit the result of this task in the subsequent pages.

Of the botanical features of this part of the Australian continent, we gained our first knowledge during the second voyage of the talented and enterprising Captain William Dampier in 1699 ; some of the plants collected by him either at Shark's Bay, at Dampier's Archipelago, or at Dampier's Land, we find introduced by Dr Woodward into Dampier's work, "Voyage to New Holland" (of which the edition of 1729 was accessible to me through the favour of the sons of Admiral P. P. King). Of other species, Dr Woodward fur-

* Read before the Botanical Society of Edinburgh, February 12, 1863.

nished an account in Plukenet's "Amaltheum Botanicum," vol. iv., 1705. Some of these interesting records, the first which botanical science gained from Australia, have received through R. Brown, and especially through Allan Cunningham, a modern scientific elucidation. But it seems that still several of the figures of Dampier's plants remain enigmatical; and although their absolute identification can only be effected by the inspection of Dampier's original specimens, of which, according to R. Brown (Prodr. Fl. Nov. Holl., 587), and Joseph Hooker (Introd. to the Flor. of Tasm., 1. cxiii.), at least some are fortunately preserved in the Museum of Oxford, I have hazarded an opinion on these almost archæologic relics since I had an opportunity of studying the characters of the vegetation from localities not distant from those visited by Dampier, in collections formed by Mr Aug. Oldfield and Mr Pemberton Walcott, near the Murchison River, or by personal observations in Arnhem's Land during Mr A. Gregory's North Australian expedition.

Fucus, foliis capillaceis brevissimis, vesiculis minimis donatus, tab. 2, fig. 2 = *Cystophyllum muricatum*, J. Agardh, spec. Algar., i. 231; Harv. Phycolog. Austr., vol. iii. t. 139.

Ricinoides Novæ Hollandiæ anguloso crasso folio, tab. 2, fig. 3 = seemingly *Adriana tomentosa*, Gaud.; *Solanum spinosum Novæ Hollandiæ, Phylli foliis subrotundis*, tab. 2, fig. 4 = *Solanum orbiculatum*, Dun.; *Alcea Novæ Hollandiæ, foliis angustis utrinque villosis*, tab. 3, fig. 2 = *Sida petrophila*, F.M.; Tab. 3, fig. 3, not named by Woodward, is already by R. Brown referred to *Diplolæna Dampierii*, R. Br.; *Dammara Novæ Hollandiæ, Sanamundæ secundæ Clusii foliis*, is referred by Allan Cunningham to *Beaufortia Dampierii*, A. Cunn.; *Equisetum Novæ Hollandiæ frutescens, foliis longissimis*, tab. 4, fig. 1 = a *Casuarina*.

Colutea Novæ Hollandiæ floribus amplis coccineis umbellatim dispositis macula purpurea notatis, tab. 4, fig. 2 = *Clianthus Dampierii*, A. Cun.; *Conyza Novæ Hollandiæ, angustis raris marini foliis* = *Eurybia Dampierii*, Cand. Prodr., v. 266, identified like the last by Allan Cunningham.

Fig. 1, in plate 3, cannot be recognised without reference to Dampier's specimens.

Fig. 1, in plate 2, represents evidently a *Lobelia*, closely allied to *L. Tupa*, L., and is most likely of American origin, several Brazilian plants being figured on the preceding plate.

Dryander (in Koenig and Sim's Annals of Bot., ii. 531) quotes from Plukenet's "Amaltheum Botanicum" those plants figured from Dampier's collection, omitting only that described as *Chamæleæ Arabum folio, fructu ex alis foliorum pediculis brevibus glomerato ex Hollandia Nova* which seems a phyllodineous Acacia in flower.

Tab. 450, fig. 10, illustrates an annual Composite not contained in our collections.

Tab. 451, fig. 4, represents a myrtaceous plant of the *Baeckeæ* series.

Tab. 452, fig. 4 = *Boroniæ* sp.

Tab. 454, fig. 6, seems a species of *Hydrocotyle.*

Tab. 453, fig. 2 = *Adriana tomentosa*, Gaud. Although this figure is by no means so expressive of the form of *Adriana tomentosa* as to remove all doubt of the identity, I know of no other north-west or west Australian plant to which it could be referred. Fig. 6 of the same plate, representing also a plant of Dampier's collection, although said to be of Brazilian origin, may perhaps also be referrible to the same plant.*

The next botanical collections brought from the north-west

* From the examination of a great number of plants collected in the most widely separated parts of both tropical and extra-tropical Australia, it appears that the genus *Adriana* contains not more than two (if perhaps only one species) which are subject to great variations.

These may be distinguished as follows:—

Adriana tomentosa, Gaudich., Voy. de l'Uranie et la Physicienne, Bot., 487, pl. 116; *A. glabrata*, Gaud., l. c.

A. acerifolia, Hook., in Mitch. Trop. Austr., 371; *A. heterophylla*, Hook., l. c. 124; *Trachycaryon Cunninghami*, F. M. in Transact. Phil. Soc. Vict., i. 15.; *Trachycaryon Hookeri*, F. M., l. c. 16.

Leaves all alternate, usually long-petioled, rarely some opposite and on short petioles, often trilobed.

From Gippsland through a great part of East Australia to Moreton Bay, and to beyond the Darling in the Murray Desert; on the Murchison River, at Shark's Bay, in Arnhem's Land.

If the identity of Dampier's plant could be fully established, it might be desirable to collect the above synonyms under the name of *A. Dampierii.*

Adriana Billardierii, Baillon, Etude générale du Groupe des Euphorbiacées, 406; *Croton quadripartitum*, Lab. Nov. Holl. Plant. specim. ii. 73, tab. 223;

coast were those secured by the naturalists, especially Leschenault, who accompanied the French naval expedition under the command of Captain Baudin, in the beginning of this century. No special essay is devoted to the elucidation of the botanical treasures accumulated on the occasion, but scattered notices of these plants appear in various works, especially in De Candolle's "Prodromus."

The results of the botanical observations instituted by Gaudichaud on the vegetation of Shark's Bay, during Captain Freycinet's expedition in 1817, are partially incorporated in the phytological volume and atlas of this expedition published by Gaudichaud. Other plants of Gaudichaud's are scattered, like those of Baudin's Expedition, through various works.

But the most important botanical collections from the north-west coast of Australia were derived from Allan Cunningham, who, as a companion of Captain, afterwards Admiral P. P. King, in his four arduous and important survey voyages (from 1818–1821), had an opportunity of examining the vegetation of very many coast points; of the extensive collections and observations of this celebrated botanical traveller we have only fragmentary records, and it appears that many of his plants still require to be examined, a task which will devolve on Mr Bentham, President of the Linnean Society, in the present elaboration of the universal flora of Australia, to whom, by the liberality of Robert Howard, Esq., these collections have become fully accessible.

Additions to our knowledge of the flora of this part of the globe are derived from the labours of the officers of the "Beagle," who visited the north-west Australian coast during the years 1838 and 1841.

The collections of Mr F. Gregory's expedition are interesting as bringing, for the first time, to our knowledge, some of the plants of the north-west interior, between the 20th and 24th

A. de Juss. de. Euph. Gen. Tentam., 30; *Trachycaryon Billardierii*, Kl. in Lehm. Pl. Preiss, i. 175; *T. Klotzschii*, F. M. in Transact. Phil. Soc. Victoria, i. 15.

Leaves all opposite, nearly sessile, or on very short petioles, always lobeless. Scattered along the coast, from Wilson's Promontory to Port Gregory, near Shark's Bay; occasionally inland; thus, for instance, at the Capunda between St Vincent's Gulf and the Murray River.

parallel, although these are not so numerous as would have been the case had not unfortunately a considerable portion of those specimens collected on the ranges, and which would include the greatest share of novelty, been lost during the progress of the journey.

The issue of this memoir has afforded to me the opportunity of giving publicity to some (now posthumous) observations on a composite plant by my lamented friend the late Dr Joachim Steetz of Hamburg, in whom botanical science has lost one of its most able, correct, and philosophical promoters of this age. His valuable observations I have introduced into this essay unaltered and unabridged.

The total number of plants, as brought under notice by Mr Gregory's expedition, is not sufficient in extent to warrant an opinion on the phyto-geographical features of the country traversed; but in glancing over the appended enumeration, we cannot fail to recognise, that Malvaceæ, Amarantaceæ, Convolvulaceæ, and particularly Leguminosæ, are evidently numerous in the tracts explored; whilst Compositæ, as in other parts of tropical Australia, are comparatively of inconsiderable number. The scarcity of species of Eucalyptus seems remarkable. In some instances southern genera, or even identical species, are blended with those of Arnhem's Land, and of other parts of tropical Australia, the tropical types being however by far the most preponderant. Endemic forms are not wanting, but new genera are, judging by our specimens, much less numerous, as might have been expected. It is further interesting to observe, that certain Indian and south-west Asiatic plants reappear on our north-west coast, in some instances not previously observed in any other part of Australia, whereby the list of Indo-Australian plants published by Dr Hooker (Introd. to the Fl. of Tasm., 1842–49) and supplemented in my report on the plants of Lieut. Smith's expedition to the estuary of the Burdekin, received some additions. The following Asiatic plants have come since the issue of the publications above alluded to, from various parts of Australia, under my knowledge :—

Nymphæa stellata, W. ; *Pericampylos incanus*, Miers (*fide* Benth.); *Harrisonia Brownii*, Adr. de Juss. ; *Trium-*

fetta procumbens, Forst.; *Sida Abutilon*, L.; *Sida crispa*, L.; *Tribulus alatus*, Delile; *Mollugo Cerviana*, Ser.; *Lumnitzera racemosa*, W.; *Bergia ammannioides*, Roth.; *Luffa graveolens*, Roxb. (*fide* Naudin); *Euphorbia Atoto*, Forst.; *Excœcaria Agallocha*, W.; *Crotalaria ramosissima*, Roxb.; *Cassia alata*, L.; *Cassia pumila*, Lam.; *Trichosanthes cucumerina*, L.; *Polyphragmon sericeum*, Desf.; *Lactaria calocarpa*, Hassk.; *Ficus stipulata*, Thunb.; *Peperomia reflexa*, Dietr.; *Dendrobium undulatum*, R. Br. (*fide* Lindley); *Lipocarpha microcephala*, Kunth; and *Carex pumila*, Thunb. (*fide* Benth.)

ENUMERATION OF THE SPECIES COLLECTED.

Menispermeæ.

Tinospora Walcottii—F. M. Nickol Bay.

Capparideæ.

Capparis nummularia.—Cand. Prodr., i. 246; F. M., Fragm. Phytogr. Austr., i. 143.
Nickol Bay. Closely allied to the true Caper of commerce, *Capparis spinosa*, L.

Cleome flava.—Banks in Cand. Prodr., i. 241. Nickol Bay.

Cruciferæ.

Lepidium pholidogynum.—F. M. (sect. Monoploca).
Remarkable for its somewhat lepidote ovary. Only a small fragment without leaves, and without note of the locality where it was found, occurs in the collection.

Pittosporeæ.

Pittosporum phillyroides.—Cand. Prodr., i. 347; F. M., Plants Indig. to Vict., i. 72.
Stream beds at Nickol Bay.

Malvaceæ.

Abutilon.—Sp. undeterminable.

Sida physocalyx.—F. M., Fragm. Phytogr. Austr., iii. 3.
Hammersly Ranges, on rocky declivities. The *Sida petrophila*, F. M. in Linnæa, xxv. p. 381, does not occur in the collection, although found already on the subtropical or tropical west coast by Captain Dampier, and described by Woodward (Dampier's *Voyages*, edit. 1729, p. 110, as *Alcea Novæ Hollandiæ foliis angustis utrinque villosis*, tab. iii. fig.2).

Sida otocarpa.—F. M. in Transac. Phil. Soc. Vict., i. 13.
Found in the interior during the expedition.

Sida corrugata.—Lindley in Mitch. Three Expeditions, ii. 12.
Rocky hills near Nickol Bay.

Sida tubulosa.—All. Cunn., ex. Hook. in Mitch. Tropic. Austr., p. 390.
Harding River.

Gossypium australe.—F. M., Fragm. Phytogr. Austr., i. 46; iii. 6.
Temporary dry stream, beds of the Maitland River, attaining a height of eight feet.

Hibiscus panduriformis.—Burm. Flor. Indic., p. 151, t. 47, f. 2; F. M., Fragm. Phytogr. Austr., ii. 115.
Beds and banks of the Maitland River, reaching a height of ten feet.

Hibiscus brachychlænus.—F. M., Fragm. Phytogr. Austr., iii. 5.
At Nickol Bay, and on the Fortescue River.

Hibiscus Coatesii.—F. M., Fragm. Phytogr. Aust., iii. 5.
Hammersly Range.

Malva brachystachya.—F. M., in Linnæa, xxv. 378 (sect. Malvastrum).
Hearson Island.

Sterculiaceæ.

Brachychiton platanoides.—R. Br. in Horsf. Pl. Javan. Rar., 234.
On the granite hills near Nickol Bay.—A tree attaining a diameter of the trunk of thirty inches. The branchlets strong, with thick scars. Leaves glabrous, thin, coriaceous, crowded at the summit of the branchlets, deciduous, divided to about the middle into five lobes, five nerved, 5–9 inches long, thinly net-veined, above shining, beneath paler and almost opaque; their lobes semilanceolate, divaricate entire, gradually upwards attenuated. Petioles terete, 2–4 inches long. Panicles terminal and infra-terminal, many flowered, thinly velvet-downy. Pedicels shorter than the calyx. Calyx infundibular-campanulate, 4–5 lines long, outside as well as inside thinly grey or fulvid-velutinous; its lobes five, semilanceolate, gradually upwards pointed, little shorter than the tube, at last reflexed; its tube obconical, the faux hardly turgid. Column of stamens enclosed, towards the summit glabrous, towards the base pulverulent-downy. The glomerule of the anthers measuring only about one line. Ovaries glabrous. Styles very short, also glabrous. Stigmas coherent into a hemispheric bluntly five-lobed cap. Follicles about three inches long, outside glabrous and nigrescent, contracted into a short and thick stipes, umbonate at the summit.

Tiliaceæ.

Corchorus Walcottii.—F. M., Fragm. Phytogr. Austr., iii. 9.
Nickol Bay and Hearson Island.—With this occurs a variety remarkable for its oblong leaves.

Corchorus sidoides.—F. M., Fragm. Phytogr. Austr., iii. 9.
Imperfect specimens, seemingly referrible to this species, occur in the collection; adhering to it are some fragments of Cassyta.

Triumfetta appendiculata.—F. M., Fragm. Phytogr. Austr., iii. 7.
Rocky hills near Nickol Bay.

Meliaceæ.

Owenia xerocarpa.—F. M., Fragm. Phytogr. Austr., iii. 14.
At Nickol Bay and on the Yule River.

Sapindaceæ.

Diplopeltis Huegellii.—Endl. Plant.; Hueg., p. 13; F. M., Fragm. Phytogr. Austr., iii. 12.
Sandy land, near Nickol Bay. A soft hairy variety, with pinnatilobed leaves.

Heterodendron oleifolium.—Desfont., Mémoires du Mus. d'Hist. Nat., iv. 9, t. 3.
Stream beds of the Hammersly Range.

Atalaya hemiglauca.—F. M., Fragm. Phytogr. Austr., i. 98.
Hammersly Range.

Mollugineæ.

Mollugo trigastrotheca.—F. M., Plants Indigenous to the Colony of Victoria, (note) i. 201.
Rocky sandstone hills of Hearson Island.

Caryophylleæ.

Polycarpæa longiflora.—F. M., Report on Plants collected during Babbage's Expedition, p. 8.
On granite hills near Nickol Bay. The inflorescence less contracted than usual.

Zygophylleæ.

Tribulus alatus.—Delile, Ill. p. 44.
East of Hammersly Range, growing in rocky land. Stems two to three feet long. The Australian specimens seem referrible to the African species, which, as far as can be judged from their description, are evidently apt to undergo great variations. Some specimens are hairy, others glabrous; in some, the wings of the fruit are more chartaceous, in others more membranous. It occurs rarely with four carpels. Of another Tribulus occur fruit specimens, gathered in the interior during the expedition; the carpels are glabrous and large, attaining rather more than half an inch in length, are slightly keeled but not crested at the back, almost alate-acute at the dorsal angles, and armed with two long thorns.

Tribulus Hystrix.—R. Br. in Sturt's Central Australia, vol. ii., Append. p. 69.

Sandy land in the interior of Nickol Bay.

LEGUMINOSÆ.

Acacia coriacea.—Cand., Memoir. Legum., 446.

The pedicels geminate, a little longer than the flower heads, as well as the younger Phyllodia, yellowish silky. Capitula globular, many-flowered. Bracteoles consisting of a minute rhomboid, densely ciliolate lamina, and a slender glabrous stipes. Calyx tubular, with five short and blunt lobes slightly fringed. Petals narrow, glabrous, nearly twice the length of the calyx.

Acacia holosericea.—A. Cunn. in G. Don. Gen. Syst. Dichl., Pl. ii. 407.

Alluvial flats near Nickol Bay; twelve feet high. Our specimens are imperfect, but belong apparently to this species.

Acacia Maitlandi.—F. M., Fragm. Phytogr. Austr., iii. 46.

Hammersly Ranges.

Acacia Gregorii.—F. M., Fragm. Phytogr. Austr., iii. 47.

Nickol Bay and Hearson Island.

Acacia lycopodifolia.—All. Cunn. in Hook. Icones Plant., t. 172.

On stony land of the Hammersly Ranges, six feet high.

Acacia pyrifolia.—Cand., Mem. sur la Fam. des Légumin., 447; F. M., Fragm. Phytogr. Austr., iii. 17.

At Cape Lambert and at Nickol Bay.

Acacia bivenosa.—Cand. Prodr., ii. 452; Benth. in Hook. Lond. Jour., i. 355. *A. binervosa*, Cand., Mem. sur la Famille Legum., 448.

On flats of good land near Nickol Bay; eight to ten feet. Found like *A. coriacea* and *A. pyrifolia* originally in Baudin's Expedition, but most probably on the western coast and not on the eastern coast, as stated in DC. Prodromus. Our plant agrees sufficiently with DC.'s description, except in the unimportant particular that the Phyllodia are prominently binerved.

Acacia elliptica.—All. Cunn. in Hook. Lond. Jour., i. 347.

Sandy land of Hearson's Island; four to eight feet.

Acacia xylocarpa.—All. Cunn. in Hook. Lond. Jour., i. 370.

Sandy land near the coast of Nickol Bay, and on the sides of rocky hills at Hearson's Island; three to four feet.

Acacia Farnesiana.—W. Sp., iv. 1083.

Nickol Bay.

Neptunia gracilis.—Benth. in Hook. Jour. of Bot., iv. 354.

Nickol Bay.

Cassia pruinosa.—F. M., Fragm. Phytogr. Austr., iii. 48.

Nickol Bay.

Cassia oligophylla.—F. M., Fragm. Phytogr. Austr.; iii. 49.
Nickol Bay.

Cassia venusta.—F. M., Fragm. Phytogr. Austr., i. 165.
Nickol Bay and Hammersly Range.

Petalogyne labicheoides.—F. M. in Hook. Kew Miscell., viii. 325. *P. cassioides*, F. M. l. c.
Without note of the special locality.

Bauhinia Leichardtii.—F. M. in Transact. Phil. Inst., iii. 50.
Oakover River. The tree-bean of the travellers. In the collection occur only seeds and fragments of flowers.

Erythrina sp.—Of a species of this genus, only seeds occur in the collection. Very possibly it is the *E. biloba* (F. M. in Hook. Jour. of Bot., 1857, p. 21), which was found on Sturt's Creek, and subsequently in various parts of the interior during Mr J. M. Stuart's expeditions.

Isotropis atropurpurea.—F. M., Fragm. Phytogr. Austr., iii. 16.
Hammersly Range.

Agati formosum.—F. M., Fragm. Phytogr. Austr., ii. 88.
Fortescue River. Confined to moist margins of stream beds; attains a height of thirty feet.

Sesbania australis.—F. M. in Transact. Vict. Inst., i. 36.
Hearson Island and Nickol Bay.

Rhynchosia minima.—Cand. Prodr., ii. 385.
No locality noted.

Canavallia obtusifolia.—Cand. Prodr., ii. 404.
Nickol Bay.

Cajanus confertiflorus.—F. M., Report on the Plants of the Burdekin Exped., p. 9.

Clianthus Dampierii.—All. Cunn. in Trans. Hort. Soc., 2d. ser., vol. i. 522.
Near the seabeach, at Nickol Bay, in sandy land.

Diplolobium Walcottii, F. M.
Nickol Bay.—In the seed collections of the expedition occurred the singular fruits of a leguminous plant of the astragaloid division, which seem to indicate a well-marked new genus, and to which the above name may be given. Small seedlings raised in the Botanic Garden of Melbourne produce a leaf, next to the primordial ones, long-petioled, and consisting of three leaflets, of which the lateral ones are obovate, the terminal one being larger, and verging more into an obcordate form. The following leaf is pinnate, conspicuously stalked, and consists of five obovate somewhat retuse leaflets of a few lines length, beneath beset with short, scattered, and appressed hairs. The petiolules are very short. Flowers purple, according to Mr Walcott. Their remnants, attached to the legumes, exhibit the following characters: The pedicels are at the apex minutely bibracteolate. The

fruit-bearing calyx is bent inward at the base, about 2 lines long, of pale colour, outside glabrous; its tube is almost cup-shaped; the lower tooth is semilanceolate, and longer than the upper one; all are ciliated, and inward bearded. The carina seems smooth, is rather long-unguiculate, bluntish, and (adding the claws) nearly half an inch long. The ten stamens seem all high-connate. Anthers not seen, nor style. The stipes of the pod is short, and somewhat hairy. *Legumes* grey-green, smooth, about one-third of an inch long, depressed, turgid, roundish-ovate, *perfectly bilocular*, *easily separable by septicidal division into two carpels*, short-beaked, rugose-costate, in consistence thick and hard, somewhat between horny and crustaceous. *Seeds one in each cell*, rarely two, oblique-ellipsoid, brown, somewhat shining, nearly 2 lines long. Testa thin-coriaceous. Albumen none. Radicle accumbent to the cotyledons, and of about half their length.

A fuller record of this, at least in the flora of Australia, unique plant, will be furnished when our cultivated plant is fully developed.

Tephrosia purpurea.—Pers. Synops., ii. 329.
Hills near Nickol Bay.

Indigofera enneaphylla.—L. Mant., 272.
Sandy land of Hearson's Island and Nickol Bay.

Indigofera monophylla.—Cand. Prodr., ii. 222; F. M., Fragm. Phytogr. Austr., iii. 45.
Nickol Bay; Fortescue River.

Crotalaria Mitchelli.—Benth. in Mitch. Trop. Austr., 122; F. M., Fragm. Phyt. Austr., iii. 50.
Nickol Bay.

Crotalária dissitiflora.—Benth. in Mitch. Trop. Austr., 386.
Hammersly Range.

Crotalaria Cunninghami.—R. Br. in Sturt's Central Austr., append., p. 71; Hook. Icon., 829; F. M., Fragm. Phytogr. Austr., iii. 52.
Stony places in Hammersly Range.

Psoralea leucantha.—F. M., Transact. Philos. Inst. Vict., iii. 54.
Hammersly Range.—Attaining a height of ten feet.

Psoralea pustulata.—F. M., Transac. Philos. Inst., iii. 54.
The specimens collected during Mr Gregory's expedition on the summits of rocky hills at Nickol Bay differ slightly from the original plant, gathered in Arnhem's Land, in longer silky hair, in shorter petioles, in broader leaflets, bracts, and stipules. Blossoms purple.

Psoralea lachnostachys.—F. M., Fragm. Phytogr. Austr., iii. 105.
Special locality unrecorded.

Swainsona occidentalis.—F. M., Fragm. Phytogr. Austr., iii. 46.
Common at Nickol Bay.

EUPHORBIACEÆ.

Euphorbia hypericifolia.—L. Sp. Pl. 660.
Rocky hills near Nickol Bay.

Flueggea melanthesoides.—*Leptonema melanthesoides*, F. M. in Hook. Kew Miscell., ix. 17.
In deep ravines between rocky hills of Hearson Island.—Allied to the Javanian *Flueggea microcarpa;* the leaves larger, with beneath more prominently visible net-veins.

COMBRETACEÆ.

Terminalia discolor.—F. M., Fragm. Phytogr. Austr., iii. 92.
Hearson Island.

Terminalia circumalata.—F. M., Fragm. Phytogr. Austr., iii. 91.
Nickol Bay.

MYRTACEÆ.

Melaleuca linifolia.—F. M., Fragm. Phytogr. Austr., iii. 115.
Without indication of the locality.

Eucalyptus polycarpa.—F. M., in Proceed. Linn. Soc., iii. 88.
Growing in grassy valleys at Nickol Bay.—Mr Walcott remarks that this is the only Eucalyptus noticed at Nickol Bay.

LYTHRACEÆ.

Ammannia indica.—Lam. Ill. 1555.
Springy land at Nickol Bay.

CUCURBITACEÆ.

Muckia scabrella.—Arnott in Hook. Jour., iii. 276.
Rocky hills and grassy ravines at Nickol Bay.

Cucumis jucunda.—F. M. in Transac. Phil. Inst. Vict., iii. 45.
Oakover River, and Nickol Bay.

Trichosanthes cucumerina.—L. Sp. Pl. 1432.
Somewhat hispidulous; leaves round, or reniform-cordate, angular, 5–7-lobed, remotely and sharply toothed; their terminal lobe the longest; their basal sinus deep; tendrils bifid or trifid, towards the base hispidulous; lobes of the calyx lanceolate-linear; male flowers racemose, female flowers solitary; fringes of the petals elongated, and pinnatisected; *berries ovate-fusiform, scarlet;* seeds blunt at the margin.—On bare granite hills at Nickol Bay. (Found by the author of this list on the Victoria River.) It not being ascertained beyond doubt whether the Australian plant is identical with the Indian *T. cucumerina*, I deemed it desirable to sketch out its diagnosis on this occasion. The plant is characterised by a remarkably strong and unpleasant scent, a circumstance which induced me to apply formerly to it the name *Trichosanthes olida*—leaves, 1–4 inches long, $1\frac{1}{2}$–5 inches broad. Fruit about $1\frac{1}{2}$ inch long, glabrous, smooth, contracted into a long neck. Seeds grey, compressed-ovate, indistinctly tubercled, about 4 lines long.

Umbelliferæ.

Didiscus hemicarpus.—*D. setulosus*, F. M. in papers of the Roy. Soc. of Tasm., iii. 238.

On elevated land at Cape Lambert.—The plant not being always setulose, it seems advisable to alter the original specific name of the plant.

Compositæ.

Ixiochlamys cuneifolia.—Sond. and Muell. in Linnæa, xxv., p. 466.

On sandy land near the coast at Nickol Bay.

Flaveria australasica.—Hook. in Mitch. Trop. Austr., p. 118.

In stream beds near Nickol Bay.

Pluchea Eyrea.—F. M., Report on the Plants of Babbage's Expedition, p. 11.

Without remarks on the locality.

Streptoglossa Steetzii, F. M.—Of the following genus the description is given by that careful observer, the lamented Dr Joachim Steetz. I regarded it as a subgenus of Pluchea, to which I had assigned (in the Report on the Plants of Babbage's Expedition, p. 12) the name Rhodanthemum. The *Pluchea basiflora* characterised on that occasion I have now excluded from Pluchea or Streptoglossa, Dr Steetz having pointed out its near relationship to Thespis; and although in other genera, for instance in *Ixiolæna*, similar discrepancies in the form of the pappus exist, we may assume it as generically different, and I have consequently distinguished it as *Thespidium*, in a list of plants, known from the vicinity of the Gulf of Carpentaria, and recently published as an appendix to the journal of Mr W. Landsborough's Expedition, the character of which would mainly consist in not compressed achenia, in fringeless paleæ of the pappus, and in hermaphrodite central flowers; otherwise it would be referrible to Thespis, with which it accords well in habit. Dr Steetz's remarks on Streptoglossa are as follow:—

"Was nun ihre Pflanze ist? Diese Frage ist schon von ihnen richtig vorausgesagt, es ist eine neue Gattung, für die ich den Namen *Streptoglossa* vorschlagen moegte, ohne jedoch eines anderen von ihnen beschossenen und vielleicht passenderen Benamung vorgreifen zu wollen. Die zweite Frage ist nicht so leicht zu beantworten, d. h. wohin sie gehoert, oder mit anderen Worten ihre Stellung im System. So meisterhaft naemlich auch de Candolle's Gruppierung der Gattungen in den verschiedenen Tribus der Compositæ im Allgemeinen ist, so stossen wir doch hier und da auf Pflanzen, die uns zwingen die diagnosen der Hauptgruppen etwas zu modificiren, Untergruppen mitunter einzuschalten, oder wenn wir dazu uns nicht berechtigt halten, der Pflanze eine unnatuerliche Stelle anzuweisen.

Ein solcher Fall tritt aber gerade bei ihren Pflaenzen ein. Dasselbe gehoert ohne allen Zweifel zu der Subtribus der Baccharideae, und zu der Divisio der Conyzeae, darf aber nicht dahin gebracht werden, wenn de Candolle's Diagnose darueber entscheiden soll, in der er sagt; *Capitula* heterogama aut dioica *nunquam radiata.* Corollæ omnes tubulosæ, fœmineæ sæpius in ambitu multiseriales. *Antheræ ecaudatæ.* Receptaculum epaleaceum. Folia ulterna. DC. Prodr., t. 5, p. 212. Die beiden unterstrichenen Charactere passen nun nicht auf ihre Pflanze, deren weibliche Bluethen wirklich eine Ligula haben, wenn auch eine sehr kurze, und deren Antheren in der That breviter caudatæ sind. Der Character: capitula nunquam radiata hat aber auch in der That un so weniger wissenschaftlichen Werth, als die flores fœminei tubulosi in manchen Arten in eine wirkliche kurze Ligula uebergehen, und als de Candolle selbst mehrere Arten von Conyza aufgezaehlt hat, die wirklich flores marginales breviter ligulatos haben. Dasselbe ist mit dem Character: *antheræ ecaudatæ* der Fall. De Candolle rechnet naemlich Berthelotia (Prodr. 5, p. 375) zu den Conyzein, nennt auch deren Antheren *ecaudatæ.* In der Wirklichkeit dagegen sind sie *breviter caudatæ*, wie die treffliche Abbildung in Delessert's Icones Selectæ Plantarum, tom. iv. tab. 21, fig. 4, deutlich zeigt. Ausserdem ist es unrichtig wenn de Candolle den Character der Conyzeæ l. c. als Capitula heterogama *monoica* bezeichnet. Waere dem so, dann muessten alle *flores centrales masculi* sein, d. h. einen *ungetheilten* Griffel haben. Aber sowohl Conyza als Blumea und andere haben wuerkliche flores centrales *hermaphroditos*, d. h. einen *vollstaendigen getheilten* Griffel. Ob die Achæniæ derselben fruchtbar oder steril sind, laesst sich an der getrockneten Pflanze nicht immer mit Sicherheit bestimmen; wenn naemlich die Achæniæ nicht saemmtlich zur Reife gelangt sind. Sterile central Bluethen mit gespaltenen, vollstaendigen Griffel sind aber nicht flores masculi, sondern flores steriles. Diess moege genuegen, um mich zu rechtfertigen, wenn ich ihre Pflanze zu den Conyzeen zaehte, und sie dicht neben Berthelotia setze, mit der sie die groesste Verwandtschaft hat. Dazu berechtigt mich nicht allein, das fast ganz gleich construirte capitulum das ebenfalls gleiche Involucrum, sondern auch die ganz gleiche Structur des Griffels und der Antheren, welche letzteren in beiden Gattungen mit dem nur selten so stumpfen freien Anhaengsel oberhalb des Connatios versehen und in beiden an der Basis kurz geschwaenzt sind, dazu kommt der Pappus paleaceus in der Central Bluethen von Berthelotia, der bis ihrer Pflanze in den Achænias beiderlei Bluethe paleaceus ist, und sich dadurch von der Subdivisio Euconyseæ unterscheidet, die durch einen Pappus pilosus gekennzeichnet ist.

"Wenn de Candolle dessen ungeachted Berthelotia zu den Euconyzeen zaehlt, so geschah das ohne allen Zweifel deshalb, weil er keine andere Gattung mit solchen Pappus kannte. Jetzt aber, nachem ihre neue Gattung, und eine andere neue, welche Dr Peters in Mosambique sammelte, hinzu kommen, wuerde eine vierte Subdivisio unter den Namen: Berthelotieæ aufzustellen sein, welche sich von den Euconyzeen durch ein Pappus paleaceus saltem achæniorum florum centralium unterscheiden wuerde.

"Ich gebe Ihnen nun in folgenden die detailirte Beschreibung des Capitulum de rmir guetigst uebersandten Pflanze, dei dann den Gattungscharacter der neuen Gattung bilden wuerde, wenn derselbe nicht durch die uebrigen Arten, von denen Sie schrieben, modificirt werden muesste, was ihre genaue Untersuchung derselben sehr leicht ergeben wuerde.

"*Streptoglossa*, nov. gen. *Character generis.—Capitulum* pluriflorum (15–20–florum in specie nostra), heterogamum; *floribus* omnibus fertilibus (sic in nostra specie videtur), *marginalibus* fœmineis, circiter 2–3–serialibus (10–14 in nostra) brevissime ligulatis; *centralibus* hermaphroditis, tubulosis, paucis (4–6). *Involucrum* turbinatum, disco florum subaequale imbricatum, bracteis paucis foliaceis linearibus inæquilongis suffultum; *squamis* 4–5,–serialibus, siccis, coriaceis; *intimis* et *penintimis* majoribus, subæquilongis, acuminatis, glaberrimis, margine scariosis et plus minusve purpurascentibus, *intimis* anguste-linearibus, *penintimis* conformibus sed latioribus; *exterioribus* gradatim brevioribus, ovatis, acutis, margine angustius scariosis; *extimis* satis fere immarginatis, dorso puberulis. *Receptaculum* epaleaceum, planum, alveolato–favosum (*alveolis* membranaceis, elevatis, minute fimbrilliferis). *Corollæ florum fœmineorum* tenues, basi tubulosæ, apice brevissime ligulatæ, floribus hermaphroditis æquilongæ sed tenuiores; *tubo* virescente, basi dilatato, calloso, sensim in *ligulam* tubo suo 4–5–plo breviorem, angustissimam, semiconvolutam, apice acute 2–3–dentatam, laete purpuream, expanso. *Stylus* sæpissime inclusus, basi in bulbum conicum cartilagineum desinens, tubus glaber, apice profunde bifidus; *ramis stigmaticis* æqualibus, tenuibus, semiteretibus, apice vix angustatis, obtusis, dorso convexis lævibus, pagina interiore planis et margine parce papillosis. *Corollæ florum hermaphroditorum* fœmineis duplo validiores, totæ tubulosæ, basi paullo ampliatæ, cæterum ubique aequitatæ, virescentes, apice *limbo* regulari breviter 5-dentato purpurascente terminatæ; limbi dentibus linearibus, erectis, conniventibus, leviter marginatis, obtusiusculis. *Filamenta* 5, plana, longiuscula, ima basi corollæ nervis enata, latiuscula, infra basin antherarum connectivo articulata. *Antheræ* albidæ, basi breviter caudatæ, apice in appendiculam liberam linearem continuam obtusissimam productæ, connectivo crasso brunneo percursæ. *Pollinis granula* majuscula, globosa, undique longiuscule echinulata. *Stylus* plerumque inclusus, basi in bulbum crassum cartilagineum obtuse-conicum desinens, medio tenus glaber apice breviter bifidus, et a medio (jam infra ramificationem) papillis latiusculis obtusis undique obsitus; *ramis stigmaticis* apice paullisper attenuatis, obtusiusculis, dorso papillosis. *Achænia* conformia, teretia obconica, *callo basilari* parvo albido glabro perforato aucta, pilis longis cinereis apice plerumque bidentatis sursum spectantibus, apice pappum exteriorem brevissimum mentientibus dense sericea, *nectario* punctiformi, annulo circulari, vix elevato cincto in disco epigyno majusculo superata, pappigera. *Pappus* uniserialis, paleaceus; *paleis* angustis, inæqualibus, corollam æquantibus vel subsuperantibus, albidis, nitidis, basi angustissime concretis, cartilagineis, glabris, versus medium denticulis longiusculis sursum spectantibus, distichis, utrinque dense fimbriatis, supra medium sensim angustatis, acuminatis, denticulis magis remotis.

(" Den uebrigen Theil des Gattungs characters, den Stengel, die Blaetter, die Infloreseenz, den Habitus u. s. w. characterisirend, werden Sie durch Vergleichung der uebrigen Arten leicht selbst entwerfen.)

" Genus nostrum proxime accedit ad *Berthelotiæ* DC. genus, propter fabricam analogam *capituli*, præsertim propter *involucrum* simillimum, propter *antheras* breviter caudatas, apice in appendiculam liberam *continuam*, *obtusissimam*, productus; distinguitur vero facillime, floribus fœmineis revera ligulatis, achæniis sericeis (nec glabris), pappo conformi in omnibus achæniis (nec alio in centralibus, alio in marginalibus). Habitum præterea *Conyzæ*, Less. *Blumeæ*, DC. et *Plucheæ*, Cass. generum præ se fert, egregie vero differt *pappo paleaceo* (nec piloso).

" Nomen composui e vocibus στρεπτὸς, convolutus, et γλῶσσα, ligula, alludens ad ligulam semiconvolutam, quasi et cochleariformen florum fœmineorum."

In a letter, dated Hamburg, 27th July 1860, Dr Steetz adds the following observations :—" Die Unterschiede nun, welche die mir guetigst uebersandte Gattung, fuer welche ich den namen Streptoglossa vorgeschlagen habe, von Pluchea, Cassini (der aber nur Americanische Arten damit bezeichnete, also § 3 der Gattung in de Candolle's Prodromus) trennen, sind im Ganzen folgende;

" STREPTOGLOSSA.	PLUCHEA, *Cassini*.
1. *Antheræ sagittatæ*; (die kurzen Anchængsel Pollen fuehrend, wie bei vielen Vernoniaceen. De Candolle und Les-	*Antheræ caudatæ.* (mit langen Anhængseln die keinen Pollen tragen).

" STREPTOGLOSSA.	PLUCHEA, *Cassini.*
sing nannten sie ecaudatæ, obgleich der letztere schon ihre Verschiedinheit davon beobachtete.	
2. *Flores fœminei ligulati. Ligula erecta, brevissima, subinvoluta.*	*Flores fœminei breves tubulosi, subtruncati.*
3. *Pappus paleaceus.*	*Pappus pilosus.*
4. *Capitula pluriflora.*	*Capitula multiflora, i.e.* floribus multo magis numerosis quam in Streptoglossa.

" Die indischen und afrikanischen Arten von *Pluchea* in de Candolle's Sinne, naemlich eine seiner Arten (N. 4) in § 1 und § 2 duerften eine neue Gattung bilden, da ein entschieden verschiedener habitus sie von Cassini's Pleuchea trennt und unter einander verbindet. Achænia und Pappus scheinen constant verschiedene Charactere zu bilden ; ich sage ; scheinen, denn leider kenne ich nicht alle Arten und nur wenige von den mir bekannten haben reife Achænia."

Monenteles sphæranthoides.—Cand. Prodr., v. 456.

Granite hills near Nickol Bay.—A strongly scented shrub of the height of 3 feet. The pappus in the specimens from Nickol Bay is quite similar to that of all congeners, and not wanting. It remains, therefore, meanwhile doubtful, until Cunningham's specimens are re-examined, whether his plant is rightly recognised in the specimens from Mr Gregory's Expedition, or whether these constitute a new species.

Monenteles sphacelatus.—Labill. Sert. Novo-Caledon., 43, t. 44.

At Nickol Bay. *M. intermedius* and *M. globifer* seem mere varieties of this species, which is widely distributed over tropical and subtropical Australia, descending to the Lower Darling River, and varying exceedingly according to the localities which it inhabits.

Pentalepis, nov. gen.—Capitulum pluriflorum, heterogamum. *Involucrum e foliolis quinque biseriatis constans.* Receptaculum planiusculum, paleatum. Flores marginales fertiles, fœminei, ligulati ; discales masculi, tubulosi. Antheræ ecaudatæ. *Stylus florum discalium indivisus. Achenia fertilia compressa, margine introflexa, aristulis duabus terminata ;* sterilia tenuissima, coronulam cilioso-dentatam gerentia. Herbæ striguloso-asperæ Australiæ boreali-occidentalis, *foliis oppositis* integerrimis v. serratis saltem superioribus sessilibus, capitulis fere cymoso-dispositis, paleis canaliculato-linearibus, corollis antherisque luteis. Genus a Wedelia (Wollastoniam includente), cui habitu simillimum, divergit involucro pentaphyllo, floribus discalibus ob stylum simplicem sterilibus et achæniorum radii complanatione. Pluribus etiam characteribus ad Verbesineas accedit et huic subtribui referendum erit.

Pentalepis trichodesmoides, nov. sp.—*Foliis superioribus integerrimis* et involucri squamis anguste-lanceolatis.

In vallibus rupestribus sinus Nickol Bay. Walcott. Planta (adnotante inventore) 4′ incipiente anthesi Trichodesma zeylanicum simulans, cujus tantum partes superiores vidi, quorum folia 1–2″ longa, per paria dissita, trinervia; rami glabrati; parce asperati. Involucri squamæ 4–6‴ longæ, sursum longe acutatæ, paleis paulo longiores. Ligulæ florum radialium circ. 2½‴ longæ, cuspidulatæ v. breviter bidentatæ; unguis parum puberulus. Corollæ disci superne paulo asperulæ; harum stylus sursum papillosus; achenium scabrum, vix sesquilinea longius, nonnunquam arista solitaria scabra ad 1‴ longa præditum. Achenia marginalia obovata puberula, in aristulas 2 per breves hispidulas producta, statu maturo nondum visa.

A second species, from Arnhem's Land, may be characterised as follows :—

Pentalepis ecliptoides, nov. sp.—*Foliis superioribus irregulariter serratis* lanceolatis v. ovato-lanceolatis, involucri squamis ovato- v. lato-lanceolatis.

In planitiebus virginem fluvii Victoriæ versus (28th March 1856.) Herba aspectu generali quasi Ecliptam referens. Folia superiora 1½–3″ longa, summa ad basin pedunculorum bracteas pauci-lineares lineari-v. angusto-lanceolatas formantia. Capitula longiuscule pedunculata; squamæ acutiusculæ, paleis subæquilongæ, 2½–3‴ longæ. Antheræ apice in laminam acutam productæ. Achenia sterilia sesquilinea paulo breviora; fertilia in quoque capitulo pauca, circ. 2‴ longa, obscure fusca, orbiculari-obovata, tenuiter puberula, margine incurvata, intus ad marginem prominentem paulo tuberculata, apice aristulis 2 brevibus hispidulis terminata.

GOODENIACEÆ.

Scævola Maitlandi, nov. sp.—Downy or glabrous; upper leaves linear; *inferior peduncles rather long, three-flowered; upper flowers arranged in spicate racemes;* bracteoles shorter than the flowers; teeth of the calyx short, deltoid; corolla outside glabrous or silky, inside bearded and penicillar, papillose; anthers blunt, unbearded; style downy; cilia of the indusium short; drupe small, dry, globular, two-celled.

At Nickol Bay.—This species seems identical with one collected at the Murchison River by Mr Aug. Oldfield. I named it in honour of Mr Maitland Brown, who, during the expedition, gathered all the inland species recorded in this list.

Goodenia microptera.—F. M., Fragm. Phytógr. Austr., iii. 34.
Nickol Bay.

CONVOLVULACEÆ.

Evolvulus linifolius.—L. Sp. Pl., 392.
Nickol Bay on sand plains.

Ipomæa maritima.—R. Br., Prodr., 486.
Sandy land near the coast of Nickol Bay and of Hearson Island. A runner, attaining a length of 80–100 feet. Of several other Ipomacæ only the seed-vessels are existent in the collection.

Breweria rosea.—F. M., Fragm. Phytogr. Austr., i. 233.
Hammersly Range.

SCROPHULARINEÆ.

Morgania floribunda.—Benth. in Mitch. Trop. Austr., 384; var. *latifolia;* leaves nearly ovate, as well as the flowers, large.
In moist springy land at Nickol Bay. This is one of the many extreme forms which *M. floribunda* (including *M. glabra* and *M. pubescens*) is forming in its almost universal range over the Australian continent.

ASCLEPIADEÆ.

Cynoctonum pedunculatum.—Decaisne in Cand. Prodr., viii. 529
Nickol Bay.

ASPERIFOLIÆ.

Heliotropium asperrimum.—R. Br., Prodr., i. 493.
Rocky ridges of Hammersly Range.—About 1 foot high. Flowers white. The leaves are narrowed into a distinct petiole, comparatively broader and shorter than in the plants from South Australia and South-West Australia; they are, further, more remarkably deep-crenated and more crisp; the spikes become finally elongated; the tube of the corolla is only about as long as the limb, and the style is shorter. Should these distinctions prove permanent, then the species may be separated under the name of *H. crispatum.*

Heliotropium paniculatum.—R. Br., Prodr., 494.
At Nickol Bay.

Trichodesma zeylanicum.—R. Br., Prodr., 496.
Nickol Bay.

VERBENACEÆ.

Clerodendron ovatum.—R. Br., Prodr., 511.
Rocky hills at Nickol Bay. Height about 15 feet. This and the following species cannot with certainty be identified except by collation of the Brownian specimens.

Clerodendron floribundum.—R. Br., Prodr., 511.
On high inland ranges. Attaining a height of 10 feet.

Eremophila maculata.—F. M. in papers of the Royal Society of Tasmania, iii. 297.
Elevated table land at Hammersly Range.

SOLANACEÆ.

Nicotiana suaveolens.—Lehm. Nicot., p. 43.
No indication of locality given.

Datura alba.—Nees in Transact. Linn. Soc., xvii. 73.
Flats on the Ashburton River. 3 feet high.

Solanum lithophilum.—F. M. in Linnæa, 1852, 434.
Table-land of the Hammersly Range; also at Nickol Bay. The plant is in all its parts larger than the legitimate one from Lake Torrens, yet appears not to be specifically distinct.

JASMINEÆ.

Jasminum lineare.—R. Br., Prodr., 521.
Rocky coast hills at Nickol Bay.

PLUMBAGINEÆ.

Plumbago zeylanica.—L. Sp. Plant., 215.
Nickol Bay.

LAURINEÆ.

Cassyta.—sp.
Nickol Bay.

PROTEACEÆ.

Hakea lorea.—R. Br., suppl. Prodr. Fl. Nov. Hol., p. 25.
Nickol Bay.—Capsules rather longer than an inch, nearly ovate towards the middle, gradually tapering into the base and apex; spurless.

Grevillea Wickhami.—Meisn. in Hook. Jour., 1852, p. 187.
On the Maitland River, and in river beds of the Hammersly Range.—Seemingly a variable species, attaining a height of 12 feet. Flowers scarlet.

THYMELEÆ.

Pimelea ammocharis.—F. M. in Hook. Jour., 1857, p. 24.
Twenty miles south of Nickol Bay, on sandy plains at the Maitland River. A shrub about 3 feet high. Flowers more numerous in the capitula and larger than those of the original specimens gathered in Central Australia; the leaves also larger, but otherwise this plant seems by no means specifically distinct.

AMARANTACEÆ.

Gomphrena canescens.—R. Br., Prodr. 416. Moq. in Cand. Prodr., xiii., ii., 398.

Frequent at Nickol Bay.—The staminodia exceed sometimes the length of the anthers. This species extends to Sturt's Creek, to the Victoria River, and to the Gulf of Carpentaria. The capitula are generally more or less pale, or dark, or purplish-red, but occasionally also whitish. The peduncles exceed sometimes half a foot in length.

Gomphrena Maitlandi.—F. M., Fragm. Phytogr. Austr., iii. 124, tab. xxiii.

Pyramid Hill.

Ptilotus villosiflorus.—F. M., Fragm. Phytogr. Austr., iii. 125.

No special note of habitat.

Trichinium incanum.—R. Br., Prodr., 415.

Top of Granite hills near Nickol Bay.

Trichinium rotundifolium.—F. M., Fragm. Phytogr. Austr., iii. 122. Hammersly Range.

Trichinium helipteroides.—F. M., Fragm. Phytogr. Austr., iii. 122. Nickol Bay.

Trichinium ærvoides.—F. M., Fragm. Phytogr. Austr., iii. 123.

No special note on locality.

Trichinium nobile.—Lindl. in Mitch. Three Exped., ii. 22. *T. semilanatum*, Lindl. in Mitch. Trop. Austr., 45.

Nickol Bay.—This variable species occurs all over Australia, from Arnhem's Land to the Lachlan River, and from the Gulf of Carpentaria to the Phillips River.

Hemisteirus psilotrichoides.—F. M. in Linnæa, 1852, 435.

Hammersly Range.

Arthrotrichum calostachyum.

Nickol Bay.—This plant, which seems to constitute a new genus, is here provisonally named. In the collections formed during Mr F. Gregory's expedition, only fragments without leaves occur. More perfect specimens, collected by myself in the interior of Arnhem's Land, were destroyed in their shipment from the N.W. coast to Sydney.

The spikes are 1–2 inches long, leafless, and borne on a smooth slender peduncle, and resemble those of some small flowered Trichinia; but from this genus our plant differs in one-celled anthers, and in the extreme shortness of filaments and style. But the villi of the calyx are those of a Trichinium. The capitellate stigma removes the plant from Gomphrena and Iresine, and brings it near Telanthera. I have also observed the ligulate staminodia of that genus. The leaves are at present wanting for examination. Should they prove alternate, the genus would be well established.

CYPERACEÆ.

Cyperus vaginatus.—R. Br., Prodr., 213.

Nickol Bay.

GRAMINEÆ.

Spinifex longifolius.—R. Br., Prodr., 198.
Sea-beach about Nickol Bay and Hearson Island.

Pappophorum commune.—F. M., Enum. of Plants collect. by A. C. Gregory at Cooper's Creek, p. 10.
Nickol Bay.

Andropogon exalatus.—R. Br., Prodr., 202.
On rocky hills at Nickol Bay.—A tall scented grass.

Panicum decompositum.—R. Br. Prodr., 191.
Nickol Bay.—From the seeds, according to Mr Walcott's observations, the natives prepare cakes; the grain was used formerly by the aborigines on the Murray River for the same purpose.

On Nerve-Force. By H. F. BAXTER, Esq. (Continued from Vol. XV. p. 16.)

§ 1. *On the Influence of Nerves over Absorption.* § 2. *On the Function of the Ganglia on the Posterior Roots of the Cerebro-Spinal Nerves.* § 3. *General Observations in regard to Nervous Action.*

Whilst pursuing some investigations some years back* in reference to the manifestation of current force during secretion in the mucous membrane of the intestines, the following circumstance presented itself. When an animal (a cat, for example) had been kept without nourishment for twenty-four hours or longer, so as to allow the intestines to become empty, if it be then fed with dry food, such as bread and meat, and killed, according to the time that had elapsed between the taking of food and the death of the animal, so would the following appearances be observed. Where the digestive process was going on within the intestine, its walls would be more vascular, and present a striking contrast to the lower and empty portions of the gut; the mesenteric vessels going to the same part would also be much distended. These facts, coupled with the observations recently made known to us by Claude Bernard, Waller, Brown-Séquard, and other physiologists, in regard to the influence of the sympathetic nerve over the blood-vessels, have suggested to my mind several impor-

* Philosophical Transactions, 1848 and 1852.

tant questions respecting nervous action. In one case, the instances I have referred to in the intestines, we have a stimulus—the food—exerted at the *peripheral* extremity of the nerve, accompanied with a *dilatation* of the vessels and an increased flow of blood to the part; whilst in the other, in the experiments of Claude Bernard and others, where the branches of the cervical ganglion of the sympathetic nerve are divided, similar effects are also produced,—viz., a *dilatation* of the vessels, accompanied with an increased flow of blood to the part supplied by the branches of the sympathetic; or we may have the opposite effects produced by stimulating the divided or distal extremities of these nerves,—viz., *contraction* when the sympathetic is stimulated, and *dilatation* when the lingual is stimulated. Can we suppose that the effects, in both these instances, are due to one and the same cause,—to a *paralysis* of the vaso-motor nerves? As the solution of this question must be decided by experimental evidence, it will be necessary to defer all theoretical arguments until some other questions have been previously solved.

In the study of nervous action, sensation or muscular motion have usually been considered as affording the most decisive, if not the sole evidence of its manifestation; but since its influence can be shown to be exerted over the blood-vessels, other circumstances, such as absorption, calorification, and vascularisation, may be adduced as affording additional evidence of its action.

§ 1. *On the Influence of Nerves over Absorption.*

That the nerves possess some influence over absorption, has been long entertained by physiologists; but the establishment of the fact that it is due to a dilatation of the vessels may perhaps be considered as of recent date.

Claude Bernard,* in some experiments in which, after dividing the branches of the cervical ganglion of the sympathetic nerve in a rabbit, the ear was then placed in a solution of prussiate of potash; upon testing the urine for its presence, the salt was found earlier than in another rabbit which had

* Lectures by Claude Bernard, published in "Medical Times and Gazette." July 27, 1861.

been subjected to a similar experiment, but whose nerves were not divided.

Dr Waller,* in his experiments "On some various circumstances influencing cutaneous absorption," says, "By dividing the sciatic nerve, absorption takes place more rapidly. I attribute the acceleration in the cutaneous absorption to the paralysis of the blood-vessels, as in my experiments on the sympathetic nerve, when I showed that, in blood-vessels, the passage of the blood is completely regulated by nerves springing from the spinal-cord. When the vascular nerves are paralysed, the artery becomes greatly distended, and the blood flows farther within it. The foot, after the section of the sciatic, is on this account more hot and red; and for the same reasons, it is easy to account for the more rapid absorption of medicinal agents."

In the following experiment I used three frogs; they were fresh caught, and of middling size. In one, A, the spine was divided in the dorsal region; in B the sciatic nerve was divided near to the ischiatic notch, accompanied with the loss of a small quantity of blood; C was uninjured. They were then suspended by means of a piece of string tied to one of the fore extremities, whilst one of the lower limbs (that of B, in which the sciatic nerve was divided) dipped into a vessel containing a solution of nitrate of strychnine, the strength being one grain to the ounce, and the limb was retained in the solution by fastening one of the toes to a piece of wood which fitted firmly into the bottom of the vessel. Separate vessels were employed, and the quantity of solution used was about one ounce. The foot, including the ankle, was the only part submerged. The experiment commenced at 9 A.M.

At 10 A.M. slight convulsive movements occurred in C when the animal was touched.

10¼, Similar movements in A.

10¾, The least touch of the body will cause convulsions in A or C, but not in B.

11½, B is convulsed when touched, and the contractions which take place are stronger and last longer than those observed in A or C.

* Proceedings of the Royal Society, vol. x. p. 122.

As my object on the present occasion is not to study the action of the poison upon the animal, but merely the resultant effect as to the time of its absorption, I need not detail the different observations that were made during the experiment. At the end of twenty-four hours B was dead and rigid, C presented occasional contractions about the lower jaw, whilst A still continued to give strong and powerful contractions when touched, and it was not until thirty-six hours had elapsed that it appeared to be dead.

I could relate other experiments tending to similar conclusions,—viz., that when the sciatic nerve is divided in the frog, the poisonous effect of the strychnine—the death of the animal—occurs earlier than in those frogs in which the spinal cord is divided, or in the uninjured frog. This result, contrary to my previous expectations, was obtained in nine out of twelve experiments. On examining the foot after the experiment, that in which the sciatic nerve had been divided appeared more swollen than in the other frogs.

The circumstances which appear to influence the results are the following:—

In my first experiments the limbs were all placed in the same vessel and fastened down to the same piece of wood; but it soon became apparent that the struggles of one animal caused convulsions to occur in the other, and as exhaustion might arise from repeated muscular contractions, and the circulation of the blood be quickened, the effects of the poison may be thus hastened. Merely jarring the table was sufficient to excite contractions. As those rigid and constant contractions, such as occur when the animal is placed upon a flat surface, were not observed to take place so early in these experiments, I am led to believe that the mere suspension of the animal may cause some delay in the action of the poison,—the surface of the body not being in contact with any foreign substance, general reflex actions are not so rapidly produced.

As it may be supposed that in those cases in which the sciatic nerve was divided, the poison ascended the limb by capillary action, and thus coming in contact with the wound, the effect of the poison would be hastened; to prevent this, a small quantity of olive oil was smeared over the lower part of the thigh, but the effect upon the animal was just the same. Care was taken to divide the sciatic nerve as high up as possible, and near the ischiatic notch, to make a small wound, and avoid injuring any vessel of importance.

It is necessary to guard against injuring the web of the foot when tying it, and also to prevent the limb from being chafed against any rough material during the experiment. In one experiment in which the spine was divided, death taking place earlier than was expected, upon examining the leg I found it had been grazed, during the contractions of the limb, against the edge of a piece of glass which had been used to keep the piece of wood down. In another experiment, in which the sciatic nerve had been divided, death taking place rather early, it was found that the web of the foot had been injured, presenting a large hole. The wood, to which the limb is attached, should be smooth and free from splinters.

The frogs should, as far as possible, present the same conditions as to size and freshness; and as the season in which the experiments are performed may have some influence over the results, I may just mention that the foregoing were performed during the latter end of August and the month of September, the weather at the time being rather cold.

From the results of these experiments, we may arrive at the following as a first conclusion: that the division of the sciatic nerve in a frog favours the absorption of the poison (strychnine).

The next question for solution is this, Why should the poisonous effects take place earlier in those cases in which the sciatic nerve is divided, than in those in which the spinal cord is divided?—*à priori*, one would be led to the conclusion that an injury, such as the division of the spine, is of far more serious importance than a mere division of the sciatic nerve, and this, so far as the injury itself is concerned, will generally be found to be the case; nevertheless, these experiments show that something has happened in the one case to favour absorption which is wanting in the other.

Dr Waller's explanation, that the vessels, under these circumstances, become dilated, and thus so far favourable to absorption, is no doubt correct. His experiments were upon mammalia. I will not go so far as to say that the vessels are not dilated in the web of the frog's foot, but upon examining it with the microscope after division of the sciatic nerve, I have not been able to observe that extreme dilatation of the vessels, such as occurs in the ear of rabbits after the division of the branches of the cervical ganglion. That the rapidity of the absorption is dependent upon the state in which the blood-vessels and perhaps the lymphatics are brought by the division of the nerve, there can be no doubt: but there appears to be something more produced than a mere dilatation of the vessels of a part; there must also be an increased flow of blood *through* the part. I will now endeavour to ascertain how this may be effected.

§ 2. *On the Function of the Ganglia on the Posterior Roots of the Cerebro-Spinal Nerves.*

The office which the ganglia situated on the posterior roots of the cerebro-spinal nerves perform, is still involved in great obscurity: that they are entirely subservient to sensation is extremely doubtful; but that they are connected with the functions of secretion and nutrition has been long considered as highly probable. To decide the point by means of direct experimental evidence, is rendered almost if not quite impossible, in consequence of the anatomical connections of the parts,—the junction and intermixture of the motor fibres from the anterior roots, and also those from the sympathetic nerve, being in such close contiguity with the ganglion, the difficulty in separating the latter from the former is so great as to render the results inconclusive. We may, however, obtain some clue, by comparing the results which Claude Bernard has obtained in his various experiments on the different nerves.

In some of his recent experiments, Claude Bernard* divided the anterior and posterior roots of the nerves forming the *sacro-lumbar plexus* in the dog as they left the cord. There was loss of motion and sensation, but no calorification or vascular action was noticed in the limb. He then divided the sciatic nerve, when an increase of temperature was ob-

* Medical Times and Gazette, August 23, 1862. I may also refer to Claude Bernard's Lectures, published in 1860 and 1861 in the same journal.

served. He naturally inferred that nerves influencing these functions must have become adjoined to the motor and sensitive nerves in the short interval between their issue from the canal and the part where the sciatic nerve was divided; and as it is only the sympathetic placed on the sides of the spinal column which could thus become joined to the nerves, he divided and destroyed the ganglia of the sympathetic and its filaments, which lay upon the side of the fifth and sixth lumbar vertebræ, leaving the nerves of the *sacro-lumbar plexus* entirely intact. An excess of temperature in the limb was immediately observed, being from 5° to 8° hotter than the other. The conclusion he draws is the following: that there are three distinct descriptions of nervous influence—1. The sensitive, due to the posterior roots of the *sacro-lumbar plexus;* 2. The motor or muscular, belonging to the anterior roots; and 3. The vascular or calorific, due to the sympathetic. He also lays down the following general proposition: the system of vascular circulation possesses a special vaso-motor apparatus, and the movement of the blood may be accelerated or retarded in the vessels, either locally or generally, without any participation in it of the musculo-motor system.

I endeavoured to repeat the experiment of Claude Bernard, by dividing the branches of the sympathetic in the abdomen in large frogs, so as to ascertain the effect upon absorption; but in consequence of the hæmorrhage that ensued, and the injury done to the animal, besides the difficulty of ascertaining how far the sympathetic alone had been divided, prevented any satisfactory results from being obtained. The frogs soon died. That the division of the branches of the sympathetic joining the *sacro-lumbar plexus* has some influence over the circulation of the blood in the vessels, as observed by Claude Bernard, I think may be considered as demonstrated; but that the sympathetic alone possesses the sole influence, may be considered as questionable.

Let us now refer to another of Claude Bernard's experiments,—viz., those connected with the lingual glands. When the branches of the sympathetic supplying these glands are divided, the vessels are dilated, and the blood flowing from the veins takes place in jets; but let the branch of the cerebro-spinal, instead of the sympathetic nerve supplying the gland, be divided, there is no dilatation of the vessels, no evidence of increased vascularity, but the blood flows freely into the veins: let the nerve be excited, there is increased flow of secretion; and if the branches of the divided sympathetic nerve be similarly stimulated, the vessels are contracted, so that we have in this experiment a production of contrary effects by acting upon different nerves. The contraction of the vessels, by irritating the divided branch of the sympathetic nerves, will be more readily seen in the experiments on the branches of the sympathetic which supply the ear of the rabbit.

Reflecting upon the results obtained by Claude Bernard, and also upon those which I have related in the previous section, together with the anatomical relations which the different nerves bear to each other in connection with the ganglion on the posterior roots of the spinal nerves, I have come to the conclusion that these ganglia serve, if not as their sole office, at least this one, that they are the reflecting centres of the vaso-motor nerves. The vaso-motor nerves must be arranged under two heads: those, like the sympathetic, which supply the arterial system, or vessels carrying blood to a part; the other, the cerebro-spinal, which go to supply the capillary system. The former would regulate the supply of blood *to* a part, the latter would exercise some influence over secretion and nutrition, by regulating the flow of blood *through* a part, either by retarding or allowing its free passage through the capillaries. If the sympathetic be divided, we have paralysis produced, and an enlargement of the arteries, in consequence, increased by the *vis à tergo* action of the heart; let the same nerve, its divided extremity, be stimulated, contraction of the vessel ensues, and a consequent diminution in the vascularity of the part. If we divide the cerebro-spinal vaso-motor nerve, the blood passes more freely through the capillaries, there is no stagnation of the blood, or enlargement of the vessels (arteries), nor increased secretion; under these circumstances absorption would more readily occur, as related in my present experiments. Let the divided extremity of these nerves be stimulated, we now have effects brought about contrary to those observed with the sympathetic in appearance, but the same in reality,—viz., a *contraction* of the capillaries, an impediment to the flow of blood occurs, and consequently an increase in secretion. The distension of the veins may arise from the absence of the influence of the *vis à tergo* action of the heart, in consequence of the secretion taking place, and thus the blood is not propelled forwards ; and so far there may be the appearance of an increased vascularity in the part from congestion. We thus see effects contrary in their results to be brought about by the same means, by the same mode of nervous action, but entirely due to a mere difference in the arrangement of the nervous system supplying the parts—viz., the blood-vessels.

The difficulty, if not impossibility, of establishing the foregoing conclusions by direct experimental evidence, in consequence of the inability to separate and divide the nervous fibres which go to constitute and form a mixed nerve, must be granted; but I will now refer, in a general manner, to those facts which appear to me to afford additional evidence in favour, as well as those which may be considered as adverse to their conclusiveness.

§ 3. *General Observations in regard to Nervous Action.*

From the views advanced in the foregoing sections, we should be led to the conclusion that a nerve, such as the sciatic, must necessarily consist of four distinct fibres, each performing a distinct office: the musculo-motor, the sensitive, and the two vaso-motor. Brown-Séquard* has found it necessary to divide the nerves according to a fourfold division, considering one of them as the nutritive; this division, as far it goes, appears to be a correct one, but it does not teach us the mode of action of the nerves. One of the most, if not the most important point connected with nervous action, is that of the situation of the reflecting centres,—the parts *to* which and *from* which nervous impressions are conveyed; and there can be no doubt that one reason of the contradictory results which arise in physiological experiments, is due partly to the want of accurate

* Holme's "System of Surgery," *Art.* Diseases of Nerves, vol. iii. p. 876.

knowledge upon this point, and partly also to the indiscriminate employment of the electro-magnetic machine as the means of exciting nervous action, since the *direction* of the electric current has a most important influence over the excitement of the nerves.* Again, we are apt to speak of the origin of the nerves, the anatomical origin, as if it were the sole point for consideration, whereas the origin of the impressions is of equal, if not of far more importance. It is at the peripheral extremities of the nerves where the effects are produced, and where the important actions take place, so that the division of nerves into afferent and efferent is preferable to that of motor or sensitive, and less likely to create confusion. But the question arises, Are there really two distinct classes of nerves—nerves of sensation and nerves of motion—or can the effects be referred to the direction in which nervous impressions are conveyed? With regard to ordinary nerves the evidence is decidedly in favour of the supposition of the existence of two distinct nerves; but when we have to speak of the action of the sympathetic, difficulties may arise in regard to this supposition.

Returning to the consideration of the question respecting the office of the ganglia situated on the posterior roots of the spinal nerves, as forming the reflecting centres of the vaso-motor nerves associated with nutrition and secretion, I will now refer to the appearances so frequently observed in injuries. Let a foreign body be acting as a source of constant irritation in connection with the skin, such as a blister or a splinter of wood, what do we see?—an increased vascularity of the part, which continues as long as the offending body remains; remove the offending body, and the vascularity disappears. Now, how can we explain this fact under the supposition that the effect—the vascularity—is due to a paralysis of the vaso-motor nerves coming from the sympathetic? Irritation of these nerves would cause contraction of the vessels, and not dilatation. It may be said the effect arises in consequence

* On "Nerve Force" in the Edinburgh New Philosophical Journal, Jan. 1862. I may also refer to a paper by Matteucci printed in the Philosophical Transactions for 1861, entitled "On the Secondary Electro-Motor Power of Nerves," as bearing upon this point.

of the impression being conveyed in the opposite direction, and thus paralysis is produced.

I will not enter farther upon this line of argument, as different suppositions would be required to meet every objection that might arise. I am not denying the connection of the sympathetic with the spinal nerves, or the results observed in Claude Bernard's experimonts respecting the division of the sympathetic in the abdomen, causing a vascularity in the limb; but I believe the effect observed in the cases I have just referred to will be more accurately explained under the supposition that the impression arising from the foreign body is conveyed by the sensitive or afferent nerve-fibres to the ganglion on the posterior root (the reflecting centre), and then reflected by the efferent fibres, the vaso-motor nerves, supplying the capillaries of the part thus producing the vascularity, just as we find any foreign body beneath the eyelid acting as a source of irritation, causing an increased vascular action in the parts and a copious flow of tears. The results observed by Claude Bernard in his experiments in dividing the sympathetic in the abdomen, would go far to prove the existence of the sympathetic vaso-motor nerves in the limb, and thus the two classes of vaso-motor nerves may act independently of each other.

Assuming the ganglia on the posterior roots to form the reflecting centres of the capillary vaso-motor nerves, we shall find that there exist two distinct reflecting centres,—one for the capillary vaso-motor nerves, and the other the muscular motor, which is connected with the spinal cord, and subservient to muscular action. With regard to the sympathetic vaso-motor nerves, their reflecting centres may be constituted by the ganglia which are found connected with its nerves, but principally those which are situated on the sides of the vertebral column. The question whether the branches of the sympathetic consist of afferent and efferent fibres, I will allude to again presently.

I have spoken of the effects when brought about by acting upon the peripheral extremity of the nerves by a physical cause, and which may be considered as *reflex;* similar results may also arise from psychical causes, and which are usually considered as *direct*, as may be seen during the act of blushing. In this latter instance we also obtain evidence in favour of the supposition that the vaso-motor nerves have distinct origins. During mental emotion, an impression is conveyed by the cerebro-spinal nerves, causing an impediment to the flow of blood through the capillaries; it would be difficult to suppose that this results from a paralysis of the sympathetic nerve causing a dilatation of the vessels. There is not only this difficulty, but the effects are too general. A part of the result is no doubt due to the heart's action, the blood being impelled with greater force and velocity.

I will now allude to the so-called *inhibitory* action of nerves, and endeavour to ascertain how far the same reasoning may apply to this class of phenomena. Brown-Séquard speaks of the nutritive fibres as being erroneously called *inhibitory*. The fundamental fact, originally established by Weber, is, I believe, the following:—If the pneumogastric nerve be stimulated, the heart's action is stopped; it does not cease beating in consequence of the contraction of its muscular fibres, for if the fibres be irritated by mechanical means, they are seen to contract; hence it has been inferred that the action of the pneumogastric is to prevent contraction. By parity of reasoning, the same argument must apply to other nerves. In repeating the experiment upon frogs, I have been unable to obtain a decisive indication of a stoppage of the heart's action by stimulating the par vagum; it was only by employing a powerful current that it could be effected, and such as would be sufficient to disorganise the nervous structure. Mr Lister has investigated the subject in reference to the heart of mammalia, and has come to the conclusion that a slight stimulus would increase the heart's action, whilst a more powerful one would arrest it.* As the nerves of the heart are associated with different parts of the cerebro-spinal system through the medium of the sympathetic nerve, the pneumogastric alone cannot be considered as the sole means by which it is connected with that system; but as the pneumogastric consists principally of fibres connected with the ganglionic portion of the

* Proceedings of the Royal Society, vol. ix. p. 367.

cerebro-spinal system, I believe its office, so far as the heart is concerned, to be that of regulating its nutrition; and consequently, any excitement of its fibres would tend to increase the nutrition of its muscular tissue, and thus cause a permanent relaxation of the fibres so long as the exciting cause remained, or a congested state of the capillaries alone may be induced sufficient to prevent contraction. The motor nerves of the heart would be connected with the sympathetic; those associated with its nutrition are derived from the cerebro-spinal nerves.*

The independence of the two classes of vaso-motor nerves, which I have endeavoured to show, will be severely tested in considering the nervous supply of the intestines. With regard to the upper and lower portions of the intestinal canal, the liver, pancreas, and kidneys, the connection of these parts with the cerebro-spinal system may take place through the nerves which assist in forming the different plexuses which supply these parts; but in regard to the middle portion of the canal, the small intestines, this cannot be so readily shown to exist.

We must not too readily assume the absolute necessity of a connection of the sympathetic with the ganglionic portion of the spinal nerves, and that these spinal ganglia serve the purpose of being the sole reflecting centres. We overlook the fact that their being connected with the posterior roots may be considered as an accidental rather than as a necessary condition. We find ganglionic enlargements supplying nerves to the carpal and tarsal joints. It may be difficult to decide in every case the existence of a reflecting centre; a mere plexus of nerves would not constitute it: we must have afferent as well as efferent fibres. The structure which has been found to exist in the submucous tissue of the intestines may perhaps perform this office; we here have the same principle carried out as we find to be applied to the lingual glands,—viz., a supply of ganglionic nerves to the glands independent of the ganglia on the posterior roots of the cerebro-spinal system,

* The various views that are entertained in regard to the function of the different nerves going to the heart will be found in the physiological reports published in the British and Foreign Medical Journal.

and it is only the accidental circumstance of being situated close to the mucous surface, and not at a distance, in which the difference consists. Although the sympathetic vaso-motor nerves do not *directly* regulate nutrition and secretion, they do so *indirectly*, by regulating the supply of blood to the part; and I believe their action in the intestines to be of the following nature: Let the animal be exhausted from the want of nutrition, and food be then given; the vessels become enlarged, partly in consequence of the flow of arterial blood being checked by the action of the capillary vaso-motor nerves connected with the submucous ganglia, and which causes secretion, and partly by the exhaustion of the nervous force connected with the sympathetic nerve; as the food is taken up, and the nutrition of the tissues is increased, so is nerve-force generated, and when the supply of nourishment has equalled the demand of the system, the force generated in the nervous tissue reacts upon the vessels, and thus produces contraction of their walls,—just as it has been suggested by Mr Paget in regard to the rhythmic contraction of the heart, a discharge of nerve-force taking place, which has been generated during nutrition. We must also suppose the vaso-motor nerves supplying the capillaries would suffer in the same way from exhaustion; but the stimulus of the food being in close contact with the ganglionic nervous structure regulating the secretion, this exhaustion may be more readily restored. In accordance with this view, the only part of the sympathetic nerve containing afferent and efferent fibres, together with the reflecting centre, would be those minute ganglia and fibres at the peripheral extremities of the nerves; the larger branches of the sympathetic would be solely efferent or motor fibres, but the ganglia, such as the semilunar ganglia, and those on the side of the vertebral column, may be connected with afferent or sensitive fibres from the cerebro-spinal system.

I have considered the action of the nerves to be associated with the contractile element of the tissue, and that it is by causing a contraction of the vessels, thus regulating the supply of blood *to* and *through* a part, that the principal results are effected. The question naturally arises, Is this the sole action of the nerve; or may not nervous action be exerted *directly* in effecting the changes which take place during nutrition and secretion? We are thus brought to the consideration of the relation existing between nerve-force and the other forces. Nervous action is not always associated with the contractile element, as is seen in the development of electric force in the fish; again, in the organs of sense, as the eye, nerve force is associated with that of light. I have elsewhere stated* that I believe the connection between nervous action and muscular contraction to consist in the reaction of nerve-force upon the electric force of the muscular tissue, and therefore it may be asked, Does not nerve force react upon the force developed during secretion? The experiments of Mr Lister have led him to suppose that the action of the nerves is exerted directly upon the changes which take place in the gland cells, for he observed motion to be produced in the cutaneous cells of a frog when the nerves were stimulated. Now this motion may arise in consequence of secretion or nutrition being excited, and these actions would prevent any distension of the capillaries. I do not think that the connection between nervous action and secretion or nutrition is *direct*, for these actions may take place without the presence of nervous structure, as we see in plants. The results which are generally referred to the influence of the nervous system upon nutrition and secretion may be brought about in an indirect manner; for it is not difficult to conceive, that if these processes be interfered with, either by checking or increasing the supply of blood to a part, that a most important alteration must necessarily take place in the constituents of this fluid, which, as it circulates through the system, may produce general as well as local injurious effects.

Before concluding, I may just refer to the following circumstance:—In some experiments on the absorption of strychnine in the frog, I exposed the sciatic nerve, and then passed a ligature beneath it, and tied the ligature tightly round the upper part of the thigh, so as to prevent the circulation of the blood; a small quantity of the solution of strychnine was injected beneath the skin of the leg, and the same was done with another frog, in which the ligature was not applied. With

* Organic Polarity, chap. xi.

the latter the poison took effect in three minutes; but in the former the poison produced no effect even twelve hours after; the ligature was then removed, when the poison began to take effect in six minutes, but slowly. When the ligature was applied the leg became extended; but upon examining the web of the foot there was no congestion, the blood did not circulate, and the surface of the limb became moist, smooth, and shining. Upon the removal of the ligature the blood began to circulate slowly, the blood discs appearing to adhere to the walls of the vessels, and were ultimately washed off, as it were, into the circulation. In another experiment the ligature was applied in the same manner, but no poison used, and I endeavoured to excite contractions of the muscles by stimulating the nerve, but none occurred; upon removing a portion of the skin, and irritating the muscular fibre, slight local contractions occurred, but there were no convulsive movements when the nerve was irritated. Upon removing the ligature the muscles gradually recovered their contractile power. The effects produced by the ligature, arresting the flow of blood, and thus putting a stop temporarily to the vital actions of the part, only show the importance and necessity of a regulated and proper supply of this fluid for the due performance of the vital functions. These experiments may also serve to illustrate the *inhibitory* action of nerves. If the pneumogastric consists of vaso-motor nerves, supplying the capillaries, as I have endeavoured to show, we can understand how, by its stimulation, contraction is prevented. In consequence of stimulating the nerve, the vessels contract and prevent the blood from flowing through its tissue; the contractile power is not destroyed, it is not exhausted, but the muscular fibre is kept in a polarised state or condition—a state of relaxation. A cut-out heart of the frog is found to contract readily and freely, but does not do so when distended with blood, in consequence of ligatures being applied to the large vessels; all that it requires is just a sufficient quantity to maintain the nutrition of its tissue. It is necessary to bear in mind the distinction between the tension arising from the blood which passes through the heart, and that which circulates through its tissue; I am now alluding to the latter.

The following conclusions may be deduced from the foregoing inquiry :—

1*st*, The division of the sciatic nerve, in frogs, favours absorption.

2*d*, That this increase of absorption arises in consequence of the division of the vaso-motor nerves.

3*d*, That the vaso-motor nerves are of two kinds; those associated with the sympathetic nerve, and those connected with the cerebro-spinal nerves.

4*th*, There is reason to believe that the ganglia connected with the posterior roots of the cerebro-spinal nerves serve as reflecting centres to vaso-motor nerves.

5*th*, That the vaso-motor nerves supply different parts: those connected with the sympathetic go principally to the vessels carrying blood *to* a part; those connected with the cerebro-spinal ganglia to the capillaries, and are principally connected with the functions of nutrition, secretion, and absorption.

6*th*, That the so-called inhibitory action of nerves may be referred to the influence which the vaso-motor nerves (the cerebro-spinal) exert over the circulation of the blood in the muscular tissue.

P.S.—A knowledge of the ultimate distribution of the nerves to the blood-vessels is highly desirable. I take the opportunity of referring to Professor Beale's researches, published in the January Number of the "Archives of Medicine," as indicating that a great difference of opinion upon this point exists. At the same time, I may remark that microscopical appearances would lead one to suppose that the distribution is not so simple as is generally supposed; and, as far as I can judge, there appear to be distinct fibres, performing, perhaps, different offices, or, at any rate, distributed to different parts.

Observations on the Embryogeny of Tropæolum majus. By ALEXANDER DICKSON, M D., Edin.* (Plate IV.)

The embryogeny of the Indian Cress is invested with a special interest, from the remarkable extent to which the pro-

* Read before the Botanical Society of Edinburgh, Dec. 11, 1862.

embryonic* portion of the germ is developed. It has accordingly engaged the attention of several observers, who have, in a greater or less measure, elucidated many of the more important phenomena.

Before giving a historical sketch of the subject, preliminary to my own observations, it may perhaps be of advantage briefly to describe the structure under consideration.

In the fully developed germ of this plant, the "embryo" is borne upon a suspensor of considerable length. At the base of the suspensor is a knob-like enlargement, from which two remarkable root-like processes take origin. One of these passes outwards, perforates the seed-coats a little to the outer side of the micropyle, and runs along the outside of the seed, between it and the investing carpel, the whole length of the loculus. The other process forces its way through the tissue of the neck of the seed, and, reaching the vascular bundle which supplies the seed, runs closely along the inner side of these vessels the whole length of their course in the placenta. Of these processes, that which lies outside the seed, in the cavity of the germen, may be called the *extra-seminal* root of the germ; whilst that which is imbedded in the substance of the placenta may fitly be termed the *placental* root.

Adolphe Brongniart (1827) described and figured the swollen base of the suspensor, with its root-like extra-seminal process, but erroneously referred them to a development of the *mamelon d'impregnation* or nuclear papilla.†

* I cannot but think that the distinction which has been drawn between "Pro-embryo" and "Embryo" is somewhat unfortunate. They are both parts of one germ or young plant, and have a common axis of growth,—the chief difference between them being, that one portion, the "Pro-embryo," is transitory, while the other portion, the "Embryo," is permanent; just as in mammals, for example, certain portions of the original germ disappear at or before birth, the remaining structure constituting the permanent organism.

† *Mémoire sur la génération et le développement de l'embryon dans les végétaux phanérogames*, Ann. des Sciences Nat., 1st Ser., vol. xii.—On reference to Brongniart's figures, it will be apparent how this error has arisen. The section of an unimpregnated ovule, there represented (pl. 44; fig. 2, A, 6), has been made somewhat obliquely, so that the tumid margin of the inner integument (secundine) has been mistaken for the apex of the nucleus, which

Schleiden (1837) gave a more correct interpretation of the structure, in recognising the knob-like base of the suspensor, with the extra-seminal process, as parts of the germ. In the earliest stage described by him, the germ is represented as a somewhat elongated dilatation of the pollen-tube, from which the suspensor, terminated by the "embryo," appears as a *lateral branch.* In this last respect he believed it to differ materially from other germs, having a cellular enlargement below the embryo, inasmuch as in these the embryo is developed from the prolonged *apex* of the primary structure. He also stated that, simultaneously with the cell-multiplication in this oblong body, there occurred obliteration of the investing portion of the ovular integuments, whereby it came to lie free in the cavity of the germen; while the lateral branch became developed into the embryo, in the cavity of the ovule; the oblong body itself growing out into a cellular cord passing around the outside of the seed.*

Dr Herbert Giraud (1842), in a communication to the Linnean Society, gave the results of his observations on this subject.† With Schleiden, he considered the knob-like base of the suspensor to be developed outside the seed; but this condition he believed to result from the base of the suspensor passing out through the micropyle, while, according to Schleiden, it was due to obliteration of the investing portion of the ovular integuments. Giraud mistook the secundine for the nucleus, the apex of which he accordingly supposed to be perforated by a canal leading to the embryo-sac. The figures he gives of the earlier stages are very incorrect. He was evidently ignorant that the extra-seminal root exists from a

was thus viewed as projecting beyond the seed-coat, and accurately closing the micropylar orifice (p. 233). With such an idea, it is not surprising that the knob-like base of the suspensor should have been taken to represent this supposed nuclear papilla.

* M. J. Schleiden.—*Über Bildung des Eichens und Entstehung des Embryo's bei den Phanerogamen.* Nova Acta Acad. Cæsar. Leopold. Carol. Nat. Curiosorum. Tom. xix. p. 55. Or, translation of the same in *Ann. des Sciences Nat.*, 2d Ser., vol. xi. p. 140. The same facts are also to be found stated in Schleiden's Principles of Botany (Lankester's translation, p. 414).

† H. Giraud, M.D.—Contributions to Vegetable Embryology, from observations on the origin and development of the Embryo in *Tropæolum majus.* Transactions of the Linnean Society, vol. xix. p. 161.

very early period in the development of the germ,—a fact which had been clearly indicated by Schleiden.

In 1843 Mr William Wilson published his admirable observations on this plant.* He showed that the knob-like base of the suspensor is at no period to be found external to the seed coats; that it neither produces obliteration of the investing integuments in the manner described by Schleiden, nor passes through the micropyle, as was stated by Giraud. Mr Wilson found that the extra-seminal root perforates the seed-coats a little distance below and to the outer side of the micropyle. He also discovered the placental root which had escaped the notice of previous observers. He apparently assents to Schleiden's view, that the embryo arises from the side of a primitive oblong body, since he quotes him to that effect without objection. Mr Wilson figures a very young germ as an ellipsoidal body, presenting a surface of between forty and fifty cells, and filling up the apex of the embryo-sac.

As I shall presently shew, I have been able to confirm Mr Wilson's observations with regard to the relations of the root-like processes to the seed and seed-vessel. I am, however, inclined to believe that his figure of the supposed ellipsoidal germ is faulty, having been probably taken from an obscurely seen or mutilated germ, somewhat advanced, and of which the suspensor has either been overlooked or broken off.

The germinal vesicle is situated at the apex of the embryo-sac, and consists of a large delicate ovoid cell, with nucleus, nucleolus, and a third body contained within the latter. The cell-wall is very delicate, being apparently just sufficient to give a definite bounding line to the homogeneous semi-opaque protoplasm. The smaller extremity of the vesicle corresponds to the pointed apex of the embryo-sac.

In the next stage which I have observed, a horizontal septum has appeared, dividing the vesicle into two unequal parts, the larger portion corresponding to its broader, the smaller

* W. Wilson, Esq.—On the Embryo of *Tropæolum majus*—Hooker's London Journal of Botany, vol. ii. p. 623; also, Researches in Embryogeny, by Mr Wilson, containing a summary of the above paper—*The Phytologist*, vol. i. p. 881.

to its narrower extremity. The smaller portion is vertically divided, probably by two septa at right angles to each other. The germ still retains its ovoid figure, but now consists of a large terminal nearly spherical cell supported by at least two, but probably by four smaller ones, which form the tapering point fitting into the apex of the embryo-sac. In the side view, it appears as an ovoid body, consisting of a large terminal cell supported by two smaller ones, forming the pointed extremity. I have unfortunately not succeeded in observing any stages immediately succeeding the above.*

In the next stage which I have seen, the germ is considerably further advanced, presenting on side view a surface of about twenty cells,—of course involving double that number on the whole superficies. In form it may be described as bottle-shaped, with a pointed base, which, as in the former stage, fits into the apex of the embryo-sac. The neck of the bottle-shaped germ consists of twelve cells, in three tiers of four cells each, and exhibits, on side view, six cells in two vertical rows. I cannot say of how many cells the body of the germ consists, being ignorant of the ratio in which the cell multiplication has progressed, but on side view it exhibits three horizontal rows of four cells each. I have not been able exactly to determine how many cells enter into the formation of the pointed base, but I think it probably consists of four cells, giving a side-view of two cells as in the very early germ above described. This bottle-shaped germ measures about $\frac{1}{260}$th of an inch in length. At this stage the germ lies obliquely in the micropylar extremity of the embryo-sac; the axis of the germ being a straight line, while that of the sac is somewhat curved towards its apex. The axis of the germ coincides in direction with the apex of the embryo-sac, which is pointed somewhat outwards. The neck of the bottle-shaped germ is thus directed obliquely inwards towards the placenta, while its pointed base has a corresponding outward direction.

* I have not given figures of the germinal vesicle and the succeeding stage, as I did not make any careful drawings of them at the time I made the preparations; and in the sections which I have preserved, they are too much altered, by shrinking, to admit of a proper representation, unless it were made in part from memory.

In the stage seen in fig. 2, the axis of the germ is no longer a straight line, but is a curve nearly coinciding with the axis of the end of the embryo-sac. As is readily understood, this is a natural result of the increased growth of the germ, whereby it is necessitated to adapt itself to the curvature of the cavity in which it is lodged. At the same time there is a noticeable increase in the curvature of the embryo-sac, and this, of course, has its share in producing the curvature of the germ. The pointed base of the germ is still directed somewhat outwards, although not so markedly as in the early stage. The neck of the germ, instead of being, as at first, directed obliquely inwards, is now nearly vertical, and perhaps even directed a little outwards. This part is now considerably increased in length, and is slightly enlarged into a sort of head at its extremity. The enlargement is the first indication of the "embryo," while the more slender portion supporting it becomes the suspensor. The inner side of the body of the germ is somewhat rounded, corresponding to the internal curvature of the embryo-sac. The outer side of the germ (that furthest from the placenta) is now marked by a small rounded enlargement, corresponding in position to the shoulder of the originally bottle-shaped body. *This small process is what eventually becomes the extra-seminal root; which is thus shown to be a distinctly lateral process, and not the extremity of the primitive germ, as held by Schleiden.* An idea of the shape of this germ is much more readily conveyed by a figure than by description. The body of the germ must be deeper from within outwards than from side to side, and, in consequence, be slightly flattened laterally.

In the stage represented in fig. 3, the suspensor is more elongated, and its terminal enlargement, the embryo, is more distinctly marked. The inner side of the body of the germ is perhaps a little fuller and more rounded than in the last stage, but any difference in that respect is very slight. The future extra-seminal root, on its outer side, is now so considerably developed, that the suspensor appears quite as if thrown to the side. It has evidently been from germs such as this that Schleiden drew his conclusion that the suspensor, with the embryo, originates as a lateral branch, from a primitive oblong body.

A somewhat older germ is represented in fig. 4. The embryo, suspensor, and extra-seminal process, do not differ much from those in the last stage, only they are further developed. The basal point is very distinctly seen, but now consists apparently of a single cell,—whether some of the cells which I supposed in the earlier stage to be associated together in forming the pointed base have disappeared, or have become merged in the body of the germ, leaving only this one as a projecting point, I cannot say. A glance, however, at the series of stages which I have delineated, is sufficient to show the identity of this point with the basal point of the originally bottle-shaped germ; in other words, *this projecting point indicates the position of the extremity of the germ, organically opposed to that which is developed as the "embryo."* The inner side of the body of the germ now bulges considerably as a rounded enlargement (fig. 4, *pr*), which must be regarded as the first indication of the placental root; which, like the extra-seminal process, is shown by its development to be a *lateral structure*.

In fig. 5 a still more advanced stage is shewn. The bulging on the inner side of the body of the germ has now become considerably developed, and has assumed a conical form. This change is due to an active cell-multiplication, which may be estimated by comparing the germs represented in figs. 4 and 5, in which the cellular structure is indicated. The single cell at the basal point is very distinctly seen, as indeed it always is when the germ is carefully extracted from the seed. The extra-seminal root at this stage has just perforated the coats of the seed.

In the succeeding stages the extra-seminal root becomes much elongated, and ultimately passes along the whole length of the outside of the seed.*

The extremity of the conical process or young placental root, represented in fig. 5, becomes more and more tapering

* Mr Wilson has figured a curious deviation in this process, in a case where its extremity penetrates some little distance into the substance of the carpel, opposite the chalazal end of the seed.

and elongated (figs. 6 and 7, *pr*). It may be said to take on development by elongation, as distinguished from cell-multiplication, at a period coincident, or nearly so, with the appearance of the cotyledons.*

The length to which the placental root has attained when the cotyledons are yet in a very young condition, is shewn in fig. 7. Having pushed its way obliquely inwards through the neck of the seed, it has already reached the placental vascular bundle, along which it extends in the placenta for a short distance. The extra-seminal root is now greatly elongated. Its manner and place of exit are precisely as Mr Wilson has described them, perforating the seed-coats a little to the outer side of the micropyle.†

As I have already mentioned, the placental root ultimately extends along the whole length of the course of the vascular bundle in the placenta. It lies to the inner side of the bundle, having made its way along the lax tissue by which the vessels are surrounded. It is in close contact with the vascular bundle, so that when it is dissected out there are almost always to be found shreds of spirals adhering to it.

Mr Wilson speaks of a pore as existing at or about the point where the placental root terminates at "the lowest point of junction [of the carpel] with the receptacle." This I have not been able to find, and I am inclined to think that there is only the *appearance* of a pore at that point in the cicatrix upon the detached coccus corresponding to the ruptured vascular bundle. A very curious anomaly has come under my observation, where the placental root on reaching the vascular bundle, instead of running along the course of the vessels in the placenta, turns back outwards again, and runs along with the bundle in the opposite direction into the seed.

I need not enter upon the details of the later stages of

* Schleiden's furthest advanced figure shows this pretty well, but the germ has evidently not been extracted without suffering some impairment of volume.

† I may mention that I had delineated these relations of the extra-seminal root to the micropyle and seed-coats, as they are shown in fig. 7, before I had seen Mr Wilson's paper, so that my testimony, as being quite independent, is the stronger confirmation of the accuracy of his statements.

the germ, as these have been admirably illustrated by Mr Wilson.

It will be seen from the foregoing remarks, that the structures making up the germ naturally fall under two heads: 1*st*, the main axis; and 2d, the lateral processes.

Of the main axis, the organic apex is developed as the "embryo;"* while the organic base remains comparatively stationary, as a point corresponding to the apex of the cavity of the embryo-sac.

The two root-processes are, as I have shown, both distinctly lateral structures. The earliest developed one (the extra-seminal) springs from the outer; the other and younger one (the placental), from the inner side of the axis of the germ.

The knob-like enlargement at the base of the suspensor corresponds to the junction of the lateral processes with the main axis. The larger portion of it, however, must be considered as the enlarged base of the placental process.

In conclusion, I would offer a few remarks upon the probable function of the root-processes.

That these processes perform the functions of roots, it is impossible for any one who looks at them to doubt. The question, however, still remains as to when and how they act as such. Mr Wilson believes that they act in the commencement of germination. "It is scarcely to be doubted," he says, "that these two processes fulfil the office of rootlets in the first stage of germination, while the embryo is still enclosed within the carpellary integument, and that if the latter were removed before the time of growth, the seed would

* I should mention, that Von Mohl, in his work on the "Vegetable Cell," makes the general statement, that in all cases "the terminal cell of the whole structure [germ] is sooner or later metamorphosed, by preponderating growth and cell-division in different directions into a cellular structure, at first of a globular form," "the rudiment of the embryo."—*Vegetable Cell*, Henfrey's translation, p. 136. I am unaware of any special observations by Von Mohl on *Tropæolum*, although he alludes to it in the passage from which I have quoted. One cannot, however, talk here of the embryo being produced from a terminal cell, since the apex of the germ is multicellular before there is any differentiation of embryo from suspensor, as I have represented in fig. 1.

fail, in consequence of the injury which would almost inevitably be sustained by these rootlets. One of them would necessarily be broken off."*

On considering this question, I am led to dissent from Mr Wilson's conclusion. It appears to me much more probable that these processes serve as roots to the *developing* than that they serve as such to the *germinating* embryo, for the following reasons:—

1*st*, It can hardly be doubted, that the rule in the vegetable kingdom is, that *roots are only formed in presence of wants, and not (so to speak) in anticipation of them.* It can therefore scarcely be supposed that these germ-roots should be developed to such a large extent in the early stages of development, were they only to serve as such on the commencement of germination. The formation of the radicle in the dicotyledonous embryo, and the presence of the rudiments of adventitious roots in many monocotyledonous embryos, might be urged as examples of roots *in anticipation;* but it must always be borne in mind, that it is *only in presence of wants that these assume a really root-like development and elongation.* As to the radicle itself, its non-development in the germination of the monocotyledon shows that it is not essentially even a root in anticipation.

In the *second* place, I would urge that the cocci of this plant, as sown in our gardens, are almost always thoroughly *dried*, having been preserved from a previous season. In these it is inconceivable that the root-processes of the germ should be able to survive the desiccation they must inevitably undergo, protected as they are only by the easily dried tissue of the carpel and placenta; and there is nothing in the delicate and watery structure of the roots themselves to preserve them from total desiccation and destructive collapse. The dried cocci, however, germinate quite freely.

From such considerations, it appears to me highly unlikely that these rootlets are concerned at all in the germinative process. It is probable that the period of their functional activity extends from a time shortly after their appearance until the seed has attained its full growth; in fact, that their

* London Journal of Botany, vol. ii. p. 626.

use is to convey nourishment of some kind to the developing embryo.

The circumstance that one of these roots lies free in a cavity lined with epithelium, while the other is imbedded in the substance of the placental tissue, suggests the probability of a dissimilarity in their functions, and there are certain differences between the roots themselves, which would tend to confirm this idea:—

1*st*. The cell-contents are comparatively dense in the extremity of the extra-seminal root, while they are more watery and transparent in the placental process.

2*d*. The extra-seminal root is terminated by elongated cells, somewhat resembling in shape the columnar epithelium cells in animals. This characteristic is well seen even in the young condition represented in fig. 4. The character of the cells hardly alters in the subsequent stages, only they become more elongated. These terminal cells are always larger than the ones immediately behind them. In the placental root, on the other hand, the terminal cells are the smallest, and do not present any note-worthy peculiarity. I should imagine, from these appearances, that the roots differed from each other in their mode of development; that in the extra-seminal root, the new cells were formed *behind* the extremity, while in the placental root they were formed *at* it. I would not, however, state this positively, as I am but little experienced in histological developments. The placental root is pointed at its extremity, while the extra-seminal is rounded.

It might have been supposed that the placental tissue was a more favourable locality for the supply of nutritive material, than the cavity of the germen; but when we compare the delicate and slender placental root with the strongly developed, and apparently better nourished extra-seminal process, we may be led to entertain a contrary opinion.

This arrangement of germ-rootlets is evidently one for a *supplementary nutrition of the embryo*. Whether this supplementary nutrition is conditioned by the absence from the contents of the embryo-sac, of certain matters requisite for the growth of the embryo, or by the surface of the embryo itself having a somewhat imperfect power of absorption, it were perhaps impossible to determine precisely; but it is probable that the former supposition is the more correct one.

DESCRIPTION OF PLATE IV.

In Tropæolum *the ovules are anatropal and pendulous, with the raphe next the placenta. It will be observed that all the objects figured are inverted, in order to let the organic apex of the germ be directed upwards. Figs.* 1-5 *are all drawn on one scale; figs.* 6 *and* 7 *on a much smaller one.*

Fig. 1. Section of young seed, with a very young bottle-shaped germ at the apex of the embryo-sac. *pri*, Primine; *sec*, Secundine; *se*, Embryo-sac; *mic*, Micropyle; *a* apex, *c* body, and *b* the pointed base of the germ. In this figure the form of the germ, and the cells of its neck and body, may be relied upon as being correctly indicated; but I am uncertain (as I have stated in the text) of the number of cells forming the pointed base. I am inclined to think, however, that two cells are to be seen on the side view as I have given them in the drawing.

Fig. 2. Section of young seed somewhat further advanced. The axis of the germ is now curved, and its apex is a little enlarged, forming the first indication of the "embryo," *emb;* the narrower portion below it becoming the suspensor, *susp.* On the outer side of the body of the germ is a small rounded enlargement, the rudiment of the extra-seminal process, *esr. Se*, *b*, *c*, and *mic*, as before.

Fig. 3. Young germ further advanced than that in fig. 2. *Emb*, *susp*, *esr*, and *b*, as before. From the increase in size of the extra-seminal process, the suspensor appears as if thrown to the side.

Fig. 4. Young germ still further advanced. The inner side of the body of the germ is now distinctly bulging. This protuberance is the first indication of the placental root (*pr*) The cellular structure is represented in this figure. The basal point (*b*) now consists of a single cell. The extra-seminal process (*esr*) has not yet perforated the seed-coats. *Emb* and *susp* as before.

Fig. 5. Young germ at the period when the extra-seminal root (*esr*) has just perforated the seed-coats. The placental process (*pr*) has become considerably enlarged, and is now conical and pointed. The cellular structure of the placental root and base of the germ is indicated, in order to show the amount of cell-multiplication which has occurred. *Emb*, *susp*, and *b*, as before.

Fig. 6. Portion of young germ at a later period. The conical and pointed placental process (*pr*) now tapers considerably at its extremity; its root-like elongation is commencing. The suspensor has been broken off short. Lettering as before.

Fig. 7. Section of a portion of a young seed (*s*), and placenta (*pl*). The placental root (*pr*) is now considerably elongated, and has reached the placental vascular bundle (*vb*), along the inner side of which it already runs for a short distance. The extra-seminal root (*esr*) is much elongated, and is seen to perforate the seed-coats a little to the outer side of the micropyle (*mic*). Vascular bundle of the raphe, *r*. The young cotyledons are now distinctly visible on the embryo (*emb*). *Susp*, Suspensor.

On the Barometric Depression, and Accompanying Storm, of the 19*th October* 1862. By THOMAS H. CORE, Privy-Council Lecturer in Mathematics, Normal School, Edinburgh.* (Plate V.)

The data on which the present paper is founded were obtained principally from the returns from the Society's stations, but from the following sources in addition: from the returns from the Northern Lighthouses, kindly furnished to me by Mr Thomas Stevenson; the log-books of various merchant ships, obtained from several shipowners in Leith; the files of the "Shipping and Mercantile Gazette," and "Mitchell's Maritime Register," in Leith Reading-room; and the Board of Trade Meteorological reports, published in each morning's "Times." As the 19th of October happened to be a Sunday, the observations connected with the storm are not so numerous and complete as I could have wished as regards England and Ireland; but this was partially remedied by a few special returns I obtained, some directly from private observers, and others from letters in the daily newspapers.

I shall first notice shortly the barometric fluctuations throughout the month of October, and then consider more particularly that of the 19th.

The monthly fluctuations are represented in Diagram I., in which are drawn the barometric curves for England, Ireland, and Scotland. For the first nine days of the month the barometer was considerably above the mean height, the weather was generally fair, some of the days being warm and pleasant, with bright hot sunshine, and there was comparatively little moisture in the air. From the 9th to the 12th the barometer sank continuously about an inch in Scotland, and four-fifths of an inch in England and Ireland, the thermometer being still high, and the air being nearly saturated with aqueous vapour. The moist and warm air being thus relieved of a considerable amount of barometric pressure expanded and cooled, and its moisture was consequently precipitated in the form of a dense fog, which was very prevalent for three or four days

* Read before the Scottish Meteorological Society on 14th January 1863.

over the whole country. From this time till the 16th a succession of fresh, and sometimes strong westerly breezes, accompanied by a slightly rising barometer, brought copious showers of rain, which had the effect of considerably cooling the air. From the 17th till the 24th the oscillations of the barometer were extensive and remarkable, the mercury falling in some places upwards of an inch in twelve hours. At the same time the weather was extremely unsettled, strong gales and sometimes even violent tempests, accompanied often with heavy rain, and at times with hail and lightning, blowing from S.W. to N.W. These storms were particularly violent on the afternoon of Friday the 17th, about midnight of Sunday the 19th, and on the evening of Wednesday the 22d, and more so in England and Ireland than in Scotland. Both in the storms of the 19th and the 22d, the pressure of the wind is recorded at many stations as being twenty-five lbs. on the square foot, which gives for its velocity the very unusual rate of seventy miles per hour. The newspapers were full of the details of the disastrous effects of these hurricanes, both on land and at sea. In London, innumerable sheds and chimney-stalks were blown down, many serious collisions took place on the Thames, by which some vessels were sunk and many quite disabled; and at high water the tide was forced over the banks, deluging many warehouses, and destroying a vast amount of property. In the Downs, where a large fleet was moored, several ships went down at their anchors; and at Shields, a whole fleet of colliers, which had put to sea in despite of a warning from Admiral Fitzroy, was dispersed, many of them foundered, and many were driven over to the coast of Norway. By the wreck and damage done to vessels belonging to the Tyne alone, the underwriters sustained a loss of L.40,000. On the West Coast, however, where the storm was blowing towards the land, the disasters were still more numerous, the whole shore being literally strewn with wrecks, both on the morning of the 20th and the evening of the 22d.

Nor was the violence of the storm confined to this country; it raged with almost equal severity over the north-western part of Europe, the Bay of Biscay, and far out in the Atlantic Ocean. At Antwerp the Queen was detained for six days, being prevented from crossing by the boisterous state of the weather. The "Times" correspondent, writing from Paris on the 22d, says, "The hurricane, which has been blowing over Paris for the last three days, and which has not yet abated, caused much damage. The garden of the Tuileries is covered with broken branches of trees," &c., &c. "A letter from Cherbourg states, that a violent hurricane has prevailed in the Channel for some days past, the wind varying from S.W. to N.W. The harbour of Cherbourg, 'the hotel of the Channel,' as it was called by Vauban, is crowded with vessels seeking shelter from the storm." Again, from Havre: "The storm is still raging with unabated violence. On Sunday night, the wind shifting from S.W. to N.W., blew in heavy squalls. The sea rose to an unusual height, and showers of rain fell in rapid succession. On Monday the hurricane continued, but not with such extreme violence." The two screw steam-ships, "Ceylon" and "Tartar," were both crossing the Bay of Biscay on their voyage homeward to Southampton,—the former on the 19th, the latter on the 20th,—and both reported having met with heavy westerly gales, with a high sea and thick weather. Again, the barque "Balclutha" left Greenock for St John's, Newfoundland, on the 29th September, and had proceeded half-way across the Atlantic, when, on the 17th, she experienced such tempestuous weather, that she was considerably damaged, and obliged to put back. Her track is represented by the dotted line in Diagram IV. The following is a short extract from her log-book, which, as is customary at sea, is kept in nautical time, and is thus twelve hours in advance of civil time:—

"Oct. 16th, N.W. by N.—Begins with hard gale and dark cloudy weather.

"4 A.M., W.N.W.—Cloudy, with continual rain and heavy topping sea.

"8 A.M., W. by N.—Hard squall.

"Noon, W.—Terrific squall.

"17th, N.N.W. to N.W.—Begins with hard gale and darkening weather, accompanied by terrific squalls, and showers of hail, sleet, and snow.

"8 P.M.—Same wind and weather, with heavy topping sea;

ship labouring very much, and straining so much that the trembling of her whole frame could be distinctly felt on deck. Throughout midnight, furious gale with terrific squalls, and blinding showers of hail, sleet, and snow.

"3·50 A.M.—Gale raging furiously, with tremendous curling sea. About this time a sea broke aboard on the port-bow with terrific force, sweeping the deck fore and aft, and doing immense damage to the ship, and also carrying overboard two able seamen.

"Latter part.—Gale somewhat abated, but heavy sea still making a clean breach over her decks.

"18th, N.W. throughout.—Commences with a continuation of heavy weather, with hard squalls and showers of rain.

"Middle part.—More moderate squalls, not so violent, and sea abating.

"Latter part.—Still moderating.

"19th, from N.W. to N.N.W. throughout.—Begins with fresh gale, accompanied with frequent squalls and showers of hail.

"Middle part.—Increasing gale with heavy squalls.

"Latter part.—Strong gale and high sea, with hard squalls and showers of hail."

The "Balclutha" now put back, and on her return voyage continued to experience very stormy weather.

What I have already said is sufficient to show that these storms, from the 17th to the 24th, were very violent, and felt over a wide area. From the 26th to the end of the month the weather was more moderate, with a steadily rising barometer and a low temperature, showers of sleet alternating with snow and rain.

The barometric range for October, or difference between the highest and lowest readings, amounted at many stations to more than two inches, which is 50 per cent. greater than the average range for October. The following table of the lowest barometric readings for each month of the year shows this fact in a different manner. The numbers in the first column are the means of the monthly minima for the five years 1857–1861 inclusive, for one selected station (Sandwick in the Orkney Islands); and those in the second column are the minima for 1862, on the average of twelve stations in Scotland.

Table of Monthly Barometric Minima.

	1857–61.	1862.	Difference.
January	28·706	28·983	+ ·277
February	28·737	29·279	+ ·542
March..................	28·594	28·924	+ ·330
April....................	29·086	29·124	+ ·038
May......................	29·330	29·460	+ ·130
June.....................	29·404	29·136	− ·268
July......................	29·250	29·568	+ ·318
August..................	29·182	29·310	+ ·128
September.............	29·203	29·030	− ·173
October................	28·938	28·430	− ·508
November.............	28·768	28·825	+ ·057
December.............	28·758	29·110	+ ·352
Means.........	28·996	29·097	+ ·101

The minimum for October 1862, it will be observed, is 28·43, or fully half an inch below the average. This minimum is the average of all the lowest readings at upwards of fifty stations in Great Britain, the lowest at some places occurring on the evening of the 19th, and at others on the morning of the 20th. Now there are three points worthy of consideration with regard to this sinking of the barometer on the 19th: *First*, The magnitude and suddenness of the fall. *Second*, The gradual advance in a north-easterly direction of the depression or trough of the atmospheric wave; and, *third*, Its less vertical depth towards the south of Great Britain. I shall now advert shortly to each of these three points in order.

An intelligent observer at Culloden, one of the Society's stations, remarks: "The barometer fell rapidly during the 19th, ·606 of an inch in 14 hours; and at eleven o'clock at night the recorded height was only 28·427 inches. This was the lowest pressure of the mercurial column, and lower than on any occasion since the 31st March 1860, when the barometer fell to 28·421, and on the 21st of January and 27th of February of the same year, to 28·212 and 28·162 respectively. Low as these readings are, they were exceeded by several still lower in previous years; but the most remarkable and greatest depression of all, within the last twenty-one years, occurred on the 27th of December 1852, on which occasion the barometer fell ·959 of an inch in 13 hours, and sank to 27·872 inches." Again, at Silloth, on the Solway Firth, the barometer fell $1\frac{1}{40}$ in $8\frac{3}{4}$ hours, and at Shields an inch in 9 hours, both of these being greater and more rapid falls than that just mentioned. At Nottingham it fell $\frac{7}{8}$ths of an inch in $10\frac{1}{2}$ hours, and at Wisbeach ·878 inch in 14 hours. From Birmingham an observer writes:—"At 8 A.M. the barometer here stood 29·245 inches, and at 9·20 P.M. it had fallen down to 28·418, or ·827 inch in $13\frac{1}{3}$ hours. This is an extraordinary depression, and a lower reading than any previously registered here for three years,"—*i. e.*, since the date of the storm in which the 'Royal Charter' was lost off the Anglesea coast.

At Wanlockhead	it fell an inch	in 13 hours.			
,, Bowhill	,,	$1\frac{1}{10}$	,,	14	,,
,, Kettins (Forfar)	,,	$\frac{3}{4}$	,,	14	,,
,, Fettercairn	,,	·87	,,	17	,,
,, Sandwick	,,	·624	,,	19	,,

In fig. 2 are represented the curves of the 19th for four of these stations,—viz., Sandwick, Silloth, Shields, and Nottingham. The general form of the atmospheric wave is best illustrated by the Silloth curve, and is that commonly known as the "dog-tooth" shape. The depression generally amounted to an inch, the time occupied in falling being from 10 to 12 hours, and the time in rising again to the same height being about twice as much.

Secondly, Nothing is more clearly brought out by the returns I have obtained regarding this fall of the barometer than that it occurred later at places situated more to the N.E. For instance, at the following places it occurred simultaneously at 11 P.M. on the Sunday evening:—Stornoway, Culloden, Kettins (in Forfarshire), Bowhill (in Selkirkshire), Bradford, and Wisbeach. Accordingly, in fig. 4, the line drawn through all these places represents the position of the trough of the atmospheric wave at 11 o'clock. It reached Castle Newe, in Aberdeenshire, at 1 o'clock; Fettercairn at 2; Sandwick and Kirkwall, in the Orkneys, at 4; arrived at Sumburgh Head, the most southerly point of the Shetland Islands, at 8; and was just passing off at North Unst at 11 o'clock on Monday morning. At 7 P.M. on Sunday, it passed through the following places:—Ushenish in North Uist, Ardnamurchan Point, Oban, Stranraer, Isle of Man, Liverpool, Birmingham, and Portsmouth; at 5 P.M. it was just arriving at Barra Head, and it had passed over Galway at 9 o'clock in the morning. We can hence calculate its velocity. The distance in the direction of its motion between Barra Head and North Unst is about 270 miles, and the time occupied in passing from the one station to the other being 18 hours, the velocity is therefore 15 miles. When a similar calculation is made for other pairs of stations, and the mean of all the results taken, the rate is found more accurately, and is very nearly 15 miles per hour. Towards the South of England, however, it is a little greater, amounting there probably to 17 or 18 miles per hour.

As a confirmation of this point, I have found from the log-book of the barque "Larne," that the same barometric depression existed in latitude 46° N., longitude 50° W., or a little to the S.E. of Newfoundland, at 8 P.M. on the 16th. The "Larne," Captain Shewan, commander, left Quebec for Leith on the 5th October, with a valuable cargo of timber, and in her log-book the reading of the barometer is registered every four hours—a practice which it is to be wished were a little more general in our merchant ships. The second part of fig. 3 exhibits these readings of the barometer from the 13th to the 19th of October, in which the depression of the 16th, and its striking similarity in form to that of the 19th, in fig. 1, cannot fail to be noticed. Assuming this then to be the same wave which reached this country about midnight of the 19th, and that it travelled in a direction making an angle of 40° with the meridian of Greenwich, a simple trigonometrical calculation gives the distance travelled at right angles to its front 1150 miles; and the time being 75 hours, gives a velocity of $15\frac{1}{3}$ miles per hour.

Thirdly, There is considerable difference in the absolute lowest readings for Scotland, and I have been unable to trace any law connecting them; but for England they increase with considerable regularity towards the south. At Shields, Silloth, Little Ross, Stranraer, the minimum is very nearly the same—viz., 28·1. At Nottingham it is 28·69; at Wisbeach, 28·8; and at Dover, Plymouth, and Portsmouth, 28·9. Throughout Scotland, the minima vary a very little on either side of 28·4, exhibiting on the whole a tendency to rise with the progress of the atmospheric wave, as if the hollow of the wave in its onward march were being gradually filled up.

The hurricane of which this fall in the barometer had given sure warning, was not long in making its appearance; and *its* progress may also be traced from S.W. to N.E. It commenced on the west coast of Ireland shortly before noon of Sunday. At Limerick it caused great damage, and raised the river Shannon several feet above its ordinary level. By noon it had passed over Waterford, was raging in Dublin, and had impinged on the S.W. corner of England, causing, off Start Point, the wreck of the barque "Lotus." This vessel had left Demerara for London six weeks before, and had on board a cargo of rum and a crew of fourteen men, all of whom perished with the exception of two seamen, who were fortunate enough to reach the shore. By six o'clock the storm had arrived at Portsmouth, central England, and the Isle of Man; and about midnight was raging with the utmost fury along all the east coast. The direction of the wind at its commencement was from the S.W., in which direction it continued for about two hours, the storm being then at its height. Towards the north of Scotland, however, where it did not commence till a little after midnight, its direction was more southerly; and in the Orkneys it was due south. From one to two hours after its commencement, the barometer began to rise as rapidly as it had previously fallen, the wind at the same time gradually veering towards the west; and at nine o'clock on Monday morning the gale was blowing from the west almost everywhere over Great Britain, its violence having now considerably abated. On Monday evening its direction was generally W.N.W., and on Tuesday morning N.W.; but in the Orkney and Shetland islands N.N.W. By Monday night it had almost died away in many places, and by noon of Tuesday it had altogether ceased. (See fig. 3, where the arrows indicate the direction of the wind on Sunday evening, Monday morning, and Tuesday morning.)

Let us now compare the direction of the storm, as experienced by several ships at sea, with its direction in Britain. As we have already seen, the storm in which the "Balclutha" found herself at noon of the 17th was from the west, or allowing for magnetic variation, from the W.S.W., and veered round by N.W. to N.N.W. Thus, on Sunday evening, when the wind was S.W. in Britain, it was N.W. in the North Atlantic, 830 miles west of Greenwich.

At one o'clock on Monday morning, the Edinburgh and Leith Shipping Company's ss. "Oscar" was in the German Ocean, a little to the N.E. of the Fern Islands, when the hurricane blowing from the S.S.W. passed over her, carrying away her mizen-mast, and forcing huge waves over her decks. At the same time the "Volunteer," from Leith to Rotterdam, was lying off the Yorkshire coast, and reports the wind from the S.W.

The s.s. "Stirling," Captain Henderson commander, left Leith for Cronstadt on the 14th of October; and after a rough passage across the German Ocean, in which one of her boilers was injured, steamed into Copenhagen harbour to repair on the morning of the 19th. During Sunday and Monday the ship was lying in the harbour, when the wind was blowing a strong gale from the S.W., and by Tuesday morning she had got her boiler repaired, and was ready for sea. Here is an extract from her log-book for Tuesday, kept in ordinary or civil reckoning:—

"4 A.M., S.W.—Very hard gale, heavy squalls, with rain.

"7·30.—Got under weigh, and proceeded.

"9.—Landed pilot off Drago, and at 9·20 passed Drago, L. V.

"12, W.S.W.—Very hard gale, with heavy squalls and rain. Heavy sea. Ship labouring very heavy, and filling her decks every roll. Steamed under Stevn's Head, to see if the gale takes off."

The ship lay under the shelter of Stevn's Head for 13½ hours, while the storm was raging in the open sea. This was on the afternoon and evening of Tuesday, by which time, it will be remembered, the storm had ceased in this country.

Now, referring to fig. 4, we have an explanation of all the facts just mentioned regarding the time of commencement and direction of this storm. Imagine a vast circular mass of air, from 800 to 1000 miles in diameter, set in motion by some powerful but unknown cause somewhere in North America, and having two independent motions,—one of rotation round its centre, and another of translation. Its rotatory velocity, in a direction contrary to that of the hands of a watch, most rapid towards the centre, and diminishing towards the circumference, was, on the average, about 70 miles an hour; and it progressed in a north-easterly direction, at the rate of about 15 miles per hour. Its centre passed on the north-western side of this country, and consequently its lower segment only traversed Britain. The continuous circles in fig. 4 show the storm or cyclone setting in on Sunday evening, and it will be seen that it strikes the southern parts of the country from the south-west, but Scotland more from the south, in accordance with the observed direction of the wind. On Monday morning its centre was to the N. of Britain, and its position is indicated by the dotted circles. The direction of the wind is now westerly, and it has commenced to blow at Copenhagen from the S.W., being still N.W. in the Atlantic. A circle drawn more to the N.E. would represent its position on Monday night and Tuesday morning, when it was passing off, with the wind from the N.W. The diameter and velocity of this cyclone may be thus computed: Its direction was W.S.W. at the "Balclutha" about noon of the 17th, and it reached the middle of England about 9 o'clock on the evening of the 19th, thus traversing a distance of 830 miles in 57 hours, which gives a rate of between 14 and 15 miles an hour. To find the diameter of the cyclone we may proceed thus:—Since its influence was felt at the same time 830 miles out on the North Atlantic and on the east coast of Great Britain, it must have measured at least between 800 and 900 miles across. Or thus: When its centre was in the latitude of Cape Wrath, or rather a little south of it, its influence extended to the northern portion of the Bay of Biscay, *i.e.*, over about 9° of latitude, thus giving it a radius of 540 miles, or a diameter of a little more than 1000 miles. Or once more: Selecting a particular station, as Shields, we find that there the storm commenced on Sunday evening about 10 o'clock from the S.W., and ended on Tuesday about 2 P.M. from the N.W., thus veering through an angle of 90° in forty hours. Now, in this time the cyclone would travel 40 times 15—*i.e.*, 600 miles. Its magnitude must therefore have been such that the chord of 90° measured 600 miles, which gives for the circle a diameter of 850 miles.

In conclusion, I may add that the storm seems to have died gradually away after having passed over this country; and by the time it should have reached the upper part of the coast of Norway, its force was quite expended; for a merchant ship from Archangel, which was in this neighbourhood at the very time, and whose log-book I inspected, had fine weather throughout the voyage. We might have anticipated as much, having already noticed the gradual diminution of the barometric depression in its journey onwards.

On the Solid-hoofed Pig; and on a Case in which the Fore Foot of the Horse presented Two Toes. By JOHN STRUTHERS, M.D., F.R.C.S., Lecturer on Anatomy in the Edinburgh School of Medicine.

I. *On the Solid-hoofed Pig.*

After quoting the words of Blumenbach, that "Swine with solid hoofs were known to the ancients, and large breeds of them are found in Hungary and Sweden," Dr Prichard* states that "There are breeds of the solid-hoofed swine in some parts of England. The hoof of the swine is also found divided into five clefts." The occurrence of a solid-hoofed variety of the hog seems, however, to have escaped the notice of modern naturalists. I have not met with any reference to it in the works of Jenyns, T. Bell, Cuvier, Owen, or Darwin; it is not noticed in Mr Youatt's work on the Pig, in which he treats of the breeds in the various counties of England, in Hungary and Sweden, and in the other parts of the globe in

* Researches into the Physical History of Mankind. Fourth Edition, vol. i. p. 354.

which the hog is known to exist, wild or domesticated; nor is there any allusion to it in what has been called the "Pig's foot controversy" between Fleming and Conybeare.*

My attention was first directed to this variation by the appearance presented by the toes in one of the skeletons of the pig in the Museum of the Royal College of Surgeons of Edinburgh. There is no record of a dissection of this pig, or of its history, except that it was presented to the College in 1839 by the late Sir Neil Menzies of Rannoch, Perthshire. On recent inquiry, through my pupil Mr Donald M'Gregor, from Rannoch, I have received some information regarding this breed, for which I am indebted to the careful inquiries made on the spot by Mr Duncan M'Gregor. The solid-hoofed breed has been well known and abundant on the estates of the late Sir Neil Menzies, at Rannoch, for the last forty years. Most, if not all of them were black. They were smaller than the ordinary swine, and seem to have had shorter ears. They liked the same food and pasture as the common swine, and showed no antipathy to herd with them. They were more easily fattened, though they did not attain so large a size as the ordinary swine; their flesh was more sweet and tender, but some of the Highlanders had a prejudice against eating the flesh of pigs which did not "divide the hoof," unaware, apparently, that the Mosaic prohibition applied to all pigs. A male and female of the solid-hoofed kind was brought to Rannoch forty years ago, by the late Sir Neil Menzies, which was the commencement of the breed there; but I have not yet been able to learn with certainty where they were brought from. Although they did not breed faster than the common kind, they multiplied rapidly, in consequence of being preserved, so that the flock increased to several hundred. At first, care was taken to keep them separate, on purpose to make them breed with each other, but after they became numerous they herded promiscuously with the common swine. As might be expected in a promiscuous flock, some of the young pigs had solid and some cloven feet, but I am unable as yet to say whether any definite result was ascertained as to the effect of crossing;

* Edinburgh New Philosophical Journal, vols. vi. and vii.; and Fleming's Lithology of Edinburgh, 1859.

whether any experiments were tried as to crossing; or whether, after the promiscuous herding, some of the pigs of the same brood presented cloven and some solid hoofs. No pig was ever known there with some of its feet solid and some cloven; nor, so far as is known, was there any instance of young born with cloven feet, when both parents were known to be solid-hoofed. The numbers diminished—from what cause is not apparent; so that last year there was only one or two—one of them a boar, which died; and now the solid-hoofed breed appears to be extinct at Rannoch.

The condition of the toes in the specimen in the Museum is likely to be so interesting to naturalists, in relation to the question of variation, that I have thought it worth while to give the following account of it, with the permission of the College:—

Fore Foot.—The distal phalanges of the two greater toes are represented by one great ungual phalanx, resembling that of the horse, but longer in proportion to its breadth. The middle phalanges are also represented by one bone in the lower two-thirds of their length, presenting separate upper ends for articulation with the proximal phalanges. The proximal phalanges are separate through their entire length. The whole foot above the middle phalanges presents the usual arrangement and proportions in the hog. In the accompanying sketch which I took, from the right fore foot, going high enough to show part of

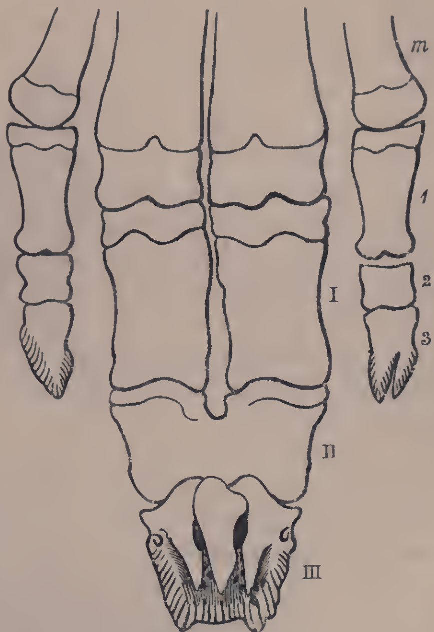

Fig. A. From the right fore foot of the Solid-ungulous Pig.

the metacarpal bones, the natural size is given, and the epiphyses are also shown.

The bones affected by the variation deserve particular description.

Middle Phalanx.—There is no symphysis or mark indicating a line of coalescence of the two phalanges. The surface across the middle is somewhat irregularly filled up to nearly the level of each lateral part. Each half of the phalanx, as indicated by the notch between the separated upper ends, has the full breadth of the proximal phalanx above it. The breadth of the phalanx is nearly an inch at its middle, the length of each side is seven lines.

Distal Phalanx.—The proportions of the ungual phalanx are,—Length, $\frac{10}{12}$ inch. Breadth, behind, $\frac{10}{12}$; at the middle, $\frac{8}{12}$; at the tip, $\frac{5}{12}$. The breadth of the os pedis of the horse considerably exceeds the length.

The anterior surface of the phalanx is considerably arched transversely, and presents a raised portion in the middle, as if two toes had come together and pushed forwards a small middle one. This narrow middle piece is marked off by a fissure on each side; also above, where it passes up to the joint forming the middle of three pyramidal processes; and below, reaching to within $\frac{1}{4}$ inch of the tip, it is marked off by the depression and streaking of the laminated part of the phalanx. The fissure which bounds it laterally presents an elliptical vascular foramen, which increases the appearance of former separation.

On each side of this median raised portion is a lateral raised portion, as shown in the sketch, suggesting the idea of three rudimentary phalanges pushed forwards by the coalescence of two large phalanges behind them. The lateral raised portions appear to be merely the representatives of the middle smooth part, which is marked off by the laminated portion of a terminal phalanx, as seen in the sketch of the terminal phalanx of the external lesser toe. Each is marked off externally from the lower or outer half of the surface by a distinct smooth groove, which begins a little above and in front of, but is not continued from, the usual lateral foramen of the phalanx, and the position of which is indicated in the sketch. The laminæ commence at the outer side of this groove. Looking to the sketch, if we suppose two phalanges, like the terminal phalanx of the external lesser toe, with laminæ on both sides, to become confluent, the appearances presented by the lateral raised portions, and the laminated parts of the great ungual phalanx, will be exactly accounted for. The median raised piece is not so accounted for; but the existence of two foramina, which are described in veterinary anatomy as situated at the base of the pyramidal process of each ungual phalanx, may partially account for it. Against the supposition of this median portion being the rudimentary phalanx of a median fifth toe, it will be noticed that the lesser internal toe has the usual three phalanges, showing it to be the index, not the pollex, as the supposition of five toes would imply. I have thought it necessary thus particularly to notice these appearances, for they do at first sight suggest the idea of one great phalanx formed by the coalescence of three small and two great phalanges. They are quite as distinct on the left fore foot. The end of the phalanx presents a notch corresponding to that in the horse, but broader and deeper, and partially subdivided by a wavy median projection, which bears no trace of symphysis.

Hind Foot.—In the hind foot, only the *Distal Phalanx* is single, as represented in the accompanying sketch (fig. B). The raised median and lateral portions are much less distinct than on the fore foot. The notch at the tip is simple, and not so wide or deep as on the fore foot. There is no trace of a double origin to the bone. Above, it rises up into a broad "pyramidal" process, on each sloping side of which is the articular surface for the widely separated lower ends of the middle phalanges. Its length at the middle is $\frac{9}{12}$ inch, at the side $\frac{7}{12}$; the greatest breadth is $1\frac{1}{12}$.

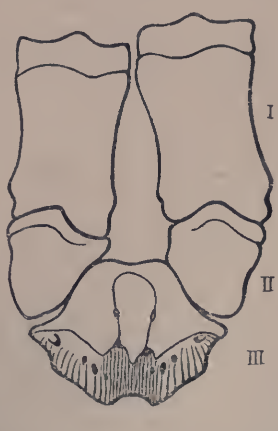

Fig. B.—From the right hind foot of the Solidungulous Pig.

The *Middle Phalanges* are entirely separate. They are little more than half an inch in length. Below, they are ⅓ inch apart, and each presents a simple convex surface for its separate articulation with the ungual phalanx, on the concave sloping side of which it rests obliquely, as if the middle phalanx would tend to slip downwards and outwards off the ungual phalanx.

The Proximal Phalanges diverge below to rest on the middle phalanges, and approximate above, where they rest on each other as in the fore foot.

The *Lesser Toes* have the metacarpal, or metatarsal, and three phalanges, and are of the usual proportionate length. The ungual phalanx of one of the lesser internal toes of the fore foot, as seen in fig. A, presents a bifurcation reaching half the length of the phalanx; and as each of the portions has laminæ on both sides, it would seem as if the hoof had also been divided.

On comparing the measurements of the various bones and regions of the limbs and trunk with those of the domestic boar in the Museum, they correspond so closely that the skeleton of this solidungulous pig may be regarded as presenting no variety, with the exception of the phalangeal peculiarities already described.

The skeleton is articulated with the toes more vertically placed than in the ordinary hog. In the hind foot, all the phalanges are in the same line, and nearly vertical. In the fore foot, the metacarpus and the proximal phalanges are vertical, the middle, and especially the ungual, sloping forwards. The lesser toes are articulated parallel to the greater. From the form of the articular surfaces, these positions do not appear to be unnatural.

The *Epiphyses* of the limbs are still separate from the shafts and processes. As shown in fig. A, they occur, as is usual in other mammalia as well as in man, at the distal ends of the metacarpals and metatarsals, and at the proximal ends of the phalanges. The distal phalanges, as usual in the horse, ruminant, pig, and some others, have no epiphysis. There is no epiphysis on the middle phalanx of the lesser toes; but, from the appearance of the upper ends, I am not certain but that they have been lost, from their small size. The epiphyses of the great middle phalanx of the fore foot, and of the middle phalanges of the hind foot, have commenced to consolidate with the shaft towards their inner side. If the now single phalanges were really formed by the coalescence of two originally separate phalanges, it is worthy of notice that all trace of that median consolidation has disappeared, while the epiphyses of the foot are still separate, except a small part of those of the middle phalanges.

I have endeavoured in vain to obtain the recent limbs of this variety for dissection. The preceding description of the state of the bones, however, shows that the solidungulous condition is not confined to the hoof, but extends to the interior of the foot. It would be interesting to examine the modification also of the soft parts, especially of the tendons and nerves. Facts regarding the breed would also be interesting: whether the variety is known to occur occasionally among ordinary breeds, and whether it is then transmitted; whether there are now separate breeds of the solidungulous hog in this country, or in Sweden or Hungary, and if so, whether the young are always solidungulous, and what is the effect of crossing with the bisulcous hog; and whether it presents any other peculiarities of form, or differs in its habits, or feeding, from the ordinary hog. I would feel much indebted by receiving information on these points from any one who may know of living specimens of the variety.

2. *Case in which the Fore Foot of the Horse presented Two Toes.*

In September 1859, I examined, on Ford Common, Northumberland, a two-year old filly which had been born with the left fore foot cleft like that of the ox. Each of the two toes had its three phalanges, which could be made to move past the corresponding phalanges of the other toe, showing the complete division of the foot as far up as the fetlock (metacarpo-phalangeal) joint. The division externally was carried to the same extent as in the ox. The lower end of the great metacarpal (cannon) bone felt as if bifurcated like that of the ox, so as to give separate articular support to the two toes. Farther up, the great metacarpal, as in the other fore limb, presented the usual form of that bone in the horse. The two lesser metacarpal bones were felt to terminate at the usual place on the right side, and as if a little farther down in the left limb; but of this I could not be quite certain. The two hoofs were quite separate and complete, each having its own horny "frog" as in the ox. No attempt at shoeing had been made, and the hoofs having become elongated forwards, had recently had their points sawn off. The whole foot was much larger or more spread than the other.

Unable to obtain possession of the animal at the time, I had to content myself with leaving instructions, with the view of afterwards obtaining the limbs for dissection. Notwithstanding, the death of the animal was not reported to me; and on inquiry I learn, with the liveliest regret at losing such a valuable preparation, that the recovery of the bones is impossible. The preceding description of the foot is from my notes written at the time of the examination, which was made in the presence of my friend Mr R. B. Robertson, F.R.C.S., now of Ardrossan, and of Mr Strutt, the veterinary surgeon at Ford.

This variation would have admitted of ready explanation under the old theory of the formation of the horse's foot, by the confluence of two originally separate toes, just as the great metacarpal bone of the ruminant is known to be formed by the coalescence of two metacarpals. But when we remember that the foot of the horse is developed as one toe, the occurrence of two toes in a "soliped" becomes a remarkable and significant fact in the history of variation.

The Place and Power of Natural History in Colonisation; with special reference to Otago (New Zealand).* By W. Lauder Lindsay, M.D., F.R.S. Edin., F.L.S. and F.R.G.S. London, &c.

Uses of Natural History to the Colonist.

My principal aim in the following remarks is to bring under your notice some of the uses and advantages of the Natural

* Extracts from a Lecture prepared for, and at the request of, the "Young Men's Christian Association" of Dunedin (Otago, New Zealand). Pamphlet, pp. 30. Dunedin, January 1862.

It may be desirable here to note, in explanation or preface, that the Lecture in question was prepared towards the close of 1861, after a four months' residence in Otago, mostly devoted to excursions investigatory of its natural

Sciences to the British colonist, and to colonial governments, more especially to the *Otago* colonist and the *Otago* government. I will endeavour to show how, and to what extent, *practical* use may be made of such sciences as Geology, Mineralogy, and Botany; how far, or in what ways, they may be rendered, when judiciously applied, subservient to the daily necessities or luxuries of the settler; how they may minister to the material riches, the substantial progress, of the State. In recommending the study of Natural Science to colonists, I am constantly met with the query "*Cui bono?*" "What is the precise use or value of such sciences to me? How will a knowledge thereof add to my wealth or prosperity? I hope to be able to indicate, by a few illustrations, that a knowledge of Natural Science is on the one hand a solid gain of an easily appreciable kind; while on the other it will not stand in the way of a colonist's usefulness as a farmer, a runholder, a storekeeper, a merchant, or a member of the Provincial Council; that scientific education does not necessarily unfit a man for manual labour, or for entering fully on any of the departments of colonial life. On the contrary, there is every reason to believe that scientific knowledge would render a settler more able to take advantage, for his own profit as well as that of the State, of the opportunities surrounding him; more ready to develop the natural resources of his adopted country; while it would tend to make him, in every other respect also, a better man. I think I could point with confidence to some of the most successful of your settlers here, whose studies at Oxford and Cambridge, at Edinburgh and Aberdeen, have, so far from unfitting them for the business of wool producers, cattle breeders, or farmers—of merchants or legislators—been the sources to them of equal pleasure and profit. Indeed I *know* that some of the producers of your highest priced wools—your most successful rearers of stock—are graduates or undergraduates of our home universities,—striplings from Oxford and Cambridge, Eton and Harrow, lacking apparently the bodily vigour necessary for being pioneer settlers,—youths whose physical

history (more especially its geology and botany). At that period almost nothing was known of the natural history of Otago; and this fact, in connection with the then recent discovery of the Tuapeka gold-field, which had directed the attention of the colonists to the natural resources of the province, led to the urgent request that the author should embody his views on some of the main bearings of natural science on the progress of a new country in a popular form, and induced him, under many disadvantages, personal and general, to accede to this request by the delivery and publication of the lecture aforesaid. It may be further proper to remark that the observations on the natural history of Otago, being essentially of a popular and general character, and consisting of a traveller's impressions during a hurried visit to a new country, do not aim at, nor can they claim, scientific exactitude—an exactitude impossible without deliberate examination and investigation, microscopical and chemical—implying not only labour, but time, the latter of which, especially, is obviously not at the command of the passing traveller.

energies at home would have been expended on the exploits of the Alpine Club. And some of your most successful farmers and runholders are educated men, whose only feeling on the subject is one of regret that they did not, before leaving home, study geology, chemistry, botany, or other branches of natural history, that would have rendered them more suited for their isolated position as outsettlers in new fields.

To a certain class of the settlers in Otago I feel it unnecessary to address myself. My intercourse with them, during the short period of my visit here, has convinced me that they are fully sensible of the advantages of natural history knowledge, as tending to make them more wealthy settlers, more useful citizens of the State, much wiser and better men. Some of them have deplored to me their ignorance of geology and botany, and have expressed an anxious desire to "make up their lee-way" by any means still in their power. Many of the higher classes of settlers feel, and say, that a knowledge of some of the natural sciences would be of immense value to them simply as a relaxation, or a relief to the tedium of a monotonous life in isolated stations, especially during winter and in inclement weather. They frankly admit that an additional zest would be given to their excursions did they know something of the rocks and minerals, shrubs and flowers, with which they come in contact. To such settlers, then, as are already wholly or partially alive to the substantial value of a knowledge of the natural sciences—who recognise them as being or possessing a distinct *power*, and as occupying a distinct *place, in colonisation*,—my remarks are less intended than for those who are yet altogether ignorant of the practical—the money-making and money-saving—purposes these sciences may be made to subserve.

I will firstly lay before you some illustrations based on your local natural history, classifying them under the respective heads of Geology, Botany, Zoology, Meteorology, and Chemistry—directing attention more fully to those connected with the first-named science, as being of chief importance at the present moment, when your gold, your coal, your building stones, your fire and brick clays, are substances and subjects of primary and absorbing interest. Thereafter I will venture some suggestions as to the best means of promoting the general cultivation and special practical applications of the natural history sciences in Otago.

General Geology of Otago.

I feel warranted in affirming that Otago is a most interesting geological field, and I would congratulate the Provincial geologist, Dr Hector, on the prospects of usefulness, the opportunities for distinction, which such a field offers him. I think it probable, moreover, that the Dunedin district—that is, Dunedin, with its vicinity within a radius of about ten miles—will be found geologically, as well as botanically, the most interesting part of the province,—interesting in its variety especially. At all events it is by far the most interesting part of the province I have visited; and I have no hesitation in saying that, if the inhabitants of Dunedin do not cultivate the natural sciences, it is not from want of abundant and magnificent opportunities. Nor in point of its mere physical features, its picturesqueness, the variety and richness of its scenery,—scenery that reminds the tourist or emigrant of the Trosachs, Loch Katrine, and Loch Lomond of his native land,—does Dunedin or the Otago harbour yield the palm to any other part of this province, or perhaps of any other of the New Zealand provinces. The geological formations of the Dunedin district are both most interesting in themselves, and most varied; they may be easily examined by any of you possessed of ordinary pedestrian powers.

The higher or hilly portions of the town bear abundant evidence of the presence of old volcanic agencies; there may be seen, in almost any of the cuttings or sections for roadways or building sites about the town, ample evidences of the most extraordinary terrestrial disturbances, the result mainly of subterranean fires. The hilly parts of the town are mostly composed of trap-tuff, a substance of very varying character, which has been originally a volcanic mud or ash, apparently chiefly deposited under, and sorted by, water. You will find it of all colours, and of all consistencies; and those of you who are uninitiated, will regard it as a most incomprehensible, because so variable, rock or substance. It appears to be one of these hardened tuffs, originally a volcanic mud, and consolidated partly by heat, partly by pressure, which is quarried at Anderson's Bay, and is largely used as a building stone in town, under the name of "sandstone." There is much in your trap-tuffs, and in the steatites, ochres, and other minerals they contain, that remind me of what I have seen in the most interesting volcanic island of Iceland. The volcanoes which have vomited forth these masses of basalt and tuff—these trappean rocks and deposits—appear to have been active at the era of the formation of the auriferous drift, that is, during the tertiary epoch; and this finds a parallel in certain of the Australian gold-fields. In the latter localities it is below these ancient lavas, or beds of volcanic mud or ashes, that the auriferous drift reposes—that lie the beds of ancient streams, whose bars detained the gold washed down from the higher regions of the Silurian slates, and which now constitute the "leads" so keenly searched for by the miner. Your basalts and allied trappean rocks are closely analogous to those of the Edinburgh district—to those of Arthur Seat, Salisbury Crags, and the Calton Hill. The columnar basalts or greenstones of Samson's Ribs, of Staffa, and of the Giants' Causeway, find their representatives or analogues in the beautiful columns of Stoneyhill (which, however, are horizontal, instead of being, as is more general, perpendicular), of Green Island Peninsula, and the Forbury. The basalt of Mount Cargill, Saddlehill, the Signalhill range, Flagstaff and Kaikorai Hill, of the ravine which forms a continuation inland of Maclaggan Street, Dunedin, and of many other localities, you quarry to use as road-metal, and the best of all road-metal it makes; while an allied rock is quarried in the Bell-hill or Church-hill, Dunedin, for building purposes, one for which this class of rocks is not so well adapted. The peculiar cannon-ball-like appearance of the masses of rock in the last named quarry, which I find the subject of general remark and wonder among the inhabitants of Dunedin, is frequently a characteristic of the basaltic rocks of old Scotland—just as the prismatic or columnar structure is, both being alike due to the circumstances under which the mass has cooled from a state of fusion. It is of some of these schistose and fine-grained basalts (clinkstone and Lydian stone), as well as of Nephrite (or jade), the "greenstone" of the Maoris, that the Maori hatchets, so commonly found on the surface of the soil throughout the province, are formed. Your hills all exhibit abundant evidences of glacier or ice action in the immense erratic blocks, which are scattered in wild profusion over their summits and ridges; and the boulder clays, which are almost everywhere plentiful in the superficial strata, at a very few inches or feet below the soil, are a testimony of a similar kind. Your alluvial lands—your Taieri plain and Inch Clutha—exhibit the same structure as the most fertile "carses" of Scotland, such as the Carse of Gowrie. I recognise in the Taieri plain the same projecting knolls, which, in the Carse of Gowrie, have given rise to such names as *Inch*-ture, *Inch*-michael, *Inch*-yra, *Inch*-innans. Nor do *your* "carses," or "inches" appear less fertile; at all events, I do not know that I have seen richer wheat in the Carse of Gowrie—that first of all the wheat districts of Scotland—than I have seen but a few weeks ago on Inch Clutha.

The sedimentary fossiliferous rocks are well represented in the province generally, as well as in the Dunedin district. Some of the limestones have a Cainozoic (Tertiary) facies; most of them a Mesozoic (Secondary) appearance, resembling generally the chalks and greensands of old England: while some of them may be, like some of those of Nelson and Wellington, Palæozoic (Permian). Jurassic (Oolitic) strata, containing the *Plesiosaurus australis*:—Triassic beds, supposed to be the equivalents of the European *Muschelkalk*:—the analogues of the beds of Maestricht in Belgium, and Faxö in Denmark: as well as Permian and even Carboniferous strata, have been detected in other provinces of New Zealand, and may be detected here; but as yet data are wholly insufficient to enable me to venture on any accurate chronology* of the rocks of Otago. Not only is it difficult to determine the European equivalents, and thereby the geological age or chronological relations of these fossiliferous limestones—and generally of the rocks of Otago—on account of the very meagre data that exist, the merest fraction of the province having been examined, and the collections being far from full or satisfactory; but the difficulty is rendered greater by the present confused state of geological classification and nomenclature in Europe—a confusion that demands instant reform, with a view to the establishment of more comprehensive and natural groups of strata, or geological "systems;" less arbitrary and artificial lines of separation or boundary between these groups or systems; and a less local and objectionable nomenclature of groups and their subdivisions. The whole of the Green Island district (by which I do not refer to any of the "districts" of your excellent Survey Office, but to the natural district formed by the range of the Green Island hills) is a mass of foraminiferous and entomostracous limestone, of the age, perhaps, of the English chalk and greensand, containing beautiful *Echinoderms* or sea-urchins, marine shells (*Terebratulæ*), and the teeth and spine rays or defences—icthyodorulites—of fishes of the shark family. The same formation extends through the Caversham valley and hills, and penetrates up the valley of the Kaikorai stream towards Flagstaff. What are its limits I have had no opportunity of determining. From this Green Island limestone you derive the Caversham building stones, of which some of the most substantial and handsome buildings in town are constructed. On the Woodburn property, on the seaward flank of Saddlehill, there is abundance of a shell Limestone; and I have met with fossiliferous limestones, apparently of different geological age,

* *Provisional Chronology of chief Rocks of Otago, as known to close of* 1861.

I. *Recent.*
    Superficial Alluvium: Brick Clays.
    Certain *Moa*-Bone Deposits.

II. *Cainozoic.*
    Auriferous Drift: Upper.
    ,, Lower: Lignite Beds and associated Strata.
    Certain Volcanic (Trappean) Rocks.
    ,, Fossiliferous Limestones and associated Strata.
    ,, ,, Clays.
    Septaria beds of Moeraki.
    ,, ,, Moa-Bone Deposits.
    ,, ,, Kauri-Gum ,,

III. *Mesozoic.*
    Certain Fossiliferous Limestones and associated Stra a.

IV. *Palæozoic.*
    Possibly certain Fossiliferous Limestones and associated Strata, &c.
    Metamorphic Slates: quartziferous and auriferous.

Preponderance of Strata of Palæozoic and Cainozoic age; especially of the Auriferous slates and their "drifts."

about the "Nuggets," near the mouth of the Clutha, and elsewhere. It remains to be seen what proportion of lime and silica these limestones respectively contain, and how far they are suitable as mortars or manures; this is a point for the analytical chemist. Other purer limestones I have met with, of limited extent, in various localities. In almost every part of the province, fossiliferous limestones, of great scientific interest, if not of great commercial value, appear to occur; at least I have had put into my hands specimens from the Mataura Ferry, the Shag Valley, Oamaru, and elsewhere. Many "industries," as you term them in the colonies, will probably ere long spring from the products of your soil. Brick clays are abundant, and bricks will be desirable where suitable building stones are deficient. Of the latter there seem none to equal the sandstones of Craigleith and Granton. Ochres and umbers, *et hoc genus omne* of pigments abound. The *Septaria* of Moerak, like those of Victoria (Australia), may yield a useful cement.

Geology of the Otago Gold-Fields.

What I may designate for present purposes the *Auriferous system of rocks* and deposits,—those rocks, or strata in other words, which yield gold to the digger,—are no less abundant in the neighbourhood of Dunedin than they appear to be throughout the province. The rocks in question consist of gneiss, mica, chlorite, talc, clay, and other slates, with associated quartzites. They are identical, in appearance, with the rocks of the same name, which occur in the Grampians and other parts of Scotland, and are perhaps of similar age (Lower Silurian). There are the same ferruginous impregnations of these slates so characteristic of, or common in, the auriferous slates of Victoria, and generally of all auriferous countries; and, though to a more limited extent than is the case in many other gold-yielding countries, there are disturbances of these slates by eruptive volcanic rocks. Of this, the outburst through, and upheaval and disturbance of, the surrounding metamorphic slates by the basaltic wedge of Saddlehill, is an example very near your capital. You may see the Metamorphic slates in question well sectioned in the cuttings of the new main south road as it crosses the shoulder of Saddlehill—that is, between the Green Island and Taieri districts They "crop out" in many of the gullies about the flanks of Saddlehill; the Chain Hills are made up of them; they meet your gaze constantly in the hills on the left-hand-side of the main south or Invercargill road, between Saddlehill and the ranges that intervene between the Tokomairiro plain and the Clutha river, where other rocks take their place, at least coastwards. Here and there these metamorphic slates form bold jagged peaks. Nowhere have I seen them so beautifully developed as on the coast at Otokia, beyond Saddlehill—your future Brighton—where they constitute its bold bluff or headland, and the adjoining cliffs. The whole of the "ranges" constituting the gold-fields of Tuapeka and Waitahuna are of the same character; which "ranges," in contour, and in their general aspect of barrenness or bleakness, resemble the uplands of Peeblesshire and Lanarkshire (the Lammermoor, Lowther, and Leadhill ranges of Scotland). You may study the gneiss and mica and other slates, with their quartziferous veins and interbedded masses, in any of the "holes" of Gabriel's or Munroe's Gullies, or Wetherstone's and Waitahuna flats, as well as in the flanks of the said ravines or valleys. But you may study them equally well, perhaps better, because more quietly and deliberately, at less expense and inconvenience—with greater comfort and with less danger, without the risk of frightening the poor digger by the suspicion that you are watching his operations with covetous eye and evil intent—in the glen that runs parallel to the main south road between Abbott's Creek and Saddlehill, on the right-hand side of the road, between it and the range of the Chain Hills, and immediately behind Mr Martin's farm of Fairfield. Here you will find what has been a gold-field in miniature—what is geologically quite as much a gold-field as Gabriel's or Wetherstone's Gullies, Waitahuna or Waipori. Some portions of this glen or gully, especially the upper portions, are riddled with the holes of gold-diggers, men fresh from the experiences of Tuapeka and Waitahuna; and the structure of the strata exhibited in such sections or sinkings is precisely that of the gold-pits of the more famed diggings of the interior. You may there see the same series of clays—yellow, red, and blue—the same "chopped slate" or slaty debris of a similar diversity of colour—the so-called "gravel" of the digger; the same "wash dirt"; the same "bottom rock;" the same "pockets" and "leads." These pits or sinkings are all in the so-called "Auriferous Drift," which appears to be, like that of Victoria, of Tertiary age, and to be divisible into an older or lower, and newer or upper series of beds. The former series includes your Lignites, with their associated clays—fire and potter's clays, kaolins, ochres, and laterites; and your quartz conglomerates and grits, so common in the Saddlehill district—the familiar "cement" of the gold-miner—blocks of which are strewn over the Tokomairiro and other plains. The newer or upper division of the "Drift" consists mainly of clays, boulder clays, and "chopped slate" gravels—the miner's "wash dirt;" all to be seen in the Saddlehill, or Tuapeka gold-fields. The hills bounding what I venture to name *Glen Martin*—the chief site of the Saddlehill gold-diggings—have the same configuration and the same structure as the ranges of Tuapeka and Waitahuna. That the slates of this glen are auriferous, there is no doubt; the glen has not only been "prospected," but worked. I have myself washed gold from its clays, and have seen specimens collected by others. The gold here is very fine, scaly or granular, generally in mere specks; but I am told some respectable "nuggets" were obtained by diggers, and some good specimens of auriferous quartz were found in the road cuttings already referred to. The precious metal does not, however, occur here in such quantity as to enable the produce of this locality to compete with the greatly superior yields of Tuapeka; respectable wages have been made, but nothing more; good "finds" and "piles" have been hitherto unknown. In other words, the gold working has not *paid*—a circumstance by no means peculiar to what may be called the *Saddlehill Gold-field;* and the field has consequently been deserted for more favoured El-Dorados.

From all I have seen and heard, I believe the gold-bearing rocks—the gneiss, mica, and other slates, with their quartzites above described—constitute the geological basis of a large part of Otago, especially of its interior mountains, of what may be denominated the Lake districts, representing the basins drained by the great central Lakes Hawea, Wanaka, Wakatip, and others, as well as the basins of the Clutha, Mataura, and other large rivers. I am led to this conclusion partly by such facts as these:—I find the gravel of the Clutha and Tokomairiro rivers composed of the debris of the rocks just named; the same debris is scattered over the tops of the ranges about the Clutha Ferry,—ranges which are themselves apparently trappean; slate and quartz debris is exceedingly common, as gravel or conglomerate, in the Tertiary auriferous drifts which are most extensively distributed; all which debris I believe to be the result of the disintegration of the mountain ranges of the interior, many, if not all of which I should expect to belong to the metamorphic formation or system—probably of Lower Silurian age. By far the most abundant and extensively distributed rocks of Otago I have seen are the metamorphic slates in question, and their derived "drifts:" the one probably of Palæozoic (Silurian), the other of Cainozoic (Tertiary) age; in other words, the one as old as the slates of the Lammermoors, and the other as new as the boulder clays—of Scotland. These quartziferous slates, or their derived "drifts," again, have been already ascertained to contain gold in many very distant parts of the province. The inference is natural and legitimate that they will do so, less or more, wherever they occur; at all events, one is justified in prospecting for gold wherever he comes upon rocks of this formation, or their derivatives, in Otago. It is impossible, however, from a *superficial* examination, to determine the absolute or comparative auriferous richness of any given tract of metamorphic slate country—to give an opinion as to where gold-digging may become *payable* or *remunerative; nothing short of actual experiment can decide such a point.* All surmises, opinions, or reports, then, based on any data short of actual trial by competent persons, and with the aid of proper apparatus, ought to be received with caution. My impression is strong that a large part of Otago is auriferous; how far, or to what extent so, I will not venture to say. And I believe further, that, so far as the adjacent provinces or other parts of New Zealand possess the same geological structure, *pro tanto* gold may reasonably be expected there also,—though here, again, it is impossible to predict whether, or to what extent, the gold-fields to be discovered, or that have been discovered, in other parts of the middle or north island, will be inferior or superior to those of Otago. The latter point can only be determined by properly organised prospecting parties, which it is manifestly the interest of governments, anxious for the possession of gold-fields, to send forth. I would recommend that such parties should, where possible, be headed or accompanied by persons acquainted, at least, with the general features of geological and mineralogical science, for reasons of a kind which the following illustrations may indicate.

In connection with this subject, let me state my conviction, that *gold mining is destined to become one of the regular, permanent industrial resources of Otago;* that the supply of alluvial gold is, at present, considering its mining population, and the means at disposal for the separation of the metal, practically *unlimited;* and that even with chemico-mechanical contrivances for the extraction of gold of a kind and quality with which the oldest gold-yielding countries are not yet provided—which science and art have not as yet furnished even to Europe—years, or cycles of years, will probably elapse, before your *alluvial* deposits are exhausted; after which the perhaps even richer original *quartzites* will fall to be searched for and operated on. So extensively is the auriferous drift distributed—so largely is it developed—so rich is it likely to prove in its gold-yield—so easily will it be worked in comparison with auriferous quartzites, that years may elapse before it is found necessary to make search for, or to work the latter, which as yet have been little looked for, and of whose existence, richness, or extent nothing may as yet be said to be known. Nor will it be found remunerative for a long period to work the beach diggings at Moeraki, the gold of which is the finest I have seen here, but which demands more labour for its separation than the nuggety golds of Tuapeka. The "drift" derived from, or the debris of, the metamorphic slates, in the upper beds whereof all your "diggings" are at present situated, forms plains of great extent, as well as valleys of every size, in every part of the province I have visited. And there are indications that it is less or more universally prevalent throughout the province—in plains and valleys—in river banks, beds, and terraces—lake beaches old and new, and in other forms and localities. This circumstance is most significant, indicating the probable extent and abundance of the diffusion of alluvial gold; for wherever this drift occurs—especially its upper series of beds, the clays and gravels of the gold pits of Tuapeka—gold may be looked for.

Geologists know that gold is almost always associated with certain groups of rocks, and that certain other groups need not be expected to yield gold. There is no great difficulty in predicting or asserting that the trap rocks of Dunedin will contain no gold, and that diggers need make neither "shallow" nor "deep sinkings" therein; though this remark does not apply to strata, which may be auriferous drifts or auriferous rocks, covered by such traps (of Tertiary age); for instance those of many of the Victorian gold-fields. But the uninitiated may be led into fallacy and error by the presence of such substances as quartz. I have already stated that the ranges about the Clutha are bestrewed with quartz debris or pebbles. These have obviously been brought by the agency of ice or water from the Highlands of the Clutha—the great interior mountain chains—and here deposited on the surface. The subjacent rocks are trappean, not schistose. Of the significance of such facts, or perhaps of the existence of such facts, however, the diggers are apparently unaware. They can say, with Cæsar, *Veni, vidi*—I came and I saw; but they cannot add *vici*—I have conquered. They have espied the quartz, and they have jumped to the conclusion—Here is quartz; it is in quartz that gold occurs; it is in the same quartz that it is found, or from which it has been derived, at Tuapeka and Waitahuna; the chances are, therefore, ten to one, it will be equally found here. So they sink pits, and penetrate the same yellow and bluish clays that cover the rocks in every part of the province I have visited; but they come upon no slate or drift, they find no gold. They strike upon trap, and they might possibly sink their pits to the earth's centre without reaching the strata of which they are in search. I have seen prospecting pits in other situations, where a little knowledge of geology would have prevented the error, the trouble, and the expense of sinking pits, however shallow, in localities where no gold could reasonably be looked for. It is not easy to calculate the amount of time that is frittered, labour and money uselessly expended, under such circumstances, by what is virtually geological ignorance and inexperience. I cannot say I have met with cases among the Victorian immigrants; a long experience has made *them*, so far as gold-bearing strata are concerned, geologists and mineralogists in spite of themselves. But I have met with ludicrous instances among the Otago diggers, who have, in regard to gold-working, much yet to learn from their Victorian brethren. "All is not gold that glitters" is especially true, and worthy of being carefully and constantly borne in mind, in these golden days. I have known Otago settlers carefully hoarding up "Nuggets" of iron pyrites, which are common in certain of the metamorphic slates, particularly in clay or common roofing slate, in which they constitute the familiar "slate *diamonds*." I have found these pyrites, also, in the shales associated with your lignites, for instance in Abbott's Creek. Not many years since a "gold mania" suddenly bestirred douce old Scotland, and there was a "rush" from various parts of the country towards the Lomond Hills in Fife, and other localities reputedly auriferous. I well remember the only trophies of the deluded excursionists were scales of mica, or cubes of the same iron pyrites, both glittering and both gold-like, but neither of them the genuine article "by a long way." The slightest geological knowledge would have prevented any one looking for gold on or about the Lomond Hills, which are trappean, surrounded partly by the old red sandstone, partly by the carboniferous system. Gold, however, does really occur in Scotland, at one period as much as £100,000 worth having been collected in the Lead Hills district. But though nuggets of 1 or 2 ounces were occasionally obtained of equal quality with those of New Zealand or Australia, it was found to exist in too small a quantity to pay its collection, when, in the reign of Queen Elizabeth, a man's daily wages rose to *fourpence;* the royal works under Sir Bevis Bulmer, Master of the Mint, were therefore given up, and have not been resumed, though gold may be found in the alluvium of the Lead Hill valleys to this day. Gold occurs also in some of the Welsh rocks, and here its extraction does pay, for the melting of the ores, in which it is found, pays independently altogether of the gold, which is thus a source of additional profit. These instances are adduced with a view to show—firstly, that gold may exist, and yet its collection not be a profitable or remunerative occupation, on account of its quantity or the expense of labour; and secondly, that it may exist under circumstances, or in situations where it cannot be collected with the same ease as the alluvial gold of Australia and New Zealand, but where the employment of chemical or mechanical appliances may yield a profitable return.*

Geologically your province bears a strong general resemblance to all other auriferous countries yet known, though there are differences in details. I speak in regard especially to California, Australia, Nova Scotia, and Russia. And this general resemblance leads me to hazard the prediction that you will probably find associated with the gold in your auriferous drifts many of the minerals that have been found associated therewith in Australia and other gold-yielding countries. Such is Titaniferous Iron Sand (Iserine), which, though less abundant here than in Taranaki, and perhaps the North Island generally, is still common both on your coasts and in the interior; it is intermixed

* Allusion is not here made nor intended to the recent discovery of the rich auriferous quartzites of the Silurian strata of North Wales (Merionethshire), and the highly remunerative operations of the Vigra and Clogau, and other gold-mining companies established around Dolgelly. These gold yielding rocks are more comparable to the *quartzites* of Coromandel (Auckland, N. Z.) than to the *alluvial* deposits of Otago.

with the sands of the Green Island coast, just as I have found it at Portobello, near Edinburgh, and as I have it also from Skipness in Cantyre, Argyllshire. Such also are Tin Sand (Cassiterite), Beryl, Garnet, and Zircon: which latter gems are sometimes so abundant as to form, near Invercargill, a Garnet Sand, that speaks eloquently of the geological character of the great central mountain of Otago.

Perhaps the best proof I can give you that geological information is eagerly sought after, and its want greatly felt, by your settlers, is to repeat, under this or other heads, some of the queries that have been put to me in the course of my excursions. Inquiries innumerable, as you may easily conceive, have pointed in the direction of *Gold*. I have repeatedly been asked, for instance, whether a particular piece of land, or district of country, is likely to contain gold. Some settlers are prompted to such inquiries by the fond hope that *their* land may prove auriferous, the source of golden returns; the majority, however, of landowners fervently wish that their possessions may have no attractions for the prospecting party or digger—may contain none of the "root of all evil"—that they may be left to their flocks and herds in peace and security. A more specific form of the same sort of question is: Ought I to "sell out" at once, while prices are high and the demand great? or should I "hold on," in hope of the discovery of gold or coal, ironstone or limestone, or some other valuable rock or mineral, on my land? Such a querist is usually keenly on the outlook, like Micawber, for "something to turn up" to his advantage. Fortunately, so far as the probability of finding gold is concerned, such queries are generally easily disposed of by any one possessing a modicum of geological knowledge.

(*To be continued.*)

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 1*st December* 1862.

Principal Forbes, one of the Vice-Presidents, at the request of the Council, delivered the Opening Address.

(This Address appeared in the last number of the Journal, page 71.)

Monday, 15*th December* 1862.—Professor CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the Representative Relationships of the Fixed and Free Tunicata, regarded as two sub-classes of equivalent value; with some general remarks on their Morphology. By John Denis Macdonald, Esq., R.N., F.R.S., Surgeon H.M.S. "Icarus." Communicated by Professor Maclagan.

In this paper the author maintains the proposition, that the class Tunicata may be conveniently divided into two sub-classes, viz., the Fixed or Stationary, and the Free or Locomotive, of at least nearly equal value in a zoological point of view, in opposition to the opinion commonly entertained, that the so-called Pelagic Tunicata compose a group only commensurate with the groups of the Compound, the Social, and the Simple, into which the Fixed Tunicata have been divided by Milne-Edwards and others.

After some general remarks on the morphology of the class Tunicata, the author proposes the classification, of which the following are the leading subdivisions, and under which he groups and classifies the various genera of Tunicata.

TUNICATA.

Sub-class 1st.—Animals fixed or stationary.

I. Branchial membrane closely adherent, or more or less perfectly sac-like; simply areolated or distinctly retiform, the meshes disposed in many transverse series without non-ciliated supporting bars.

1. Gemmæ springing directly from the parent, with a temporary bond of union—Simple Tunicata.
2. Gemmæ springing separately from a definite "ascidiarium" (Hux.), and communicating indirectly through a central common vascular system—Social Tunicata.
3. Gemmæ arising separately from the parent with or without vascular intercommunication, but always immersed in a common test or "ascidiarium"—Compound Tunicata.

Sub-class 2d.—Animals free, locomotive.—Pelagic Tunicata.

II. Branchial membrane sac-like, with transverse slits in single longitudinal series, strengthened by longitudinal non-ciliated rods, apertures terminal or sub-terminal.

III. Respiring by an upper and a lower gill-band, connected with each other laterally, and with the walls of the atrium; having branchial slits, but no supporting longitudinal rods; apertures terminal.

IV. Respiring by a central and inferior gill-band, with free borders and transverse ciliated stripes, but without slits or rods; apertures terminal or sub-terminal.

V. Pharynx ciliated below, without a distinct gill-band; branchial slits reduced to two ciliated openings on the sides of the rectum.

2. On the great Refractor at Elchies, and its Powers in Sidereal Observation. By Professor C. Piazzi Smyth, Astronomer-Royal for Scotland.

Monday, 5th January 1863.—Professor KELLAND, V.P. in the Chair.

The following Communications were read:—

1. Biographical Account of Professor Louis Albert Necker, of Geneva. By David James Forbes, D.C.L., F.R.S., V.P.R.S. Ed., Principal of the United College of St Salvador and St Leonard, in the University of St Andrews.

Louis Albert Necker was born at Geneva on the 10th April 1786. His father, Jacques Necker, was Professor of Botany, and also a councillor of state and syndic of Geneva. This Jacques Necker was nephew of the financier Necker under Louis XVI., and cousin-german of Madame De Staël. Louis Necker was therefore one generation farther removed from those eminent persons. His mother, Albertine de Saussure, daughter of the illustrious Swiss naturalist, was a person of unusual talent, and of the most amiable disposition. His attachment to her throughout her life was of the tenderest and most constant kind. She died in 1841. She is known to the public by her excellent work called "*Education Progressive*," and also by a biographical notice of Madame de Staël.

The family of Necker is stated to have been originally Irish, and to have taken refuge in Protestant Prussia during the religious persecutions of Queen Mary of England. Early in the eighteenth century, Charles Frederic Necker, great-grandfather of the subject of our biography, left Custrin in Pomerania for Geneva, being charged with the education of a young German prince. He was a jurist of eminence, and having determined to settle at Geneva, a chair of law was instituted for him in 1724. He died in 1760. His son Louis Necker was Professor of Mathematics at Geneva, and author of several works, while another son was Jacques Necker, the celebrated financier. These brothers both died in 1804. The former was grandfather of Louis Albert Necker, the subject of our biography, and father of Jacques Necker who in 1785 married the daughter of de Saussure. This Jacques Necker retreated with his family to England during the French Revolution, and after his return became Professor of Botany at Geneva. He was remarkable for his unflinching opposition to the French sway. On the Restoration of the Swiss Government he was named one of the first magistrates of Geneva, and died in 1825, very highly respected and regretted. Besides Louis Albert Necker, his eldest son, he had another, Theodore, and two daughters.

Louis Necker finished his school studies at Geneva in 1800, and entered the *Académie*, where he followed the various courses of the higher studies for four years. In July 1803, in company with his father, he made his first journey into the Alps, commencing with Chamouni, and extending it to Zermatt. In 1806 Louis Necker proceeded to Edinburgh (being then twenty years of age), for the purpose of prosecuting his studies at the University, and of im-proving his mind by foreign travel. After the age of twenty, Scotland became to him a second fatherland. As became the grandson of De Saussure, he was already conversant with mineralogy and geology; and he could not in all Europe have found a school better fitted to educe his talents than Edinburgh presented at that period. In the University, indeed, under the zealous Jameson, the doctrines of Werner reigned supreme. Yet it was well for a young geologist of that day to become acquainted with his teachings; and in so far as they were overstrained or erroneous, there was an ample corrective in the distinguished school of Huttonians, who then discussed and elucidated the theory of their master, partly in the University, but principally in the hall of the Royal Society, and by their writings. Necker was personally acquainted with Playfair, Sir James Hall, Lord Webb Seymour, Hope, Allan, and others, who met nearly every week at the period of Necker's stay in Edinburgh, to discuss in this Society the theories of geology, and to listen and reply to the less numerous, yet undaunted supporters of Wernerianism, headed by the persevering Jameson. Already, during the winter of 1806–7, Necker had visited the interesting coast of Fife, and the principal islands of the Forth; and under the guidance of Sir James Hall himself had inspected the numerous and interesting geological sections which abound on its southern shore as far as St Abb's Head. At other times he travelled in company with Patrick Neill and others of the Jamesonian school, and had an opportunity of judging impartially the opinions of either party. Of course the discussions of the winter were to be farther pursued in the field during summer; and Necker, nothing loth to judge for himself concerning the facts of which he had become accustomed to hear such conflicting explanations, undertook excursions not only in the geologically interesting neighbourhood of Edinburgh, but to the west of Scotland, and even into the farthest Highlands, then but little visited. The origins of granite and trap were of course the main objects of his search, so far as geology was concerned; and, no doubt by the advice principally of Playfair, who used to call Arran an epitome of the world, one of his early excursions (in May 1807) was to visit that island, which he appears to have studied with scrupulous care, having spent nine days in the northern and most interesting part of the island. He was accompanied by a fellow-student named Shute. He there became a convert to the igneous theory of granite, and seems to have been among the first to direct attention to the granite veins of Tor-nid-neon, afterwards more carefully explored by Mr James Jardine.

On the 6th August 1807, Necker again left Edinburgh to visit Staffa and the Western Highlands. He travelled by Inverary and Oban, and traversing Mull, enjoyed at the small island of Ulva the hospitality of Mr Macdonald of Staffa, with whom he formed a close friendship, and of whose kindness I have heard him speak warmly even in his later years. From Ulva he made two excursions to Staffa, to the geology and mineralogy of which he of course devoted the utmost attention. He next visited the Island of Coll, where he observed traces of the action of the Gulf-stream in the transported seeds and other products of West Indian origin. He crossed to Tiree, with its ornamental marble; on leaving which he was driven back to Coll by stress of weather, but finally reached Eigg, ascended the Scuir, celebrated for its pitchstone, its fossil wood, and for the cavern which was the scene of a well-known historic massacre. Thence he touched at Rum and Canna, carefully visiting what was most interesting in each; crossed to South Uist, and finally to Skye, reaching Talisker on the 23d September. The advanced season of the year compelled him soon to think of returning southwards. After a stay of a few days only, he left Skye with vivid feelings of regret at having obtained only a glance at its noble scenery and interesting mineralogy. Little did he then think that that island should one day be as familiar to him as his native Switzerland, and should, after more than half a century, afford him a final resting-place! He returned to Edinburgh by Inverness, Elgin, and Blair-Athole, without, however, visiting Glen Tilt.

These particulars have been chiefly gathered from a journal of his Tour in Scotland, by Mr Necker, evidently nearly all written at the time, but (with a procrastination which became habitual with him) not published until 1821* (fourteen years later), when the interest of the details was considerably diminished. It is written, for the most part, with great animation, and conveys a lively impression of the literary society of Edinburgh at that day, and of the state of society in the remoter Highlands and Islands, as well among the higher as the lower classes. It includes many excellent descriptions of scenery, and many accurate details of the mineralogy and geology of the places he visited. The caution with which he holds the balance between Huttonian and Wernerian doctrines is almost amusing. But though the decidedly Wernerian views of his illustrious grandfather tended, perhaps, more than anything else to secure his favourable mention of Werner's classification of Rocks, and his adoption of his nomenclature, the Huttonian bias of his mind is everywhere visible; and he does not hesitate to declare, that whatever may be the worth of Hutton's Theory of the Earth in its most wide and speculative sense, yet that the facts of geology have been more correctly and impartially stated by his followers than by their opponents.

The travels described in the three volumes I have mentioned seem all to have been performed either in the winter of 1806–7, or in the following summer and autumn. There is no doubt that he passed the succeeding winter in Edinburgh, but then, for a time, we lose trace of him. It appears from a passage in his book (vol. ii. p. 67), that he visited Devonshire and Cornwall in 1809 with geological objects. I cannot be sure whether or not he had previously returned to Geneva. I understand that his home journey took place through Holland, and was not free from embarrassment, owing to the war. In 1808 he was elected a member of the *Société de Physique et d'Histoire Naturelle de Genève*, which seems rather to

* *Voyages en Ecosse et aux Isles Hebrides, par L. A. Necker de Saussure*, 3 vols. 8vo. Geneva, 1821.

indicate that he returned home in that year. In 1810 he was appointed, under the French *régime*, joint Professor of Mineralogy and Geology at Geneva; and became Honorary Professor (under the Swiss Government) in 1817. In both these capacities he delivered various courses of lectures, as well on geology as mineralogy; and his geological excursions with his students are still advantageously recollected. In 1813 he visited Auvergne, the Vivarais, and the South of France, for geological purposes, and at the same time the Pyrenees, and probably the coasts of Genoa.*

I find that in 1820 he made an excursion to Italy. Indeed, he not improbably had passed the previous winter there, though I do not know the occasion. At all events he visited Mount Vesuvius in April; and he then made interesting observations on the dykes or injected lavas of Monte Somma, his account of which still remains classical, and connects itself with his studies of Huttonian geology in Scotland.

In 1821 he at last brought out his work on Scotland, and having thus relieved himself of a task of which he had no doubt long felt the weight, he set himself seriously to what he no doubt considered the main business of his life—the study of the geology of the Alps, in continuation and verification of the labours of his grandfather, De Saussure, whose academic chair he had for some years occupied. He had previously travelled in Switzerland from time to time with geological objects in view, but from and after 1821 (as he himself tells us) he made regularly two annual excursions, one in the early part of summer in the lower and outlying parts of the chain, and another towards autumn in the higher Alps. He justly remarks that the importance of the study of the inferior and external parts of the range was at that time not fully appreciated, and still less, perhaps, the excessive fatigue, heat, and even peril, attending the investigation, step by step, of these rugged calcareous mountains, which fully equal in height, even when allowance is made for their elevated bases, the highest mountains of Britain. In all these cases he examined on foot, and step by step, the range of country within which his special journey was confined, making elaborate notes and drawings on the spot, which he inked in at leisure, thus accumulating a mass of authentic and valuable details, of which unfortunately but a very small part ever saw the light. The environs of Geneva and the important and intricate country between its lake and the bases of Mont Blanc, formed the most frequent scene of his geological labours. In 1826 he made a special study of the Valley of Valorsine (near Chamouni), with its interesting granite veins and pudding-stones. It may be conceived with what interest he compared the former traces of the vast upheaving forces which raised the Alps, with those which he had sedulously examined nearly twenty years before in the Isle of Arran.

But his researches were far from confined to his own district of Switzerland and Savoy. He had previously visited the Eastern Alps, including the environs of Trieste, and a great extent of

* *Voyages en Ecosse*, tome i. pp. 45 and 215. See also *Etudes sur les Alpes*, p. 363.

country then almost unknown to geologists, extending southwards nearly to Dalmatia, and northwards to Vienna. Family affairs in part, I believe, directed his course to Trieste, and the visit was repeated for some consecutive years. To connect his studies in the East with those in the Western Alps, he undertook in 1828 a special journey, which lasted from May to September, of part of which he published a brief account (*Etudes Geologiques*, Preface, and *Bibl. Univ.*, Oct. 1829). This last is a paper on the interesting hypersthenic syenite of the Valteline. He started by the Tarentaise, Little St Bernard, and Val d'Aoste, by Val Sesia, along the whole series of the Italian lakes to the Vicentin, and thence to Belluno a Pieve di Cadore, from whence he reached Trieste by the Valley of the Tagliamento. He thence traversed Carniola and Carinthia, entering the Tyrol near Fassa, and pursuing his route by the Stelvio and Valteline, until he regained his former track at Como. In 1829, or subsequently, he returned once again with admirable perseverance to the Alps of Carniola, and those of Istria and Illyria; yet undertook also researches into the enigmatical fossiliferous deposits of the Tarentaise, to which, about that time, M. Elie de Beaumont had called fresh attention.

We have now reached the year 1829, when Necker was forty-three years of age, and from this period we may probably trace the commencement of the second and far less happy stage of his life. As one of his attached countrymen observes, in a letter to me, the two phases were so unlike, that they might seem to have belonged to different individuals; the first period marked by the greatest bodily and mental activity, exuberant spirits, and relish for society; the second by comparative indolence, too often by moody reserve, and a painful tendency to misconstrue the kindest intentions of his warmest friends.

My acquaintance with M. Necker commenced at Edinburgh in November or December 1831. The privilege of making his acquaintance was to me at the time a great one. His favourite sciences were those which then occupied most of my own attention, —geology, meteorology, and general and terrestrial physics. He was perfectly at home in the Alps, which I had already visited, and to which I was about to return. I may say confidently that with few persons have I spent more delightful hours at any period of my life, or been rewarded by a larger amount of instruction, conveyed with a simplicity and grace which were peculiarly his own. M. Necker's appearance at this time was remarkably prepossessing. He was rather short than otherwise; well proportioned and active; his complexion was dark but ruddy; his eyes, of a fine blue, beamed with intelligence; his nose was aquiline, and the upper and lower parts of the face slightly retreating; the mouth firm but sweet; his gait rapid, nervous, and earnest. He spoke English with the utmost fluency, but with a foreign accent far from disagreeable. He had a keen sense of humour, which never forsook him, and he possessed a stock of natural gaiety which flavoured his conversation even long after he was subject to those fits of melancholy from which, in later life, he suffered so severely.

He left Edinburgh for London in February 1832, where I also passed some time in his society. Later in the same year we met at Geneva, where I experienced his hospitality, and had the good fortune to be introduced to his excellent mother. The same autumn he invited me to join him in a tour through part of Switzerland, including the Oberland and Valais. This pleasant tour lasted for a fortnight, and showed the resources of my friend in many new lights. From the commencement of 1832 until his death, almost thirty years later, we maintained a correspondence which, though often recurring at long intervals, was not discontinued. By the aid of these letters I can trace some particulars of his migrations, which might otherwise have escaped me.

In 1833 and 1834 he appears to have been much engaged in the preparation of a treatise on Mineralogy, which had for long occupied his thoughts. He spent the winter of 1834–5 in Paris, carrying it through the press This was M. Necker's most considerable and most systematic work. It shows to advantage the combination of scientific knowledge which he possessed,—which, as I have already intimated, extended over a wide range of subjects, including not only the Natural History Sciences, but Physics and Chemistry. Such a combination is eminently required by the philosophical mineralogist. His science is unfortunately at present cultivated by few, and profoundly studied by hardly any. Had this not been so, Necker's fame would have been more widely spread than it is. In a very remarkable paper, first published in Jameson's Edinburgh Philosophical Journal for 1832, he treated of "Mineralogy as a Branch of Natural History." He showed that a well characterized mineral is to be regarded as an *individual*, and that such individuals are to be grouped under species, genera, orders, and classes, as in the classification of the organic creation, by having a philosophical regard to *the whole* of the characters and properties which belong to the individuals of each species, in the same way as was done by Cuvier for animals, and by Decandolle for plants. His aim was to conciliate as far as may be the hitherto conflicting systems of classification,—that by Chemical properties alone, and that from External characters alone. His doctrine was (in brief) that those chemical characters are most to be regarded which visibly and palpably affect the external features of the mineral individual; that the indications of ultimate chemical analysis are not, correctly speaking, mineralogical characteristics at all; and that, where chemical and external indications are in apparent contradiction (which is rare), the latter are to be preferred.

I do not feel entitled to give an opinion as to the success with which Necker applied his principles to the reform of mineralogical classification. But it is admitted by competent judges that he laid down those principles with great success, and in a highly philosophic manner. I think that the labour—both mental and mechanical—of writing and editing this elaborate treatise, so full of minute details, and of discussions (at least in the introduction) of almost metaphysical subtlety, was perhaps greater than the author's then enfeebled health could well support. Necker was never afterwards quite the same man as before. His nervousness increased painfully, accompanied by fits of absence, and excessive love of seclusion. He considered, probably with justice, that the rigorous winters of Geneva aggravated his sufferings, and returning to Scotland, he passed the winter of 1836–7 in Edinburgh. In the summer of 1837 he returned to Switzerland, and made probably his last journey of any length in the Alps. He crossed the Col of Mont Cervin, studying carefully the geology of that wonderful country, and also the southern portion of the mountains separating Grindelwald from the Valais. In 1838 we find him again in Edinburgh, preparing to pass the winter, which he did at Portobello, near Edinburgh, and close to the seaside, where he hired a small house, and lived in almost complete seclusion. I visited him occasionally; but any society was oppressive to him. His windows looked right out upon the sea, and he pleased himself by thinking that nothing but the ocean separated him in a right line from Norway. Leaving Portobello in May 1839, he spent part of three months in his old favourite resort, the Isle of Arran. Here he occupied himself with much diligence and zeal in surveying accurately the granitic and trappean formations of the island. The results were presented to the Royal Society of Edinburgh, in April 1840, in an elaborate paper, which embraces a minute tabular description of no less than 149 individual trap dykes in the north-eastern part of the island alone, besides giving indications of many more. It was an occupation well suited to M. Necker's state of health, affording constant, yet moderate occupation of mind, and attraction out of doors, with the advantages of a temperate climate, and removal from any interruption, or anxiety. The wonderful patience and conscientious ability with which this labour was executed is worthy of all commendation; and the really astonishing nature of the phenomena which it chronicles with so much minuteness, exempts it from the suspicion of being a useless or puerile employment. So close a survey introduced M. Necker to many singular mineralogical and geological peculiarities previously overlooked; and having myself since gone over much of the ground with his memoir in my hand, I can testify to its wonderful fidelity. It is impossible to foresee how important this catalogue of dykes may one day prove to the future dynamical geologist.

We have an interesting chronicle of Necker's life at this time, in a series of letters to his mother, which were printed soon after in the *Bibliothèque Universelle de Genève.* They commence at Portobello in February 1839, and they unfortunately terminate in September. These letters, now buried in a large periodical work, are charming in themselves, and give a delightful picture of the writer's capacity for intellectual enjoyment. He always presented to his mother the gayer side of his impressions. The little traits of his daily life are told with characteristic näiveté, and are interspersed in the most natural manner imaginable with a notice of what he saw interesting in botany, ornithology, mineralogy, or upon other scientific topics, which he evidently felt sure would be neither unintelligible nor uninteresting to his correspondent. In quitting Arran, he adds the significant remark, "Je regrette Arran où je me suis fait un bien prodigieux." The later part of the season he spent in the Orkney and Shetland Islands, interesting to him, as well from the picture of primitive manners which they present, as from their remarkable geology. This part of his tour is detailed in his letters to Madame Necker; and there is a letter to M. Moricand of Geneva on the geology of the Island of Unst, in a subsequent number of the *Bibliothèque Universelle*. From the Shetlands he proceeded to Skye, where he passed the winter of 1839–40. Here he found so much to interest him geologically, and also found the damp but mild climate to suit him so well, that he was gradually led to adopt Portree as his permanent abode.

During his residence in Skye, in the winter of 1839–40, he was, I believe, actively engaged in preparing for the press the first volume of his *Etudes Geologiques dans les Alpes*, of which no other ever appeared. He spent the summer of 1840 at Geneva, where the work was no doubt chiefly written. In the autumn he quitted Geneva, with the deliberate purpose of making Portree his future residence. He passed the winter in Paris, seeing his work through the press.

The *Etudes Geologiques* form the third of Necker's separately published writings. They were probably expected by the author to be, when completed, his best memorial, and the chief contribution to science of a lifetime devoted to its pursuit. But the work as it stands goes but a little way to realise those reasonable hopes. It is but a fragment, and a fragment of which the merits and defects are equally characteristic. We find evidence of patient, clear-sighted investigation into natural operations which would have escaped a less diligent observer, and whose significance a less intelligent reasoner might have disregarded. The work oscillates between a memoir on local geology and a systematic treatise; and it does not exactly fulfil the purpose of either. Even in its present fragmentary form there is much to interest the geologist in the isolated volume of studies which M. Necker has left. The followers of Sir Charles Lyell will find in it a fund of admirable observations on the effect of causes still in action; and although the doctrines of glacial operation have made great progress since 1841; and although Necker was systematically disinclined to side with those who attributed to the formerly vast extension of glaciers conspicuous effects both in and out of Switzerland, his information on the distribution of erratics in the basin of the Lake of Geneva is very interesting and suggestive, and many of the facts and difficulties which he propounds are worthy of great consideration.

As the *Etudes sur les Alpes* was the last, not only of Necker's larger and separate, but even (I believe) of his more occasional printed contributions to science, I may as well advert here to one or two of the latter—his detached memoirs—which I have not already had occasion to mention. There are several on subjects of pure mineralogy, perhaps of no great intrinsic importance. There is a paper in the Transactions of the Royal Society of Edinburgh, Vol. XII., on the True and Apparent Dip of Strata; and there is a pleasing and somewhat elaborate paper in the second volume of the Genevese Memoirs on the native birds of the district. To these I shall merely make this general reference. But I wish to mention three occasional papers, somewhat original in their nature, and which are characteristic of the pleasure which Necker took in cultivating subjects connected with Physical Geography and Natural Philosophy, in an enlarged acceptation, just such as M. Saussure would have relished.

The first of these was an attempt to connect in a general way the great lines of geological stratification over the globe, with the lines of equal magnetic intensity, as traced by Hansteen and General Sabine. This was as early as 1830, and it is only fair to state, that the knowledge either of the one or of the other class of phenomena was then, at all events, too limited to justify any confident deductions on the subject. The comparison of these lines of direction was not, however, made without considerable research, and the growing interest of the inquiry, and perhaps the increasing probability of its having some physical foundation, induces me to recall attention to Necker's memoir. The recent speculations of Dr Lloyd tend in the same direction, and I think also the observations of MM. Schlagintweit. In Necker's later writings, such as the preface to his *Etudes*, and in his letters to Mad. Necker, we find that he continued to give weight to the theory of the connection of magnetic with geological phenomena.

The next of these papers is contained in a letter addressed to Sir David Brewster, printed in the "Philosophical Magazine" for 1832. It describes a very beautiful optical phenomenon observed by the author in the Alps, when the direct rays of the sun are concealed by a line of forest fringing some rising ground between the spectator and the sun. The outlines of the trees, and even their entire stems, are then seen to shine with a white light of dazzling brilliancy, resembling frosted silver. The effect is not peculiar to any season of the year, or to any hour of the day. It is no doubt due to the diffraction or inflection of light acting under rather unusual circumstances, and is the most notable example of the kind to be seen by the naked eye, without any artificial arrangement. I well recollect M. Necker showing me this beautiful appearance in the course of our tour of 1832, and I have often observed it since. The remarkable circumstance is, so far as I recollect, the absence of prismatic colours, which might, however, be anticipated from the infinite variety of dimension of the objects diffracting the light.

The third of these occasional memoirs by M. Necker, having for its subject certain "diverging rays which are seen long after sunset," appeared in the *Annales de Chimie et de Physique* for February and March 1839. It was communicated, I believe, by Arago's request. This paper excited little notice at the time, and is now perhaps nearly forgotten. Yet, though somewhat diffuse in composition, it contains observations and speculations worthy of record. It contains ample and specific descriptions of the second coloration of Mont Blanc, and the exact intervals after sunset at Geneva of the various appearances of illumination presented by the Alps, which have been more vaguely described by several writers. But the more interesting and original part of the paper refers to the production of divergent beams streaking the calm western sky, at a period about 45 minutes after the sun's disappearance. These, no doubt, are most usually caused by detached clouds intercepting the sunlight, and throwing their dusky shadows athwart the vaporous sky. When such is the cause, M. Necker remarked that bad weather usually followed within a short period. But he also observed that some of these crepuscular phenomena had a more fixed character, and did not indicate a change of weather; moreover, that they recurred (he thought) as often as the sun set in the same position,—that is, every spring and autumn, especially on certain days of February and October, at Geneva.

Hence he began to entertain the idea that the dark rays were shadows of distant mountains lying westward from the spectator, on the horizon of which the sun was situated when the rays appeared. In the special case mentioned, he believed the Monts Dôme, near Clermont, in France, to originate those rays, and he obtained information from various quarters tending to confirm his idea. From having very often conversed with M. Necker on the subject of his "Rayons crepusculaires," I know that for a number of years he gave this curious inquiry his close attention; and he believed, I think, that from Edinburgh he could see the gigantic shadows of the hills of Arran and Jura.

M. Necker was an honorary member of the Wernerian Society of Edinburgh, and of the Geological Society of London. In the *Proceedings* of the latter (vol. i. p. 392, Feb. 1832) is a short abstract of a paper by him, on the Geological Position of Metalliferous Deposits.

Returning now to the history of M. Necker's later years, I may abridge my record of them within a brief compass. We have seen that he returned from Paris (where he had been printing his "Etudes sur les Alpes,") in April 1841, through Edinburgh, to Portree, in Skye. He was there met by the grievous tidings of the death of the mother to whom he had been so deeply attached. This event occurred at Mornex, near Geneva, on the 13th April, precisely two days before he quitted Edinburgh. From this time he never again revisited his native country, and his habits became more and more recluse. For some years after his great loss he refused to see almost every one who, with the kindest intentions, sought to interrupt his solitude, and he suspended nearly all correspondence. He rambled occasionally over different parts of the Island of Skye, especially amongst the Cuchullin Hills, and in the environs of Portree and the Storr. But gradually he ceased to absent himself even for a night from home, and confined his excursions within the distance which his pedestrian powers allowed. Once in two or three years, as other engagements permitted, I visited Skye about this period, for the purpose of ascertaining his condition, and of offering such sympathy as he was willing to receive. My friendly overtures were rarely if ever repulsed; and though it was painful to witness the isolation and depression of a person so cultivated and so amiable, there were always intervals in which his old spirits and old interests awoke out of the partial torpor induced by his enfeebled health and monotonous life. Scarcely a day passed during any one of my visits in which we did not walk together to some of the charming localities near Portree, and discuss with renewed interest the scientific problems which his intelligence and quick observation were ever unfolding, whether from the noblest natural object, or the most trivial daily occurrence, in his neighbourhood. It was evidently agreeable to him, even in his sadder moments, to use and listen to his native language, to recall the scenery of his glorious Alps, the achievements and writings of his eminent grandfather, the memory of his accomplished mother, and the cherished reminiscences of his early life in Edinburgh. Nothing was more surprising than to find how few passing events of either public or domestic interest escaped him in his apparent isolation, from which even correspondence was at times almost banished. At this period, however, he read the newspapers with great perseverance, and he seemed never to forget anything that he once read, or to fail in connecting it with what he had previously known. I used to be amazed to find that he occasionally knew more of what was happening in Edinburgh than I myself did; and he tracked with an unfailing instinct the changes which time rapidly produced in the wide connections of his early Scottish friends, many of whom very erroneously believed that he had quite forgotten them. His periodical reading at this time embraced the *Journal des Debats*, the *Caledonian Mercury*, and the *John o'Groat Journal* (a Caithness paper); and from this singular library he managed to extract a wonderful amount of current information, not only public and domestic, but also concerning physical events and changes, and literary intelligence. Of modern books he read very few, but probably occupied his leisure in reviewing the records of his geological tours, and, perhaps, in extending them for the purpose of future publication. He was a very assiduous observer of Meteorological changes, of which he kept a constant record, and by the aid of his barometer, and his great knowledge of atmospheric effects, his cautions became of the most practical value to the fishing population of Portree, by whom, as indeed by all the islanders, he was regarded with much respect and interest, to which the peculiarity of his manner of life, and his extreme shyness towards persons in his own rank of life, no doubt contributed. The prediction of storms was with him for many years a matter of systematic study, and his warnings were at least as much regarded by the Skye sailors as any which Admiral Fitzroy could now furnish. Indeed, one use which he made of his newspaper studies was to trace, by means of the *Shipping Intelligence*, the progress of gales not only over Britain but to the most distant parts of the Atlantic, and he has often discussed with me the results of these interesting, and far from easy investigations. In other respects also he took a sincere interest in the welfare of his poorer neighbours. His kindness was unpretending, and the extent of his liberality will never be known.

It is little to say that it was exercised occasionally in ways peculiarly of his own devising, and that he was sometimes the dupe of designing or unworthy petitioners. But in a country, a portion of whose population may be said to be ever on the verge of destitution, the presence of so generous a friend was a public benefit.

The death of his only brother in 1849 affected him considerably, but led him to welcome the younger relatives, who now almost every summer gladdened his solitary chamber. It is cheering to know that the later years of so good a man were blessed with a revival of domestic interests, from which an invincible melancholy, foreign alike to his original disposition and his principles, had for a time debarred him. In the only letter from him of at all recent date which I possess,—it was written in 1859, and was evidently the result of considerable physical exertion,—there is pleasing evidence that neither advancing age, nor expatriation, nor twenty years of solitude and of struggle with constitutional depression, had quenched his sympathy with his friends, or his interest in the cause of science.

At this period, 1859, he was suffering severely from attacks of rheumatism, which confined him almost entirely to the house. Though enjoying tolerable general health, he became more and more of an invalid. I ought here to record, that throughout the whole of his twenty years' residence at Portree, he was lodged in the house of Mr John Cameron, whose attention and kindness he very highly valued. The knowledge of this circumstance relieved materially the anxiety of M. Necker's friends. Nothing in his last illness requires special notice. He sunk gradually through increasing debility, and without pain, and quietly expired at 7 P.M., on the 20th November 1861, in the seventy-sixth year of his age.

2. On the Structure and Optical Phenomenon of Decomposed Glass. By Principal Sir David Brewster.

3. Notes on the Anatomy of the Genus Firola. By John Denis Macdonald, R.N., F.R.S., Surgeon of H.M.S. "Icarus." Communicated by Professor Maclagan.

4 On the Zoological Characters of the living *Clio caudata*, as compared with those of *Clio borealis* given in Systematic Works. By John Denis Macdonald, R.N., F.R.S., Surgeon of H.M.S. "Icarus." Communicated by Professor Maclagan.

Monday, 19th January 1863.—His Grace the DUKE of ARGYLL, President, in the Chair.

The following Communications were read:—

1. Notes on the Geology of Lüneburg, in the kingdom of Hanover. By the Rev. Robert Boog Watson.

Lüneburg is the capital of the old Hanoverian duchy of the same name. It stands on the small navigable river Ilmenau, about thirty miles S.E. from Hamburg, and about 150 feet above the sea. The country around is a flat sandy heath, from which the gypseous limestone rock of the Kalkberg rises, not unlike Dumbarton Castle, to a height of 180 feet above the plain. The strata which here present themselves are—

1. Recent sea sand.

2. Boulder sand, sometimes 100 feet thick, full of boulders large and small, of gneiss, chalk, flints, flint-fossils, and great lumps of amber.—Absent from the site of the town and from the Kalkberg, but present at elevations in the neighbourhood considerably greater than either. Lüneburg was not, therefore, as it has been described, "a Helgoland in the Boulder Clay sea." (Roth. Zeitschrift der Deutschen Geol. Gesell. 1860.)

3. Miocene clay, with fossils, sometimes from 200 to 300 feet thick.—It rests unconformably on the chalk; but within the town, and round the Kalkberg, where the chalk is absent, it lies directly on the gypsum. It has not been disturbed by intrusion from below, as the underlying strata have been, but its upper surface has been violently torn and abraded during the Boulder Clay period. It often crops out through the overlying sands, and its presence is generally indicated by fine woods of forest trees.

4. Upper white chalk, with flints and characteristic fossils.—Absent from the site of the town and around the Kalkberg, but spreading out all around, appearing on the surface, however, only in one patch on the north side of the town.

5. Triassic clays, limestones, and shales, with fossils.—Present on the surface only in a patch west of the chalk, and intermediate between the chalk and the Kalkberg, but found below the surface in a thin layer over the entire site of the town, and further met with wherever borings have been made through the chalk.

6. Gypsum and anhydrite.—Found wherever borings have been made sufficiently deep. In the Kalkberg and the Schildstein, a hillock to the west of the Kalkberg, they have penetrated the surface. In general, the gypsum forms but comparatively a thin skin over the unaltered anhydrite; but in the Kalkberg, the whole mass of the rock, which has been quarried to the very heart, is gypsum. The gypsum and anhydrite are a good deal like one another; resemble marble; compact, greyish-white in colour, and slightly translucent. The gypsum especially is full of fissures, one of which has been followed 130 feet deep, filled with dolomite; more commonly they are filled with a gypseous breccia, which in one of the fissures contained the bones of a recent bat (*Vespertilio noctula*). These fissures produce a false appearance of vertical bedding. The crystal Boracite is found in the gypsum and anhydrite. It is only found elsewhere in the precisely similar gypsum rock of Alsberg, at Segeberg in Holstein. Non-crystalline, it appears in the Keuper gypsum of Lüneville in France.

No fossils exist.

The gypsum forms an anticlinal axis, with the Kalkberg for its highest point, sinking away to the east under the town in the form of a narrow round-backed bank, which dips steeply to north and south. Associated with the anhydrite are brine springs almost at saturation point, coming to judge by their temperature from a depth of 400 or 500 feet. These have so exhausted the under surface that great subsidences have occurred.

The points of geological interest connected with this locality are:—

I. That it is far the most instructive, and indeed almost the only place in the great flat of Northern Germany, where the underlying strata have been brought to the surface, these being generally buried deep under sand and clay.

II. That there is here an exhibition of a very peculiar agency by which these strata were elevated, and of the time when this occurred.

One of these inferior strata is anhydrite, a sulphate of lime deposited from water, but deposited without water of crystallization entering into its formation. Later, through exposure to moisture, it has accepted water into chemical combination with the sulphuric acid and lime, and thus changing to gypsum, has expanded to a bulk more than one-fourth greater than before, an increase nearly four times as great as that of water in freezing. This expansion, prevented from developing itself freely, has accumulated at the point of least resistance, and forced up the Kalkberg just like the plug of ice which rises through the fuse-hole of a mortar-shell when filled with water and frozen.

The origin of the sulphuric acid cannot be traced. Heat, pressure, and strong brine have all been proved sufficient to effect the deposition of the sulphate of lime in an anhydrous state.

The expansion through metamorphism must have occurred after the deposition of the chalk, and before that of the miocene clay, the chalk having been disturbed, and the clay thrown down on it after its disturbance.

III. That the age of these gypseous and saline deposits, though a difficult question, can be determined.

No borings have been carried through the anhydrite to show on what it rests. Evidence of age therefore lies in the fossils of the overlying strata, which, resting on the gypsum, have been brought up along with it. These strata are minute in extent, but abound in fossils—chiefly casts. They indicate the Upper Trias, but the particular member of it to which the beds are to be assigned has been keenly debated. Very recently, however, the discovery of five specimens of *Ceratites nodosus* have, in connection with the rest of the evidence, and especially as associated with *Myophoria pes anseris*, given the preponderance in favour of the Lettenkohl. This is a subordinate formation now admitted to exist; but whether to be ranked as the highest of the Muschelkalk or the lowest of the Keuper, or a transition link between the two, is doubtful. Its flora connects it with the Keuper, its fauna with the Muschelkalk. In the Lüneburg beds no vegetable remains have been found, and the want of these renders the relation of these beds to the Keuper more obscure. The absence of such vegetable remains is indeed a characteristic of the Muschelkalk; but this is but a negative resemblance, and its force is counteracted by the absence in the Lüneburg beds of such distinctive fossils of the Muschelkalk as the *Encrinites liliiformis*, *Nautilus bidorsatus*, *Terebratula vulgaris*, &c.

The question then must be determined by the *Myophoria pes anseris* and the *Ceratites*, both of them interesting in themselves from their facility of recognition and from their very limited range in time. The genus Myophoria is confined to the Trias, and the two deep teeth at the hinge in either valve make it easily recognisable from the Trigonia, which has three teeth. The species *Pes anseris* is ribbed, so as exactly to resemble the foot of a goose. It does not last on into the Keuper; it has just barely begun to appear in the latest strata of the Muschelkalk; it abounds in almost incredible numbers in the intermediate Lettenkohl. Now at Lüneburg, the limestone is almost made up of it alone, so abundant is it. This fact therefore connects these beds with the Lettenkohl.

The *Ceratites nodosus* confirms this conclusion. The entire genus is confined to the Trias.* It forms a link both in form and in time between the expiring goniatites and the yet future ammonites. The *Ceratites nodosus* may be very easily recognised by the characteristic feature of the genus, which is, that in each septum all the lobes which point in towards the interior of the shell are toothed, while the projecting rounded saddle between each two lobes is smooth. The species *nodosus* is marked by thick ribs on the sides, radiating outwards, and terminating just at the edge of the back in high knobs or knots; whence its name. The projection of these knobs being on the side of the shell, the back is rendered unusually broad, and has a very square appearance. Minute variations are very frequent, but are not sufficient to constitute more than mere varieties, and the general marks mentioned are unfailing.

The *Ceratites nodosus*, then, thus easily recognised, is confined to the narrowest limits, as it first appears in the upper strata of the Muschelkalk, and disappears finally and for ever in the Lettenkohl, without so much as reaching the Keuper. Wherever found, therefore, it stamps the strata with one of the most definite assay-marks of science; and such was the importance attached to its discovery in the Lüneburg strata, that Von Strombeck, the great Triassic authority of northern Germany, in the absence of the solitary specimen discovered, but unfortunately lost, refused to believe in its existence. Since then, however, five other specimens have been found. They are mere casts, and but broken fragments of an inch or two in length, and, as is so often the case with ammonites, seem to have lain long in the water after the death of the animal. They have, however, the distinct characteristics of the *Ceratites nodosus*.

These specimens have been the more carefully examined, and the inferences deducible from them the more keenly discussed, from the fact that they have been thought to offer some support to the Darwinian theory of transformation. Von Strombeck and others be-

* It disappears wholly in the Jurassic, but reappears in a few species (four or five) in the Cretaceous. See Pictet, " Paléontolgie,"-vol. ii. p. 662. This is therefore an exception to the absoluteness of what is stated above.

lieve that the latest generations of the *Ceratites nodosus*, as exhibited in the highest strata of the Muschelkalk elsewhere, show a progressive tendency to a certain aberration from the earlier type, as figured by Von Buch in his monograph "über Ceratiten." This aberration, though marked, is not sufficient to constitute, but may be represented as a step towards, a new species. The Lüneburg specimens present this aberration in its widest form, while still obviously belonging to the species *nodosus*. If, therefore, the beds in which they are found can be attributed to the Lettenkohl, then a greater lapse of time is secured. To this lapse of time the change of form may be assigned, and thus some colour may be found for attributing to this same cause the whole of those minute changes of form which the successive species of ceratites present, and which so completely link them on at either end with the antecedent goniatites, and the succeeding ammonites.

As to the question of form. The Ceratites of Lüneburg differs from that figured by Von Buch in this, that in the latter the knobs on the side are included in the first lobe, while in the Lüneburg specimens the back is so much broader that the first lobe fails to reach so far as the knobs, and the second saddle is as it were drawn off the side towards the back, and it therefore, instead of the first lobe, thus includes the knobs. Von Buch's drawings, however, though otherwise most careful, and in this case professedly made from the same specimen, do not agree with one another (see "über Ceratiten," Plate I. fig. 1, and Plate II. fig. 1.) in this very respect of the relation of the knobs to the lobes and saddles; and so, in regard to this particular point, nothing can be made of them. Further, it appears that in all young specimens the back is relatively narrow, and the first lobe extending round the corner of the back at that period of life reaches the knobs on the side; but invariably, as the shell increases with age, the back becomes relatively broader, and then it is only the second saddle instead of the first lobe which includes the knobs. The only peculiarity then of the Lüneburg specimens is precisely what in other cases would be called a dwarfing—*i.e.*, the signs of age appearing in connection with smallness of size; which fact, taken in connection with the rarity of this fossil in the Lüneburg beds, probably points to the existence of climatic or other circumstances unfavourable to the life of this cephalopod.

The other question, that, namely, of the lapse of time,—in other words, whether the Lüneburg strata are Lettenkohl or not,—must be settled on its own merits. Admitting the Lettenkohl as a distinct subordinate formation later than the Muschelkalk, then it appears that the *Myophoria Pes anseris* is rare in the Muschelkalk, abundant in the Lettenkohl, and abundant at Lüneburg; its evidence therefore points to the identity of the Lüneburg strata with the Lettenkohl. On the other hand, the *Ceratites nodosus* is frequent in the Muschelkalk, but hitherto unknown in the Lettenkohl; its evidence therefore, unlike the other, rather connects the Lüneburg beds with the Muschelkalk. In other words, the *Myophoria Pes anseris* proves that these strata are not Muschelkalk but Lettenkohl, while the *Ceratites nodosus* shows that they lie nearer the Muschelkalk than any Lettenkohl strata yet found.

As regards the underlying gypseous limestone, this conclusion determines its age as greater than that of part of the Lettenkohl. That it is much older is not likely; and the existence elsewhere in the Lettenkohl of similar formations, accompanied as here by salt, indicates that the Kalkberg of Lüneberg belongs to the Upper Trias, and probably to the Lettenkohl itself.

Curiously enough, this conclusion dissociates Lüneburg from Germany, where the Lettenkohl is not at all, or but very slightly, saliferous,—the saline deposits of Germany being found in the lower Muschelkalk,—and connects it with France, Switzerland, and England, where it is in the Lower Keuper distinctively that salt is richly present.

2. On the Occurrence of Stratified Beds in the Boulder Clay of Scotland, and on the Light which they throw upon the History of that Deposit. By Alex. Geikie, Esq., F.G.S.

Monday, 2d February 1863.—The Hon. LORD NEAVES, Vice-President, in the Chair.

The following Communications were read :—

1. On the Influence of Weather upon Disease and Mortality. By R. E. Scoresby-Jackson, M.D., F.R.S.E., F.R.C.P., Lecturer on Materia Medica and Therapeutics at Surgeons' Hall, Edinburgh.

2. History of Popular Literature, and its Influence on Society. By Wm. Chambers, Esq., of Glenormiston.

Having introduced the subject, Mr Chambers referred to the earliest examples of popular literature in the reign of Elizabeth; they were embellished with wood engravings, believed to be executed in Germany. Such was the origin of those very curious tracts known as "chap books," now very rare, and much prized by bibliographic amateurs. The subjects of these books resembled the Folk-Lore of the Germans, and were the embodiment of the superstitions, fancies, and traditions of a much earlier period; the least exceptionable being the ballads of a heroic and tender kind. Next was traced the rise of newspapers, and the importance they began to assume in the reign of Queen Anne, a period also signalised by the popular writings of Steele, Addison, and Defoe. The imposition of the stamp-duty in 1712 checked this sudden rise of popular literature; and various circumstances postponed its reappearance until the reigns of George IV. and William IV., by which time great advances had been made in education and in a general taste for literature,—the writings of Cowper, Burns, Campbell, Wordsworth, Scott, Byron, and others, along with the influence of certain reviews and magazines, having latterly given much impetus to thought. Mr Chambers then spoke of the origin of Chambers' Journal in February 1832, the Penny Magazine in the subsequent March, and other cheap prints, devoted in an especial manner to popularise literature. Finally, he drew attention to the abolition of fiscal duties on the products of the press,—the prodigious copiousness of cheap popular sheets, cheap newspapers included,—and the capacity of modern machinery, moved by steam-power, for their rapid production. On investigation, he found that only a small proportion of the whole was of an immoral, or otherwise objectionable kind; much of the writing in this popular department of literature being by authors of repute, to whom large sums were paid for their services. He estimated that there were not fewer than three hundred millions of newspapers now circulated per annum in the United Kingdom; while the quantity of cheap literary sheets issued per annum amounted to 144,000,000.

The following note from Principal Sir David Brewster was read by Professor Tait:—

"I send you, for the Royal Society, six of my best specimens of Decomposed Glass. In presenting them, perhaps you might mention the disappearance of all colour, by introducing a drop of water, and the passage of a prismatic line over each film, owing to the water entering more quickly between some of the elementary films than between others. These may be found by using a balsam that will quickly indurate."

Monday, 16*th February* 1863.—Dr CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. Sketch of the Recent Progress of Sanskrit Literature. By John Muir, D.C.L., LL.D. (This Paper was given at the request of the Council.)

2. On a Pre-Brachial Stage in the Development of *Comatula*, and its importance in Relation to certain Aberrant Forms of Extinct Crinoids. By Professor Allman.

The author described a stage in the development of *Comatula* subsequent to the free stage of the larva, and anterior to that in which it acquires arms. He believed that the subject of the paper was of much interest in affording a key to the nature of certain aberrant forms of extinct *Crinoidea*, such as *Haplocrinus*, *Stephanocrinus*, &c., for the peculiarities of these genera were for the most part exhibited in the young *Comatula*, where they admitted of an easy determination as elements in the composition of the Crinoid.

Royal Physical Society.

Wednesday, 26th November 1863.—Alexander Bryson, Esq., President, in the Chair.

The Chairman, as retiring President of the Society, delivered an address bearing upon "The Present Position of Mineralogy in regard to Geological Science," in which he argued that mineralogy should have awarded to it an important place in the curriculum of a geologist.

The following communications were read:—

I. *Analysis of the Discoveries on the East Coast of Greenland, bearing on the Site of the East and West Bygds, and on the connection of Scoresby's Sound and Jacob's Bight; with a Plan of Renewed Exploration.* By Robert Brown, Esq., Botanist to the British Columbia Expedition.

In this paper the author reviewed the early history of Greenland, the state of the ancient Scandinavian colonies, and the different expeditions sent in search of them; and brought forward a number of facts to prove in opposition to the opinions of Eggers, Graah, and most modern geographers, that there is not yet sufficient ground to doubt the testimony of the ancient historians, that the colonies existed not only on the *Vester* but also on the *Æester Bygds*, and the probabilities are, that under more favourable circumstances than the imperfect expedition of Graah met with, remains will yet be found. He concluded by laying before the Society a plan of a new expedition by means of reindeer sledges conjoined with boats, for the settlement of this and the disputed point regarding the connection of Jacob's Bight on the west coast, and Scoresby's Sound, or some of the inlets in the vicinity on the east coast, regarding which an almost certainty exists; and by which the geography of the east coast, from Cape Dan to Cape Barclay, will be explored.

II. *On some Species of* Hæmatopinus *parasitic on the* Pinnipedia. By Robert Brown, Esq.

Three species were described found by the author in Davis' Strait and Baffin's Bay (Sea), during the summer of 1861. (1.) *Pediculus Phocæ* (Lucus, in Guerinz. Mag. Zool.), *Hæmatopinus setosus*, Burm. On the belly of *Calcocephalus Grœnlandicus*, Mull. (2d coat). (2.) On the body of the Walrus (*Tricochus rosmarus*). (3.) At the base of the mystachial bristles of the Walrus.

Wednesday, 24th December 1862.—James M'Bain, M.D., R.N., President, in the Chair.

The following communications were read:—

I. *The Bituminous Shales of Linlithgowshire and Edinburghshire.* By Andrew Taylor, Esq.

Mr Andrew Taylor prefaced his paper by a general comparison of the stratigraphical subdivisions of the English and Scottish Carboniferous systems. The progress of research may yet demonstrate the whole Scottish coal series to be parallel in geologic sequence with the Mountain Limestone section of the English formation. Below the eastern outcrop of the upper fresh-water deposits of the Clyde coal basin, near Longridge, the strata assume the character of a series of marine limestones, mingled with several seams of true coal and ironstone. The marine limestones attain their greatest development on the Bathgate hills. One of the uppermost of the marine beds has for several years been worked at Leaven Seat, near Longridge. It is capped by a thick bed of shale, a foot and a-half of which yields, on distillation, so much paraffin as to render it of commercial value. As the limestone may be traced throughout the uplands of Lanarkshire into Renfrewshire, it is highly probable that this bituminous shale may be found more or less richly developed above it in various parts of its course. The course of the marine limestone through the Bathgate hills to Fifeshire, thence across the Forth, and again from Kirkcaldy to Gilmerton and Dalkeith, encloses a segmental area of country whose chief petralogical characteristics have been well described by Mr Maclaren as the calciferous sandstone group. A well-known fresh-water limestone, extensively worked at Burdiehouse, is known to extend throughout this area. A shale capping this limestone is in some parts of Linlithgowshire so richly bituminous as to have been mined for the purposes of distillation. Chemical works with this view have been erected at Mid-Calder and Broxburn; and a careful observation of this shale in other quarters has induced Mr Taylor to believe that it retains its bituminous character throughout the county. A richly bituminous shale had lately been examined, from Carlops, near Penicuik. It occupies precisely the same geological position as that already described. It was therefore highly probable that this bituminous shale might be found throughout the whole course of the Burdiehouse limestone. He then gave a detailed description of the Torbanehill mineral field,—which mineral he considered neither a proper shale nor a true coal. He concluded by drawing the following general conclusions:—1. The Scottish Carboniferous system is probably of much earlier age than the true English Coal Measures, being physically more united with the Upper Old Red Sandstone series. Further research may probably yet prove the Scottish Carboniferous and Upper Old Red series of rocks to correspond with the English Mountain Limestone series in reality, and form one formation. 2. The strata east and west of Bathgate are the underlying beds of the Scottish series, and must be taken as covering a great lapse of time prior to the deposition of the upper fresh-water coal formation of Lanarkshire. 3. The petralogical peculiarities of the strata around Torbanehill are such as to justify us in assigning a distinct method of formation to a mineral which neither physically, chemically, nor microscopically possesses the characteristics of a true coal. 4. The Torbanehill mineral is diffused over a limited area; a distinct stratigraphical position cannot therefore be assigned to it in any general synopsis of the Scottish Coal Measures.

II. *Ornithological Notes.* By JOHN ALEXANDER SMITH, Esq., M.D.

1. *Pernis Apivorus*, Penn., the Honey Buzzard. A fine specimen of ae adult female was shot by Mr Gavin Hill at Dalmahoy, near Ratho, on the 13th June 1862. The bird was comparatively tame, flying from branch to branch of the tree. Length from bill to point of tail 24½ inches. The extended wings measured, from point to point, four feet. The stomach was filled with the semi-digested remains apparently of wasps and larvæ, and the elytra of beetles. The eggs in the ovary were well developed. 2. *Tetrao Uragallus*, Penn., the Wood-Grouse or Capercailzie. The bird now exhibited was an example of a curious change of plumage which occasionally takes place in birds,—a female assuming the plumage of the male. This capercailzie is a female of the

ordinary size, measuring nearly two feet in length; but the general dark character of its plumage is that of the adult male,—the dark head and back, and the glossy green breast, the abdomen being mottled with white. The colours, however, are not so brilliant as in the male. The ovary contained eggs the size of rape-seed; but was darker in colour, and harder in texture than natural—apparently diseased. The bird was shot on the 2d November, near Dunkeld, on the property of Hugh Bruce, Esq.

Wednesday, 28th January 1863.—David Page, Esq., President, in the Chair.

The following communications were read:—

I. *Remarks on Torn-off Digits in Man; with reference to Analogous Injuries in the Lower Animals.* By A. M'K. Edwards, Esq. (Specimens were exhibited.)

II. *Some Remarks on Mineralogical Classification.* By Andrew Taylor, Esq.

Allusion was made to certain recent and valuable mineralogical researches of Professor J. P. Cooke of America, which went to show that two crystalline forms might vary very widely in chemical composition, and still retain their distinctive crystallographic forms. And if two beautifully crystallized products differed so widely in composition that any single analysis might lead to an erroneous conclusion as to the general formula of the substance, the question arises, might not a similar persistency of crystalline form, with diversity in chemical composition, be found in the laboratory of nature? If this be so, it must greatly alter our ideas of a mineral species. These researches were adduced to show that methods of mineralogical classification were more artificial than natural.

III. (1.) *A Young Otter* (Lutra ——?) from Old Calabar was exhibited.
(2.) *Note on the Young of the Chough*—(Fregilus graculus). By John Alexander Smith, M.D.

(1.) Dr Smith said, the specimen of an otter, preserved in spirits, and now exhibited, was sent to him a few days ago by Andrew Elliot, Esq., publisher here, from his friend Dr Hewan, Old Calabar. He need not remind the Society how much all naturalists, and ourselves in particular, were indebted to the gentlemen of this U.P. Mission for various additions made by them to our knowledge both of the animal and vegetable kingdoms. This young otter was of a light ash or pale mouse colour, with darker patches on the head and fore legs; it measured 17 inches in length, inclusive of the tail, which was 5½ inches long. Its general characters agreed with the restricted genus *Lutra* of authors; but its dentition being imperfectly developed, made it impossible to say whether or not it was the same as the otter which Mr Andrew Murray, from the examination of an adult skull sent from Old Calabar, considered new, both as a genns and species. Dr Hewan writes "that it was named *jyung* by the natives, and that with age it becomes as large as a spaniel or poodle dog; it inhabits both marshy and dry land, and lives on fish,—small kinds caught on the banks of the river at low water,—also on shell-fish, such as craw-fish."

(2.) *Fregilus graculus*—the Red-Legged Crow. Some time ago the Society was favoured with some remarks on this bird by the Rev. T. B. Bell of Leswalt. Dr Smith requested him to examine the young in the nest, as some little difference of opinion existed in regard to the colour of the bill and legs of the young birds. Mr Bell stated, as the result of his examination, that both the bill and legs were red, although not quite so brilliant as in the adult.

Botanical Society of Edinburgh.

Thursday, 13th November 1862.—Professor BALFOUR, Vice-President, in the Chair.

Dr Balfour apologised for the absence of Mr Archer, the President, who was engaged with museum matters in London. He then opened the twenty-seventh session of the Society by giving an account of its origin and progress, and by giving biographical sketches of the members recently deceased—among whom he noticed H.R.H. the Prince Consort, Professor Blume and Professor de Vriese of Leyden, Mr Borrer, Dr J. T. Mackay of Dublin, Professor Traill, Professor Blytt of Christiania, and Dr Emile Dubuc.

The following Communications were read:—

I. *Notice of Plants collected in the neighbourhood of Silloth, near Carlisle.* By Professor BALFOUR.

The author gave a brief account of Silloth, noticing its advantages as a watering-place. He communicated the meteorological observations made in regard to it by the Rev. Francis Redford, rector of the parish, and he enumerated some of the more interesting plants found in its vicinity. Among them may be mentioned—*Glaucium luteum, Chelidonium majus, Brassica monensis, Iberis amara, Ulex nanus, Eryngium maritimum, Helosciadium inundatum, Atriplex arenaria, Ruppia maritima, Triticum acutum, Botrychium Lunaria.* The communication was illustrated by specimens.

II. *Letters from* Mr WILLIAM BELL, A.B.S. Ed., *Saharunpore Botanic Garden.* Communicated by Mr JOHN SADLER.

III. *Description of Two New Species of Lichens from Ireland.* By BENJAMIN CARRINGTON, M.D., F.L.S.

IV. *On the Wild Ferns met with in the neighbourhood of Bridge of Earn, Perthshire.* By Mr JOHN SADLER.

V. *Remarks on the Cultivation of Cotton and Tea in India.* By WILLIAM JAMESON, Esq., Saharunpore. Communicated by Professor BALFOUR.

In a letter to Professor Balfour, dated 30th July 1862, Mr Jameson says:—"Much attention is now being paid to cotton cultivation in this country. I wish the British cotton lords to send out agents. They might get it not only of good quality but in any quantity. By recent returns furnished to Government by the different district collectors in the North-West Provinces, it has been shown that there are 850,000 acres under cultivation with cotton, yielding 857,000 cwt., half of which is consumed in the country, and the other half sent to Calcutta for exportation. In addition, large quantities are sent from the independent States of Gwalior, &c., also to Calcutta for exportation. But what is wanted in this country are agents to make advances, and purchase from the native cultivators their cotton on the spot. By so doing, the cotton cultivation in the North-West Provinces might easily be tripled.

"Tea cultivation in the Kohistan of the North-West Provinces and Punjaub has now become a great success, so much as to have induced me to recommend Government to part with their experimental tea farms. One farm I sold a short time ago for L.10,000. The remainder will be put up in three lots, and for them I expect to realise about L.60,000. They will form an excellent nucleus for companies, of which there are now many already established. Dr Cleghorn has been visiting some of my tea plantations, and from him I daresay you have received accounts regarding their flourishing condition. Per post I send you a report on the condition of our gardens, which will show you that we are not idle in this country."

VI. *Letter from* Dr THOMAS ANDERSON, *Superintendent of the Botanic Garden, Calcutta, on the Introduction of Cinchona Plants into India.* Communicated by Professor BALFOUR.

Dr Thomas Anderson, superintendent of the Calcutta Botanic Garden, writing from Darjeeling of date 13th August 1862, says:—"I am here superintending the introduction of Cinchona into the Sikkim Himalayas since the 1st of June, when I had 211 plants. The experiment has been so successful that on the 1st August the nursery contained 1611 plants and seedlings. I have seven species under cultivation. Among these are *Cinchona succirubra*, *C. Calisaya*, *C. nitida*, and *C. micrantha*. It promises to be a most successful experiment on those moist hills."

In the same letter he says—"I have told my gardener to send you a small wardian case containing plants of Wallich's gigantic bamboo from Burmah. The largest plant in the Calcutta Botanic Garden flowered last year after forty years' cultivation. The plant ought to grow well in your big palm-house."

A note was read from Dr Alex. J. Smith, in which he stated that *Asplenium septentrionale* had recently been collected by Mr Halliday, of Moffat, on one of the Moffatdale Hills, called Whitecoom.

Nature-printed specimens of alpine *Hieracia* were exhibited from Mr Baker.

Thursday, 11th December 1862.—Professor BALFOUR, Vice-President, in the Chair.

The following Communications were read:—

I. *Observations on the Embryogeny of Tropæolum majus.* By ALEXANDER DICKSON, M.D.

(The paper appears in the present number of this Journal.)

II. *Remarks on the Bursting of the Spathe of Palms and Opening of Leguminous Fruits.* By Mr JOHN SADLER, Curator.

Mr Sadler gave the views of different authors regarding the bursting of the spathe of palms with an explosive report. That some species of palms in their native habitats may make, while bursting their spathes, a sound, caused by compressed air, audible to a very attentive ear, he did not deny; but he was of opinion, from certain experiments which he and others had made on *Seaforthia elegans*, that in this country no indication of a report (as affirmed by some) was met with. The author then explained that the crackling sound of various leguminous fruits while shedding their seeds was not (as supposed) due to heated or compressed air, but to the shrinking or tension of the tissues. He concluded by reading extracts from a letter which he had received from Mr William Bell, of Saharunpore Botanic Garden, in which he stated that, from all the information he had gathered at Ceylon, Calcutta, and elsewhere, he could find nothing to support the theory of explosion caused by heat developed within the spathe.

III. *On the Propagation and Irritability of* Drosera *and* Dionæa. By Mr JOHN SCOTT.

The author, after a few introductory observations on the distribution of *Droseraceæ*, remarked that the modes of propagation and means of dissemination of *Drosera* (sundew) and *Dionæa* (Venus' fly-trap) were varied. Thus, independently of reproduction by seeds, the leaves of a number of the *Droseras* present a remarkable aptitude for the production of adventitious buds. This property is well illustrated by the British species, all of which produce with the greatest facility young plants on the surfaces of their petioles and laminæ. So frequent is this mode of propagation, that it must be familiar to all who have collected these plants in the later summer or autumn months, when the earlier developed leaves are beginning to decay. These falling on the moist mossy bed are reimbued with the formative force, and along their surfaces small cellular protuberances first make their appearance with a few pale fawn-coloured scales, after which one, or usually two leaves, are developed, and then a little rosette of undeveloped leaves, beset with scales, forming a pseudo-hybernaculum. The young plant up to this period is generally attached to the generative leaf, so that its nourishment is entirely derived from the parent. The vital activity of the recipient plant now in a great measure ceases, the generative leaf undergoes decay, and leaves it a free and independent organism, which, ere spring returns, may have been transported to some distant nidus by the floods, which generally sweep their habitats during winter. As illustrating susceptibility to mechanical irritation, he gave the following experiments on *Drosera rotundifolia* (round-leaved sundew), performed in a temperature of 65° Fahr. :—" Selecting a vigorous plant, I carried on a gentle irritation of the hairs for a short time; their collapsing soon became evident, and in half an hour they were all curved in upon the surface of the laminæ. Again, placing an insect upon the surface of another, the hairs had begun to collapse in twelve minutes, and in twenty minutes nearly all those near the base of the leaf had their glands applied to the insect, while those on the apical part had undergone little or no change. This had been occasioned by the position of the insect, which had been accidentally placed on a line with the petiole near the base of the lamina. Thus it would appear, that the *Droseras* do not possess the communicative powers of either their ally the *Dionæa*, the lobes of which collapse on the touching of a single hair, or of the *Mimosa*, which exhibits the same rapid communicability to the other pinna of the leaf when the equilibrium of one is disturbed." The author also detailed some experiments in support of Dr Nitsche's statement, " that their susceptibility to irritation is invariably proportionate to the activity of their secretions, and dependent on the process of assimilation." None of the author's experiments with chemical stimuli elicited any susceptibility to irritation, though he seemed to think that chloroform had an anæsthetic influence. In one of his experiments he placed two portions of the leaf of *Drosera binata* under a bell-glass exposed to the vapour of chloroform. In four minutes no perceptible change having taken place in either, he took one of them out, and found that the hairs were completely anæsthetised. In treating of the cause and functional import of these movements, he was inclined to suppose that in regard to the former no merely physical hypothesis was sufficient to account for the phenomenon, but that it was due entirely to the vital force; and in regard to the latter, he thought Mr Knight's view, that decomposing animal matter might be necessary for certain of the functional requirements of the plant, very plausible, on considering how peculiarly adapted the leaves of *Drosera* and *Dionæa* were for the purpose of catching insects.

IV. *Notice of Plants collected in the Neighbourhood of Elie, Fife.* By Mr J. W. Brown.

Mr Brown gave a list of the rarer plants met with in the district, and noticed several which had not before been observed in that quarter. He accounted for the appearance of some scarce species, such as *Statice Limonium*, *Senebiera Coronopus*, &c., by their introduction with ballast.

V. *On a New Character observed in the Fruit of Oaks.* By M. Alphonse De Candolle. Communicated by Professor Balfour.

(The paper appeared in the January number of this Journal.)

Mr Naylor exhibited specimens of the *Peloria* variety of *Linaria vulgaris*, and a peculiar abortive state of the same plant.

Specimens were exhibited of *Sarracenia purpurea*, a plant which has been of late used in cases of small-pox. The experience of medical men in Edinburgh seems to lead to the conclusion that the so-called remedy is of little or no value. Specimens of *Sarracenia variolaris* were also shown. The plant receives its name not from any qualities in reference to *variola* (small-pox), but from the small-pox-like markings on the outside of the upper part of its pitchers.

Thursday, 8th January 1863.—Professor Maclagan, President, in the Chair.

The following Communications were read:—

I. *On Irish Hepaticæ.* By Benjamin Carrington, M.D., F.L.S.

II. *On some British Cyperaceæ recently discussed by Dr Carrington.* By Charles C. Babington, M.A., Professor of Botany, Cambridge.

It is only within the last few weeks that I have become acquainted with the "Notes upon the Cyperaceæ," by Dr Carrington, contained in the "Transactions of the Botanical Society" (vol. vii. pp. 259 and 320). Having read them with much interest, I may be allowed, and indeed perhaps I am called upon, to make a few remarks upon the species there noticed. They are chiefly in confirmation of Dr Carrington's statements.

(1.) *Carex Grahami*, Boott.—It is quite possible that this may be a monstrous form of *C. pulla*, Good., but I am much more inclined to agree with Dr Boott in believing it to be distinct. I possess a considerable quantity of the ripe utricles of *C. Grahami*, derived from plants cultivated in the late Mr Borrer's garden. In such of them as I have opened I find what seem to be ripe nuts. These are pale yellow, not half as long as the utricle, about $\frac{7}{100}$ of an inch long, oblong, compressed, or trigonous (except very near their base, which is usually triquetrous), prolonged into a very long beak at the top, which is often curved, on account of its length exceeding the space between the nut and the contracted mouth of the utricle. The termination of this beak of the nut is not marked by any decided joining between it and the style; but probably the lower part, which is terete, belongs to the nut, and the compressed or triquetrous part (which is often half its length) is the base of the style. In this upper part the colour gradually changes from the pale yellow of the nut to the fuscous tint of the true style.

Unfortunately I cannot find a ripe utricle of *C. pulla* to contrast with that of *C. Grahami*. In Kunth's "Cyperographia" (411), the nut of *C. pulla* is described as follows:—*achenium subrotundum, mucronatum, biconvexum, subtiliter punctulatum, pallidum.*" This is the only description of it that I can find. Dr Carrington does not describe the nut, but gives a figure of it, which certainly cannot be called "subrotundum," and is difficult to describe in few words; it is nearly twice as long as broad, cuspidate (if that term is understood as defined by me in the "Manual," ed. 5, p. 12, and figured by Lindley in his "Introduction," ed. 4, vol. ii. p. 356, § 3), with nearly parallel sides. It is at least twice as long, relatively to the utricle, as that of *C. Grahami*.

Perhaps a few words may be allowed concerning the name of the plant. I call it *C. pulla*, after Goodenough, and am thus in accordance with a considerable number of the best writers. Anderson remarks (*Plantæ Scandinaviæ Cyperographia*, p. 19); *quod ad C. saxatile Linnæi attinet, in Herb. Reg. Acad., Sc. Holmiensis specimen asservatur a Dno Montin, Linnæi contemporaneo, in Lapponia lectum et C. saxatilis* (Linn.) *inscriptum, quod aperte ad C. rigidam referendum; aliud tamen a collectione Dni Solander, C. pullæ proprius accedit.* It seems most probable that Linnæus originally intended to designate *C. pulla* by the name of *C. saxatilis*, but afterwards he unquestionably included *C. rigida* under that name, and probably made it the type of the species. As the name *C. saxatilis* is most variously used by authors, and as there still remains some reasonable doubt concerning the Linnean plant, I consider it best to use names for the plants about which there is no ambiguity, viz., *C. pulla* and *C. rigida*. I should be much obliged to any Scottish botanist who would send to me the ripe fruit of *C. pulla*.

(2.) *Eleocharis Watsoni*, Bab.—I have only one difficulty in arriving at the same conclusion as Dr Carrington, namely, that *E. Watsoni* is a state or variety of *E. uniglumis*, Link. That difficulty is, that Mr D. Moore (who found *E. Watsoni* on the Murrow of Wicklow, in flower in May 1862), informs me by letter, that "the roots are tufted, scarcely creeping at all." If he is correct in this remark, and there is no reason to disbelieve him, *E. Watsoni* and *E. uniglumis* can hardly be the same species. *E. uniglumis* is a very far-creeping plant; very much more so than *E. palustris*. Mr Moore has the Wicklow plant in cultivation, and will therefore be able easily, in due time, to settle this question, and thus decide the specific identity or otherwise of the plants. The stems of the Wicklow plant are very much taller than those of the specimen (for there was but one) gathered at Taynloan; one of them is 13 inches long. But the plants seem to accord in all other respects. Dr Carrington objects to my terminology in describing the nuts; but there is very little difference between us. The nut of *E. palustris* is too short and broad to be called "exactly obovate," I mean when ripe, as I believe the nuts now before me to be. I have never seen it so relatively long as is represented in Plate VII. of the "Transactions." My description of *E. Watsoni*, founded upon very slight materials, is now shown to be erroneous; its nut is not "oblong," but closely resembles what I find in *E. palustris*, although it is perhaps even slightly more obovate. In *E. uniglumis* also I find the fruit to be better described by a pyriform (bluntly obovate, and more narrowed at the base than in obovate) than by "rotund-obovate."

(3.) *Scirpus Holoschœnus*, Linn.—I possess a single stem of the plant, said to have been found near Watchet in Somersetshire, which was given to me many years since by Professor Henslow, but by whom gathered it is now useless to inquire. As the late Professor sent a large quantity of duplicate specimens of British plants to the Botanical Society, it is probable that the piece received by Dr Carrington is part of the same set. The only authority for its being found near Watchet, is contained in Collinson's "History of Somerset," from whence it is copied into the "Botanist's Guide" (ii. 748) in the following form :—"Near the sea-side below Watchet," and from thence into the "New Botanist's Guide." It is one of a considerable number of localities of plants communicated to Collinson's work by Mr W. Sole, the author of the "British Mints," and is therefore probably correct. The record will be found in Collinson's book at page xxi of the Introduction. When printing the first edition of the "Manual," I believed that Mr Lingwood had gathered *S. Holoschœnus* at Watchet, but soon afterwards learned from him that he did not do so; neither could I learn by whom the specimens given away by Professor Henslow were gathered.

In the earlier part of the "Botanist's Guide" it was only stated to occur "on the sea-shore in this county (Somerset), Robson;" and that is all that we learn from Robson's "British Flora" (p. 240), except that he adds "Devon and Hampshire."

Other authors give Petiver and Ray as authorities for the Somerset station. Ray has very little to do with the matter. In his "Historia Plantarum" (ii. 1303), he says of the plant in question :—"Nuper etiam in Anglia detexit, in comitatu Somerseti D. Stephens." In the "Synopsis" (ed. 3, p. 429) he says, "found by Mr Stephens in Brounton Buroughs in Devonshire;" and Dillenius adds, "it also grows in Somersetshire and Hantshire; *Pet. Conc. Gr.*, 195." As the "Historia" was published long before this posthumous edition of the "Synopsis," this correction was doubtless made by Ray himself, who had learned that Somerset was put in the place of Devon in the "Historia." We are thus reduced to Petiver, who states, that "the Reverend Mr Stephens first found this in Devon; it also grows in Somerset and Hantshire." Therefore there is no trace of Watchet in these books, and the correctness of that station for *Scirpus Holoschœnus* rests upon the authority of Sole. It is greatly to be desired that the district should be carefully examined. It is of small extent, and the presence or absence of the plant might soon be ascertained.

III. *Remarks on some Fibrous Plants of Madras.* By Dr Alexander Hunter.

In this paper Dr Hunter says—From experiments that I have tried in cleaning fibres of a great number of Indian plants, I feel satisfied that the steeping and rotting process is not suited to the heat of the climate, as plants putrefy rapidly under water in India, and the fermentative process, which goes on for weeks sometimes in a cold climate, is occasionally completed in from twelve to eighteen hours in India, and is immediately succeeded by putrefaction, which discolours and takes the strength from fibres. The best method of separating the woody fibre and bark (or boon of flax, as it is called) is to crush or beat the plant as soon after it is cut as possible, taking care not to double up the stalks, otherwise the fibres get entangled like tow; continue the beating for half an hour, and then place in water for a night; to remove the sap, squeeze and hang up the bundles in the shade to dry; when thoroughly dry, the bundles may be rolled up in coarse gunny bags of cloth, and well beaten on a board with a wooden mallet. This separates the woody fibre and boon, leaving the flax soft, white, and very pliant. The more the fibre is beaten and knocked about, the finer and softer the flax becomes, and the interposition of the cloth prevents the fibre from being cut by the beating; it should afterwards be combed or hackled.

IV. *Remarks on the Cotton Plant of the Peruvian Coast.* By C. R. Markham, Esq.

The author remarks:—While travelling in the Coimbatore and Madura collectorates, in the autumn of 1860, I was struck with the resemblance of the climate in many respects to that of the coast-valleys of Peru. This part of India appeared to me to be admirably adapted for the cultivation of the valuable species of cotton which is indigenous to the Peruvian coast-valleys, while it seemed unlikely that North American cotton could ever be extensively raised to advantage in so dry a climate. It is very important to introduce a cotton with a longer staple than that of the indigenous plant of India, and therefore better suited to the demands of Manchester, which will thrive in the exceedingly dry climate of the Madras Presidency. I have therefore made arrangements to obtain supplies of cotton seeds from the driest part of the coast region of Peru for introduction into India. The staple of this Peruvian cotton is longer than that of "Uplands" Pernambuco, and much longer than any indigenous Indian cotton, though shorter of course than Egyptian or "Sea Island." The respective lengths of the staples of different kinds of cotton, compared with Peruvian, are as follow:—

Species of Cotton.	Minimum inches.	Maximum inches.	Mean inches.
Sea Island,	1·41	1·80	1·61
Egyptian,	1·30	1·52	1·41
Peruvian,	1·10	1·50	1·30
Brazilian,	1·03	1·31	1·17
New Orleans or "Uplands,"	0 88	1·16	1·02
"Uplands" grown in India,	0·95	1·21	1·08
Indigenous Indian Cotton,	0·77	1·02	0·89

The Peruvian cotton plant is indigenous and perennial, and was cultivated by the subjects of the Incas in the coast valleys long before the discovery of Peru by the Spaniards. They irrigated their cotton fields by means of channels conducted from the numerous lakes in the Andes, picked and cleaned the cotton, and wove it into clothes. The Jesuit Acosto, who wrote shortly after the Spanish conquest, says that "cotton groweth in hot soil, and there is great store in the valleys on the sea coast of Peru." The ancient Peruvians used a machine for cleaning their cotton, which closely resembled the Indian *churka*. It consisted of two rollers, about the thickness of a finger, with handles at opposite ends, which turned them different ways; the wool was pinched through by degrees, and, as the seeds could not pass between the rollers, they were stripped off, and dropped outside. The same machine was, according to Frezier, used by the Brazilians in 1720. Fifty years ago, Stevenson tells us, that at Casma, on the Peruvian coast, an improved method of separating the seeds had been introduced. It consisted of a large hollow cylinder put in motion by two mules with straps passing round it, and round a small wheel attached to a fluted steel cylinder, a quarter of an inch in diameter, and a second cylinder was placed horizontally and in contact with the first. The cylinders were turned different ways, the second one being worked by a hand; the wool was dragged in between them, and the seeds were thus stripped and thrown off. The long strip of coast line between the Andes and the Pacific Ocean which extends from the River Loa in 20° 48′ S., to the River Tumbez, in 3° 35′ S., a distance of 1620 miles, consists of a sandy desert, intersected by chains of rocky, barren hills, and traversed by sixty rivers and streams, with as many fertile valleys on their banks. This region is bounded inland by the Cordillera of the

Andes, and varies from nine to sixty miles in breadth. The coast valleys, thus surrounded by sandy deserts, which extend from the foot of the Andes to the shores of the Pacific, are the native habitat of the Peruvian cotton. The rivers, generally rising in small lakes in the mountains, force their way through narrow gorges into the coast plains, and form valleys, filled with luxuriant vegetation, the homes of the olive, the vine, the sugar cane, the cotton plant, and every kind of fruit. The climate of this region is very peculiar, rain is unknown, and the northern part, especially, is exposed to a long season of excessive dryness. The summer, or dry season, on the Peruvian coast, extends from November to May, when it is exceedingly hot, and the rays of the sun are reflected back from the sand with scorching power. During this period many of the coast rivers are dried up during several months, though the larger ones have a perennial supply of water. The mean temperature is about 85° Fahr., rising as high as 96°, and occasionally falling to 80° in the valleys; but in the sandy deserts, in places where high hills closely overhang the plains, the thermometer occasionally falls very low during the night, the rush of cold air from the upper region being in proportion to the degree of radiation on the plains, and the force with which the sun's rays have struck on the scorched ground during the day. The winter, or moist season, commences in May and lasts until November. In the middle of May a veil of mist begins to spread over sea and shore, and the mornings are damp and hazy. In June the thickness of the mist increases, sometimes amounting to drizzle, and continues until October. It never amounts to rain; but the moisture being formed in the lower atmospheric region, falls on the ground in large drops, caused by the union of small bubbles of mist. These fogs are called *garuas*. They are formed at about nine in the morning, and are not dispersed until late in the afternoon. They are most prevalent in the southern and central part of the Peruvian coast; and when they set in, the lomas, or chains of hills, bordering the desert near the sea-shore, are carpeted with wild flowers; but in the north the *garuas* are very scanty, the climate is much drier, and it is for this reason that I have selected the province of Piura, in the northern part of the coast, as the district from which to procure supplies of cotton seeds for introduction into India.

V. *On the Flora of Jersey.* By F. NAYLOR, Esq.

Mr Naylor stated that during two visits to Jersey in the latter part of the summers of 1861, 1862, both of several weeks' duration, he made frequent botanical excursions, and left little of the island unexplored. The list of flowering plants and ferns, so far as he knew, now amounted to 850 species. Since the publication of Mr Babington's "Primitæ Floræ Sarnicæ," 1839, fifty two species have been added to the flora of that island, several of which were first observed by the author. The paper was illustrated by dried specimens of all the rarer species.

VI. *Notes on the Flora of Moffat, with special reference to the Ferns and other Cryptogamic Plants.* By Mr JOHN SADLER.

Thursday, 12th February 1863.—Professor BALFOUR, Vice-President, in the Chair.

The following Communications were read:—

I. *Notice of Plants collected in the counties of Leeds and Grenville, Upper Canada, in July* 1862. By GEORGE LAWSON, LL.D., Professor of Chemistry and Natural History, Queen's College of Canada.

(The paper appears in the present number of this Journal.)

II. *A Record of the Plants collected by Mr Pemberton Wallcott and Mr Maitland Brown in the year* 1861, *during Mr F. Gregory's Exploring Expedition into North-West Australia.* By Ferdinand Mueller, M.D., Ph.D., F.R.S., Government Botanist for the Colony of Victoria. Communicated by Professor Balfour.

(This paper appears in the present number of the Journal.)

III. *Extracts from Indian Letters from* Dr Cleghorn. Communicated by Professor Balfour.

In one of the letters, dated Punjab, 18th October 1862, Dr Cleghorn said:—"In fulfilment of Lord Canning's instructions, I have just completed one of the most extensive and adventurous journeys ever made on the Himalaya, and from the rapid nature of the movements, often very fatiguing. It has been my duty to follow the flexures of four of the great Punjab rivers (Sutlej, Beas, Ravi, and Chenab) from the plains up to the highest points where timber of value is found to grow. In some places I diverged to examine the main tributaries, or to test the amount of breakage in many of the timber slides."

Lahore, Punjab, *2d December* 1862.

"I write a line enclosing fresh seeds of *Meconopsis aculeata*, a most beautiful plant, which will, no doubt, be acceptable to Mr M'Nab. I am the guest of Col. Robert Maclagan, and I am much engrossed in putting together my notes after ten months of continuous travel. I have lately crossed the Indus, and examined the vegetation of the Peshawur Valley, and the banks of the Cabul river. The great trunk road passes through a well cultivated plain. The wheat, barley, maize, and cabbage, are superb. The fields are fenced with *Rhamnus*. The avenues consist chiefly of *Melia* and *Tamarix*. Extensive sandy tracts are clothed with *Aerua*, *Andropogon*, and *Calotropis*, but the most common plant on both banks of the Indus is *Peganum Harmala*. The islands in the bed of the Indus are self-sown with *Populus euphratica* and *Dalbergia Sissoo* which yields the most valuable wood we possess, both for house-building and for agricultural purposes. The trade in deodar wood will undoubtedly increase on the Indus and Cabul rivers, and it seems desirable to encourage commercial relation with the wild tribes on our frontier. They are much divided among themselves, and only a few Mahomedans, who have great religious influence, can travel with safety through the wood ed tracts of Suwat and Kafiristan. At the time of my visit (the end of November) snow was falling on the surrounding mountains, and all the herbaceous vegetation was withered. A few months hence (April) the plain is covered with a rich carpet of various colours. The most interesting plants noticed on a rapid excursion were *Alhagi maurorum*, the Camel-thorn; *Withania coagulans*, D.C. (*Puneeria coagulans* of Stocks, see Hook. Icones, ix. 801) used in Scinde and Affghanistan for coagulating milk; and the prophet's flower, *Arnebia echioides*, much esteemed by the Mussulman population, who assert that the fine purple spots on the corolla are the marks of Mahomet's fingers. The seed will be sent to you. It is a rather showy plant. Enclosed are the seeds of *Diospyros tomentosa*, the fruit of which is dried and sold in the bazaars. It is about the size of a pigeon's egg, and tastes like a plum. There are also enclosed the seeds of *Delphinium Brunonianum*, the Musk plant, gathered at an elevation of 14,000 feet. It is mentioned in the 2d vol. of Hooker's Journal, p. 95. There are also seeds of *Convallaria cirrhifolia*."

IV. *Notes on the Physiological Action of the Calabar Poison Bean* (Physostigma venenosum, *Balfour*). By Thomas R. Fraser, M.D.

This paper was an abstract from Dr Fraser's graduation thesis of last session. It was concluded from an experimental investigation that the spermoderm of the Calabar bean possesses properties as a sedative of the spinal cord, hydragogue cathartic, and diuretic. The most energetic action was obtained from the kernel. It was concluded,—1*st*, To act on the spinal cord by destroying its power to conduct impressions; 2*d*, This destruction may result in two well-marked and distinct effects—*a*, in muscular paralysis, extending gradually to the respiratory apparatus, and producing death by asphyxia; *b*, in rapid paralysis of the heart—probably due to an extension of this action to nervous ganglia of the heart—causing death by syncope; 3*d*, A difference in dose accompanied this difference in effect; 4*th*, The action does not extend to the brain proper, *pari passu* with the action on the spinal cord; the functions of the brain may, however, be influenced secondarily; 5*th*, It produces a paralysis of muscular fibre,—striped and unstriped; 6*th*, It acts as an excitant of the secretory system, increasing especially the action of the alimentary mucous membrane; 7*th*, Topical effects follow the local application of the watery emulsion and alcoholic extract; these are,—destruction of the contractility of muscular fibre, and contraction of the pupil when applied to the eyeball or eyelids. It is probable that this last action may be of importance in illustrating the action of the bean. Valentin has shown that the iris receives its nervous supply from two sources, from cerebral and from spinal filaments. He has concluded that the cerebral filaments are supplied to the circular muscle or contractor of the pupil, and the spinal to the radiating muscle or dilator of the pupil. The actions of these two nervous supplies must be regarded as antagonistic. When, therefore, the influence of one set of fibres is removed, that of the other will be unchecked, and will produce a greater degree of its proper action. Thus, when the influence of the cerebral supply is removed, the fibres, which are acted on by the spinal nerves, will be unchecked, and dilatation of the pupils will result. The kernel of the Calabar bean can in its action be referred to the spinal cord in the same way. The contraction of the pupils may be caused in three ways,—by cerebral irritation, by spinal depression, and by a combination of cerebral irritation and spinal depression. The symptoms disprove any cerebral irritative action, and so neither the first nor last of these can be regarded as the cause of the contraction. The symptoms, on the other hand, distinctly indicate a *depressing* action on the spinal cord. By this action the power of the cord to transmit impressions is destroyed, and so, necessarily, the power of transmitting the spinal influence to the iris. The balance between the dilator and contractor muscles is removed, the circular fibres, being unopposed, act, and the pupil is contracted. Dr Fraser described a similar physiological action to result from the administration to man.

V. *Register of the Flowering of Spring Plants in the Open Air, at the Royal Botanic Garden, Edinburgh.* By Mr M'Nab.

The register showed the dates at which the flowering took place in 1861, 1862, and 1863 respectively. Those for the latter year were as follows:—

Aubretia grandiflora, Jan. 16; *Corylus Avellana*, Jan. 16; *Tussilago fragrans*, Jan. 18; *Helleborus orientalis*, Jan. 18; *Hepatica triloba*, Jan. 20; *Helleborus purpureus*, Jan. 26; *Galanthus nivalis*, Jan. 26; *Garrya elliptica*, Jan. 23; *Rhododendron atrovirens*, Jan. 27; *Sym-*

phytum caucasicum, Jan. 28; *Primula denticulata*, Feb. 2; *Leucojum vernum*, Feb. 2; *Tussilago alba*, Feb. 2; *Omphalodes verna*, Feb. 2; *Eranthis hyemalis*, Feb. 3; *Erica herbacea*, Feb. 6; *Galanthus plicatus*, Feb. 7; *Crocus susianus*, Feb. 9; *Crocus vernus* (blue), Feb. 10; *Rhododendron Nobleanum*, Feb. 11; *Sisyrinchium grandiflorum*, Feb. 12; *Nordmannia cordifolia*, Feb. 12. Plants in flower on 12th Feb. 1863 not included in the above list, but which have been flowering more or less during the winter months:—*Helleborus niger*, *Tritonia media*, *Cheiranthus Cheiri*, *Mathiola incana*, *Gentiana acaulis*, *Arabis albida*, *Viola odorata*, *Jasminum nudiflorum*, *Bellis perennis* (single white, double red, and double white), *Primula veris* (varieties), *Primula vulgaris* (varieties), *Andromeda floribunda*, *Viola tricolor* (varieties).

Dr John Lowe sent the following list of plants flowering in the open air on 6th February, in his garden at Lynn, Norfolk:—*Eranthis hyemalis*, *Galanthus nivalis*, *Viola odorata*, *Primulas* of various kinds, *Coronilla* sp., *Hepaticas*, *Arabis albida*, *Crocus* (yellow), *Helleborus*, *Omphalodes verna*, *Cheiranthus Cheiri*, *Erica herbacea*, *Jasminum nudiflorum*, *Doronicum caucasium*, *Daphne Mezereon*, *D. Laureola*, *Mathiola incana*. The following wild flowers were also in flower on 6th February in the neighbourhood of Lynn:—*Galanthus nivalis*, *Lamium album*, *L. purpureum*, *Vinca major*, *V. minor*, *Primula veris*, *Corylus Avellana*, *Ulex europæus*, *Sarothamnus Scoparius*, *Malva sylvestris*, *Draba verna*, *Anthriscus sylvestris*, *Stellaria media*, *Bellis perennis*, *Senecio vulgaris*, *Leontodon Taraxacum*, *Mercurialis perennis*.

William Ivory, Esq., exhibited thirty-one species and varieties of plants which were in flower on 12th February, at St Rocque, near Edinburgh.

Mr John Sadler exhibited twigs of various pear trees from the Experimental Garden, with flowers nearly expanded.

The following letter was read by Professor Balfour from Sir John Hill to Dr John Hope, Professor of Botany, Edinburgh, dated November 26, 1762, in which the writer alludes to the growth of fungi in animals. The letter was communicated by Mr Small, College Library.

Letter to Dr John Hope, *Professor of Botany, Edinburgh, from* Sir John Hill, *author of a "General Natural History," "The British Herbal," "Flora Britannica," "Hortus Kewensis," a work on the "Construction of Timber," and "The Vegetable System, or a Lecture on the Structure, Physiology, and Classification of Plants."*

London, *Nov.* 26, 1762.

Sir,—I beg you to accept my very sincere thanks for the favour of your letter. I feel a satisfaction very difficult to be expressed, on seeing the certain prospect of Botany arriving at a most respectable height and lustre in your part of the kingdom, and I need not add that the pleasure is greatly increased by its being under your care and inspection. I shall not let your promises be forgotten of telling me the steps you have taken to forward the vegetable history of Scotland, and I shall be happy in contributing everything in my power toward adding to the riches of the garden, and of serving you in anything that may be agreeable to you. My parcel of seeds I shall send by the method you mention, as soon as I receive those which my Lord Bute proposes to give me from Kew to add to them. I am extremely pleased to see by the Loch Rannoch catalogue that the *Betula nana*, as well as *Uva Ursi*, are there. It was quite unknown to me. I had traced that *Betula* almost round the globe in parallel latitudes, but did not know it was in Britain before. If it can be done without much trouble, I should be very happy to receive the roots of all the plants of that catalogue in a condition of growth for my garden at Bayswater, where I have an upland bog, skirted with heath, for the reception of such plants. I am very happy to hear of the young clergyman's application to botany; I am sensible a great deal is yet to be done and yet to be known in Scotland, and one of his sacred character is most desirable to attain it, because he has learning, and will be above falsehood, which has done more harm to Natural History than ignorance itself.

I beg you will dig up a root of the *Cicuta*, and see whether it yields a milk on being cut, or inflames the tongue on touching it, both which Dr Stork asserts, and neither are the case here in England.

Give me leave to add the newest matter of Natural History here. I think one's letters should always do that if there be opportunities. We have been astonished and confounded with a new miracle in nature, as it may be called,—a progression from animal to vegetable. Colonel Melville brought from Dominique insects with small plants growing on their backs. The account he received with them was, that at a certain period of life the creature ceased to move, and grew up into a plant. The thing was laid before the Royal Society here. The plants were small, but the account said that they grew to trees of two feet high. Mr Da Costa, a Jew mineralist, confirmed the account by producing Torrubias, a Spanish naturalist, who has figured groves of these trees with animal roots; and Mr Edwards has figured, in a new book of birds, some of the insects flying with trees upon their backs. My Lord Bute, a few weeks since, was pleased to put some of the insects into my hands to examine. I found the accounts to be perfectly erroneous, and in some instances purposely false. The insect is the *Tettigometra*, which buries itself in the ground to rest till the Cicada bursts out from it, as the butterfly from the caterpillar's chrysalis. The plant is a *Clavaria*, no way differing from that Clava simply but in that it has no lobes from its sides (pray see if you have such, this is the season). If the creature perishes by accident, the seeds of this fungus falling upon it, shoot first a sperm, and then the entire plant grows from it. This is the whole matter, and there is no more miracle in the place of its growth than in that of our fungus, *ex pede equino*. I blush that any one should have invented such falsehoods, as that of the mushroom growing to a tree; I blush much more that naturalists should have confirmed them. Torrubias, as a Spaniard, might be expected to exaggerate; but that a Jew should scandalise himself by such a vain credulity is stranger. I hope Mr Edwards will retract his error. His book is not yet published, and I have given him notice of it.—I am, with great respect and esteem, Sir, your very humble servant,

(Signed) J. Hill.

SCIENTIFIC INTELLIGENCE.

GEOLOGY.

Discovery of Remains of Vertebrated Animals provided with feathers, in a deposit of Jurassic age (L'Institut, Nov. 5th 1862).—We take from the "Bibliothèque Universelle," the following *résumé* of the publications made by A. Wagner and H. von Meyer on the feathered fossils recently discovered at Solenhofen.

The principal specimen, the object of these communications, is to be found in the beautiful collection of fossils belonging to Mr Häberlein of Pappenheim—a specimen which has been described at Munich by A. Wagner, not as the result of a personal examination, but after the report of an enlightened naturalist in whom the learned Bavarian anatomist seems to put full confidence. H. von Meyer has since then figured in the *Palæontographica* a single feather, very well preserved, having both the shaft and the vane. They describe the specimens under two different names, the former under that of *Griphosaurus*, the latter under that of *Archæopteryx lithographica*.

The nature of the animal made known by these curious fragments is doubtful. Two hypotheses are possible. Either these feathers are those of a veritable bird, and it is necessary then to carry back the date of the appearance of this class, as has already been necessary for that of mammals; or they covered the body of a reptile, and, contrary to all precedent, it is necessary to admit the existence of feathered reptiles. The details which follow seem to render this last alternative rather the more probable one.

The specimen of Mr Häberlein is the one which furnishes the principal data for this discussion. It is an incomplete skeleton lacking the head, the neck, and the terminations of the anterior members. The feathers are preserved toward the base of the wings and about the region of the tail. According to the before-mentioned report, it is this latter part which is the most characteristic. The sacrum recalls the form of that of a Pterodactyl; the tail, which is six inches long, is composed of numerous vertebræ (twenty) diminishing uniformly, the last being the smallest,—a structure, in our view, more analogous to the organisation of reptiles than to that of birds. The feathers are situated upon the bone in a manner entirely unique; they are not set as in a fan, but grow on the two sides of the tail through its whole length, making an angle with it. They thus form, as it were, a flat leaf-like expansion, the extremity of which is much rounded, and extends beyond the last of the vertebræ.

The feathers of the wings are larger, and form a fan upon each side, supported by a short and stout bone, badly preserved, which corresponds in position to the carpus. It is preceded by a fore-arm composed of a single-bone (radius), and this by a humerus of equal length; both are robust.

This spinal column, by its free lumbar and sacral vertebræ, recalls rather the reptiles. The left posterior member is complete, the right is reduced to the femur and the tibia. The femur is a stout bone, the tibia is longer and more slender; no fibula can be distinguished. The foot has no reptilian characteristics, but, on the contrary, approaches some forms of birds' feet. The tarsus is thick, composed of a single bone, a little shorter than the tibia, and parted at its extremity into three pullies, to which are articulated three toes of moderate length terminated by strong hooked claws.

Upon the whole then, the animal has partly the characters of birds, viz., the form of the foot and also the existence of feathers; partly those of reptiles, viz., the form of the spinal column, of the sacrum, and especially of the tail. It has some new and anomalous characters in the implantation of the feathers, both those of the tail and those of the fore-arm.

Mr Wagner appears disposed to consider the reptilian characteristics as predominating. He relies, moreover, upon a consideration which appears to us very just, in observing that the type of birds is singularly constant, without any marked aberrations; while we are habituated to the fact that reptiles are excessively variable.—*American Journal of Science and Arts*, January 1863.

ZOOLOGY.

On Man's position in the System of Mammals. By JAMES D. DANA.—The precise position of Man in the system of Mammals has long been, and still remains, a subject of discussion. There are those who regard him as too remote from all other species of the class to be subject to ordinary priniples of classification. But zoologists, generally, place him either in an independent order (or sub-class, if the highest divisions be sub-classes), or else at the head of the order containing the Quadrumana. Science, in searching out the system in nature, leaves psychical or intellectual qualities out of view; and this is right. It is also safe: for these immaterial characteristics have, in all cases, a material or structural expression; and when this expression is apprehended, and its true importance fully admitted, classification will not fail of its duty in recognising the distinction they indicate.

Cuvier, in distinguishing Man as of the order *Bimana*, and the Monkeys of the order *Quadrumana*, did not bring out to view any profound difference between the groups. The relations of the two are so close, that Man, on this ground alone, would be far from certain of his separate place. No reason can be derived from the study of other departments of the Mammals, or of the animal kingdom, for considering the having of two hands a mark of superior rank to the having of four.

Professor Owen, in his recent classification of Mammals, makes the characteristics of the brain the basis of the several grand divisions. But, as he admits, the distinctions fail in many cases of corresponding to the groups laid down; and although the brain of Man (his group *Archencephala*) differs in some striking points from that of the Quadrumana, yet no study of the brain alone would suggest the real distinction between the groups, or prove that Man was not co-ordinal with the Monkeys. In fact, the nervous system is a very unsafe basis of classification below the highest grade of subdivisions—that into sub-kingdoms. The same sub-kingdom may contain species with, and without, a distinct nervous system, and a class or order may present very wide diversities as to its form and development,—for the reason, that the system or plan of structure in species is far more authoritative in classification than the condition of the nervous system.

The fitness of the parts of the body of Man for intellectual uses, and his erect position, have been considered zoological characteristics of eminent importance, separating him from other Mammals. But even these qualities, although admitted to be of real weight, are not to many zoologists unquestionable or authoritative evidence on this point.

But, while the structural distinctions mentioned may fail to establish Man's independent ordinal rank, there is a characteristic that appears to be decisive,—one which has that deep foundation in zoological science required to give it prominence and authority.

The criterion referred to is this:—that while all other Mammals have both the anterior and posterior limbs organs of locomotion, in Man the anterior are transferred from the *locomotive* to the *cephalic* series. They serve the purposes of the *head*, and are not for locomotion. The *cephalization* of the body—that is, the subordination of its members and structure to head uses—so variously exemplified in the animal kingdom, here reaches its extreme limit. Man, in this, stands *alone* among Mammals.

The author has shown elsewhere that this cephalization is a fundamental principle, as respects grade, in zoological life. He has not only illustrated the fact, that *concentration of the anterior extremity of the body and abbreviation of its posterior portion* is a mark of elevation; but further than this, that *the transfer of the anterior members of the thorax to the cephalic series* is the foundation of rank among the orders of Crustaceans. In the highest order of this class—that of the *Decapods* (containing crabs, lobsters, shrimps, &c.), *nine* pairs of organs, out of the *fourteen* pertaining to the head and thorax, belong to the head—that is, to the senses and the mouth. In the second order, that of the *Tetradecapods*, there are only *seven* pairs of organs, out of the fourteen, thus devoted to the head,—two of the pairs which are mouth-organs in the Decapods being true legs in the Tetradecapods. In the third or lowest order, that of the *Entomostracans*, there are only *six*, *five*, or *four* pairs of cephalic organs; and, besides, these, in most species, are partly pediform, even the mandibles having often a long foot-like branch or extremity, and the antennæ being sometimes, also, organs of prehension or locomotion.

Two of the laws bearing on grade, under this system of cephalization or decephalization, have been stated; its connection with (1) a concentration of the anterior extremity and abbreviation of the posterior extremity, and the reverse; and with (2) a transfer of thoracic members to the cephalic series, and the reverse. There is a third law which should be mentioned to explain the relations of the Entomostracans to the other orders,—namely, (3) that a decline in grade, after the laxness and elongation of the anterior and posterior extremities have reached their limit, is further exhibited by a *degradation* of the body, and especially of its extremities.

In the step down from the Decapods to the Tetradecapods, there is an illustration of this principle in the eyes of the latter being imbedded in the head instead of being pedicellate. In the Entomostracans (1), the elongated abdomen is destitute of all but one or two of the normal pairs of members—not through a system of abbreviation, as exhibited in crabs, but a system of *degradation;* and in some species, all the normal members are wanting, and even the abdomen itself is nearly obsolete. Again (2), the two posterior pairs of thoracic legs are wanting in the species, and sometimes more than two pairs. Again (3), at the anterior extremity, one pair of antennæ is often obsolete, and sometimes the second pair nearly or even quite so. The *Limulus*, though so large an animal, has the abdomen reduced to a straight spine, and the antennæ to a small pair of pincer legs, while all the mouth organs are true legs—the whole structure indicating an extreme of degradation.

In the order of Decapods, having nine as the normal number of pairs of cephalic organs, the species of the highest group have these organs compacted within the least space consistent with the structure of the type; in those a grade lower, the posterior pair is a little more remote from the others and begins to be somewhat pediform; a grade lower, this pair is really pediform, or nearly like the other feet; and still lower, two or three pairs are pediform. Still lower in the series of Decapods (the Schizopods), there are examples under the principle of *degradation* above explained; (1) in the absence of two or three pairs of the posterior thoracic appendages; (2) in the absence or obsolescence of the abdominal appendages; (3) in the Schizopod character of the feet. These Decapods, thus degraded, approximate to the Entomostracans, although true Decapods in type of structure. Thus the principle is exemplified within the limits of a single order, as well as in the range of orders.

This connection of cephalization with rise of rank is also illustrated abundantly in embryonic development. It is one of the fundamental principles in living nature.

When then, in a group like that of Mammals, in which *two* is the prevailing number of pairs of locomotive organs, there is a transfer of the anterior of these two from the locomotive to the cephalic series, there is evidence, in this exalted cephalization of the system, of a distinction of the very highest significance. Moreover, it is of the more eminent value that it occurs in a class in which the number of locomotive members is so nearly a constant number. It places Man apart from the whole series of

Mammals; and does it on the basis of a character which is fundamentally a criterion of grade. This extreme cephalization of the system is, in fact, that material or structural expression of the dominance of mind in the being, which meets the desire both of the natural and intellectual philosopher.

This cephalization of the human system has been recognised by Carus; but not in its connection with a deep-rooted structural law pervading the animal kingdom. It is the comprehensiveness of the law which gives the special fact its great weight. Aristotle, in his three groups of Mammals, the *Dipoda*, or two-footed, the *Tetrapoda*, or four-footed, and the *Apoda*, or footless species, expresses distinctions according with this law. The term *Dipoda*, as applied to Man, is far better and more philosophical than *Bimana*.

The erect form of the structure in Man, although less authoritative in classification, is a concomitant expression of this cephalization. For the body is thus placed directly beneath the brain or the subordinating power, and no part of the structure is either anterior or posterior to it. Two feet for locomotion is the smallest possible number in an animal. Cephalic concentration and posterior abbreviation are at their maximum. The characters of the brain distinguishing the Archencephala (Man) in Professor Owen's system, so far as based on its general form or the relative position of its parts, flow from the erect form.

Man's title to a position by himself, separate from the other Mammals in classification, appears hence to be fixed on structural as well as psychical grounds.—*American Journal of Science and Arts*, January 1863.

MISCELLANEOUS.

Ferrol on the Cause of the Inundation of the Nile.—In order to account for the Nile's inundations, it is necessary to understand the causes of the rainy seasons, and the laws which govern them, in the region of the sources of the Nile, and its principal tributaries. Although we know but little of these from direct observations in the region itself, yet I think we may have a pretty correct idea of them from the observation of the laws which prevail generally at other places in the same latitude. It is well known that there is a belt surrounding the earth near the equator where the north-east and south-east trade-winds meet, in which an enormous amount of rain falls daily. In the regions of the trade-winds on each side of this belt, which embraces nearly one half the surface of the globe, very little rain falls; but the vapour is carried to the latitude where the trades meet, where the ascending currents carry it up to a point where it is condensed, and hence nearly all the rain which would otherwise fall over the whole regions of the trade-winds, falls in a narrow belt only a few degrees wide. This belt is not stationary, but vibrates with the seasons nearly 1000 miles in latitude, having its most northern position in mid-summer, and its most southern in mid-winter, of the northern hemisphere. In the Atlantic ocean the middle of this belt, when farthest north, is about the latitude of 12°, and when farthest south, it is a little south of the equator, and it is about 8° wide. Hence in the latitudes occupied by the belt, when in its extreme positions, there is one rainy season annually, continuing about five months at places near the inner limits of this belt when in its extreme positions. The width of this rainy belt, the range of vibration, and the amount of rain which falls, may be considerably modified by the continents, and especially by high mountain ranges, but still there can be no very material change in the seasons, or the laws which regulate them. Hence in South America, when the rainy belt occupies its most northern position about the 1st of August, the water-shed of the Orinoco receives an immense amount of rain, and an inundation takes place, which, near the mouth of the river, is at its maximum in September. In like manner, when this belt occupies its most southern position about the 1st of February, all the tributaries which flow into the north side of the Amazon becoming flooded by the immense amount of rain, an inundation follows in that river, which is at its maximum toward the mouth about the last of March, or about two months after the middle of the rainy season.

The annual inundation of the Nile, it seems to me, can be very satisfactorily accounted for in the same manner. Wherever the source of this river may be, it can have little effect in causing the inundation, for it must be a very small part of all the tributaries which make up the Nile; and it is to the sources of the principal tributaries that we must look for the cause of the inundation. We have seen that at the southern part of Lake Nyanza the rainy season is from November to April, as it should be, if there is a vibrating rainy season there, as observed at other places near the equator, and hence we have reason to conclude that in mid-summer of the northern hemisphere it prevails 12° or 15° north of the equator. The extreme northern position of the north side of the rainy belt doubtless coincides with the southern limit of the great African desert, and the deserts of Arabia, which, but for the narrow strip rendered fertile by the irrigation of the Nile, would be one continuous desert, caused by the absence of rains in the belt of the trade-winds. The rainy belt, therefore, from May to November, must be between the parallels of about 5° and 17° north latitude. If now we examine a map of this region, it is seen that the great water-shed drained by the Blue Nile and its tributaries, embracing nearly all of Abyssinia, and also several important tributaries of the White Nile, is situated principally between these latitudes. Hence the immense amount of rain falling in this region during the rainy season, must cause an inundation of the Nile, just as it does of the Orinoco or of the Amazon. From what has been stated, the middle of the rainy season here must be about the 1st of August, and the greatest height of the lower parts of the Nile is about the 1st of October, so that the flood would have about two months to descend. From what we know of the usual velocity of the currents of other rivers generally, this would be just about the time required.

The rainy belt from November to May is perhaps mostly south of the equator, and the source of the Nile, or some of its tributaries, must extend into this belt during this season, else the Nile, flowing more than 1000 miles through a rainless region, from which it does not receive a single tributary, however small, could not be supplied with water. This is an argument in favour of the hypothesis, that the Nile has its source in Lake Nyanza; but I think the water-shed of that lake would not be more than sufficient to supply the Nile at low water, and that if ever the geography and meteorology of this region shall be well understood, the cause of the inundation of the Nile will be found in latitudes further north, as stated above.—*American Journal of Science and Arts*, January 1863.

Royal Society of Edinburgh.—The Keith, Brisbane, and Neill Prizes.—The above prizes will be awarded by the Council in the following manner:—

I. Keith Prize.—The Keith Prize, consisting of a gold medal and from L.40 to L.50 in money, will be awarded early next session (1863–64), for "the best communication on a scientific subject, communicated in the first instance to the Royal Society during the Sessions 1861–62 and 1862–63." Preference will be given to a paper containing a discovery.

Award of the Keith Prize.—17th biennial period, 1859–61. John Allan Broun, Esq., F.R.S., Director of the Trevandrum Observatory, for his papers on the Horizontal Force of the Earth's Magnetism, on the Correction of the Bifilar Magnetometer, and on Terrestrial Magnetism generally.

II. Makdougall Brisbane Prize.—This prize is to be awarded biennially by the Council of the Royal Society of Edinburgh to such person, for such purposes, for such objects, and in such manner as shall appear to them the most conducive to the promotion of the interests of science, with the *proviso* that the Council shall not be compelled to award the prize unless there shall be some individual engaged in scientific pursuit, or some paper written on a scientific subject, or some discovery in science made during the biennial period, of sufficient merit or importance in the opinion of the Council to be entitled to the Prize.

1. The Prize, consisting of a Gold Medal and a sum of Money, will be awarded at the commencement of the Session 1864-65, for an Essay having reference to any branch of scientific inquiry, whether Material or Mental.

2. Competing Essays to be addressed to the Secretary of the Society on or before 1st June 1864.

3. The competition is open to all men of science.

4. The Essays may be either anonymous or otherwise. In the former case they must be distinguished by mottoes, with corresponding sealed billets superscribed with the same motto, and containing the name of the Author.

5. The Council impose no restriction as to the length of the Essays, which may be, at the discretion of the Council, read at the Ordinary Meetings of the Society. They wish also to leave the property and free disposal of the manuscripts to the Authors; a copy, however, being deposited in the Archives of the Society, unless the paper shall be published in the Transactions.

6. In awarding the Prize, the Council will also take into consideration any scientific papers presented to the Society during the Sessions 1862–63 and 1863-64, whether they may have been given in with a view to the Prize or not.

Award of the Makdougall Brisbane Prize.—2d biennial period, 1860–62. William Seller, M.D., F.R.C.P.E., for his Memoir of the Life and Writings of Dr Robert Whytt, published in the Transactions.

III. Neill Prize.—The Council of the Royal Society of Edinburgh having received the bequest of the late Dr Patrick Neill of the sum of L.500, for the purpose of "the interest thereof being applied in furnishing a Medal or other reward every second or third year to any distinguished Scottish Naturalist, according as such Medal or reward shall be voted by the Council of the said Society," hereby intimate,

1. The Neill Prize, consisting of a Gold Medal, and a sum of Money, will be awarded at the commencement of the Session 1865-66.

2. The Prize will be given for a paper of distinguished merit, on a subject of Natural History, by a Scottish naturalist, which shall have been presented to the Society during the three years preceding the 1st May 1865; or failing presentation of a paper sufficiently meritorious, it will be awarded for a work or publication by some distinguished Scottish naturalist on some branch of Natural History, bearing date within five years of the time of award.

Award of the Neill Prize.—2d triennial period, 1859–62. Robert Kaye Greville, LL.D., for his contributions to Scottish Natural History, more especially in the department of Cryptogamic Botany, including his recent papers on Diatomaceæ.

Poisoning by Milk.—Most of the occupants of two of the first-rate hotels in Valetta, the Imperial and Morrell's, were seized with symptoms of virulent cholera. In the former hotel, not less than twelve persons, including the landlord and servants, and in the latter seven persons, were attacked. Medical assistance was immediately procured, and appropriate remedies were applied. We are happy to state that the patients are now doing well, although for a time the violence of the symptoms led to apprehensions of a fatal result in many of the cases. From inquiries made, it appears that all the sufferers were seized within twenty minutes to two, or three hours after breakfast; and that as the only article of diet common to all was milk, and as on other occasions of similar seizure the cause was clearly traced to that article, it is reasonable to infer that in the present instance the milk used for breakfast contained the poisonous ingredient. This conclusion becomes almost a certainty, when it is known that several persons living in the same hotels, who had not taken milk that day, escaped, while, without one exception, those who had taken it were seized with the alarming illness described. The family of Mr Emmanuele Zammit, and, we believe, other families in Valetta, were attacked in like manner the same morning after partaking of milk for breakfast; even a cat which had taken some, showed the same symptoms of having been poisoned. Among the sufferers at the Imperial were General Bell, and Mr Spence the eminent sculptor of Rome. Towards the end of last year, a number of exactly similar cases happened at Sliema, where the whole family of a field-officer, with one exception, was poisoned evidently by goats' milk; and about the same time other cases occurred among the officers and men of her Majesty's ships Marlborough, Algiers, and Firebrand, but with no fatal consequences. We have also heard of other cases occurring from time to time. Poisoning by milk, therefore, appears to be not an uncommon occurrence in Malta; but we are not aware if experiments were ever made by scientific men to ascertain beyond doubt the real cause of the milk assuming this dangerous character. The natives attribute it to the goats browsing on a particular plant belonging to the natural family *Euphorbiaceæ*, or spurgeworts, which they call *tenhuta*, and which they say possesses the property of rendering the milk poisonous to human beings without inflicting any serious injury on the animal itself.—*Malta Times*, Jan. 22, 1863.

CHEMISTRY.

Seeds of Abrus precatorius.—Professor Martius of Erlangen, in a letter to one of the editors of this Journal, says, "I wish to call your attention to the fact, that the seeds of *Abrus precatorius* contain an alkaloidal poisonous matter. It is easily obtained by boiling the crushed seeds several times with alcohol of 0·830 to 0·812, filtering, and then distilling the alcohol until two ounces remain from a pound of seeds. If it stands a long time, the poisonous matter crystallises out. Weak alcohol extracts the colouring matter."

PUBLICATIONS RECEIVED.

1. Proceedings of the Literary and Philosophical Society of Manchester, Nos. 5–9, June 1862–63.—*From the Society.*

2. Journal of the Chemical Society, January and February 1863.—*From the Editors.*

3. Beshrivelse over Lophogaster Typicus. By Dr M. SARS.—*From the University of Christiania.*

4. Synopsis of the Vegetable Products of Norway. By Dr F. C. SCRIBELER. Translated by the Rev. M. R. BARNARD, B.A.—*From the same.*

5. Geologiske Undersogelser i Bergens Omegn. Af M. HIORTDAHL og M. IRGENS.—*From the same.*

6. Canadian Naturalist and Geologist, for December 1862.—*From the Editors.*

7. Annual Report of the Geological Survey of India, and of the Museum of Geology, for the year 1861–62.—*From Dr T. Oldham.*

8. Memoirs of the Geological Survey of India, Vol. IV. Part 1.—*From the same.*

9. Memoirs of the Geological Survey of India. Palæontolagia Indica, Part 2–1 and 2–2.—*From the same.*

9. Bulletin de l'Academie Royale des Sciences de Belgique, No. 12, 1862.—*From the Academy.*

10. Transactions of the Tyneside Naturalists' Field Club, Vol. V. Part 4.—*From the Club.*

11. Journal of the Asiatic Society of Bengal, No. 4. for 1862.—*From the Secretaries.*

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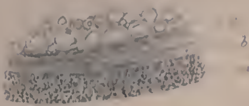
Fig 1



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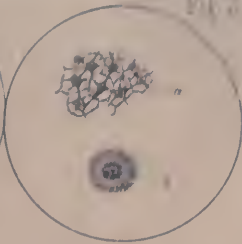

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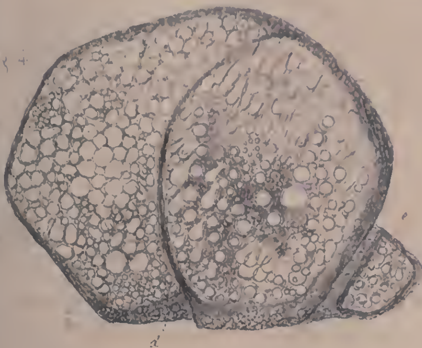

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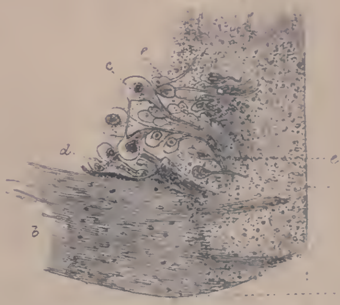

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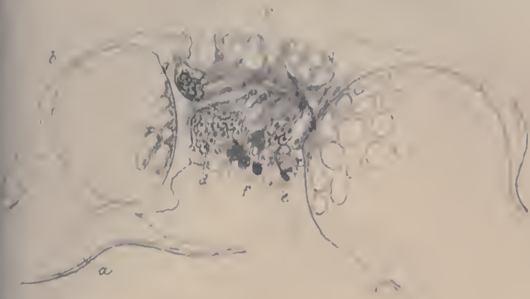

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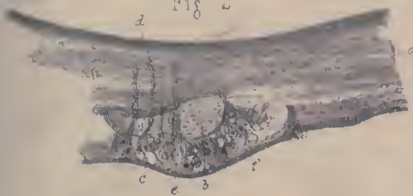

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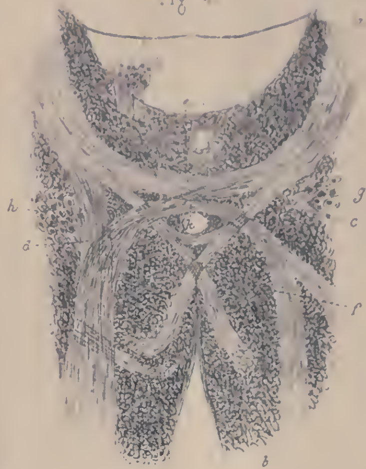

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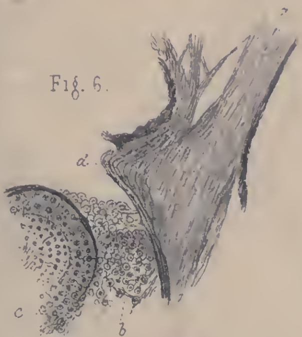

Fig. 5.

FIG. 1

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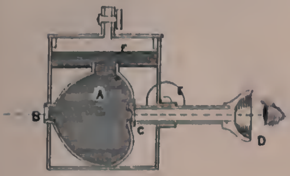

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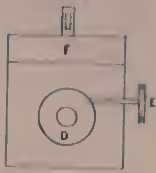

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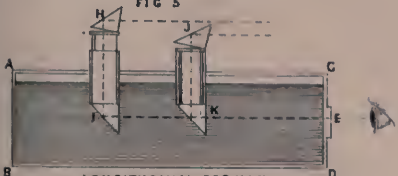

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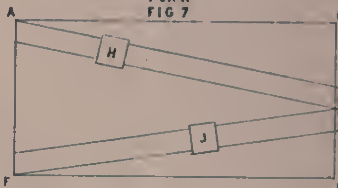

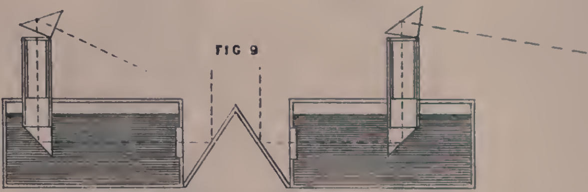

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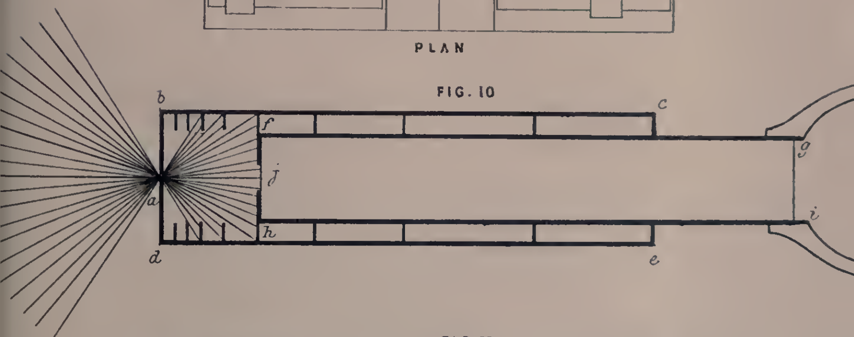

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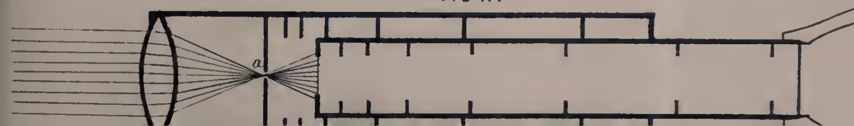

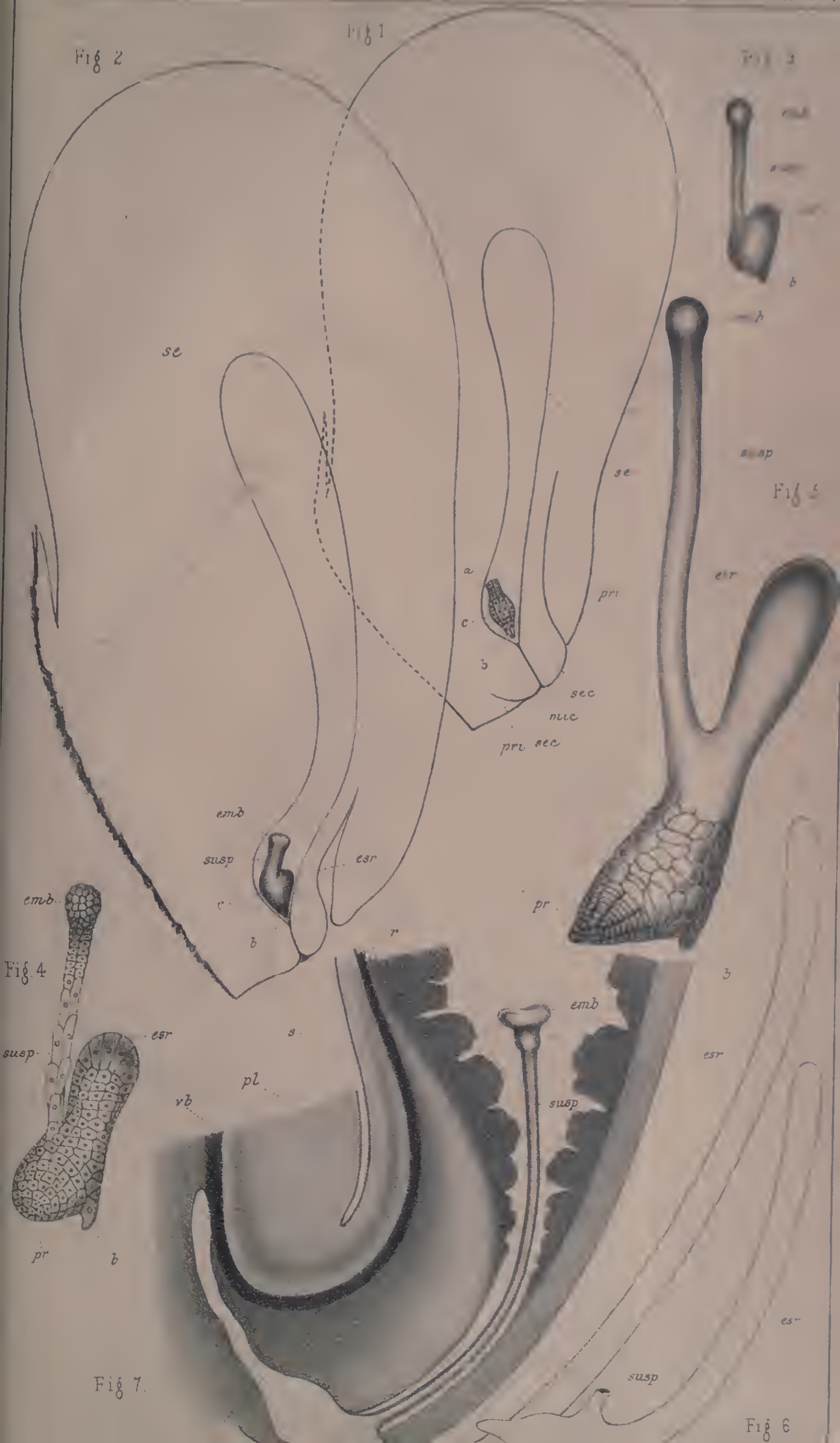
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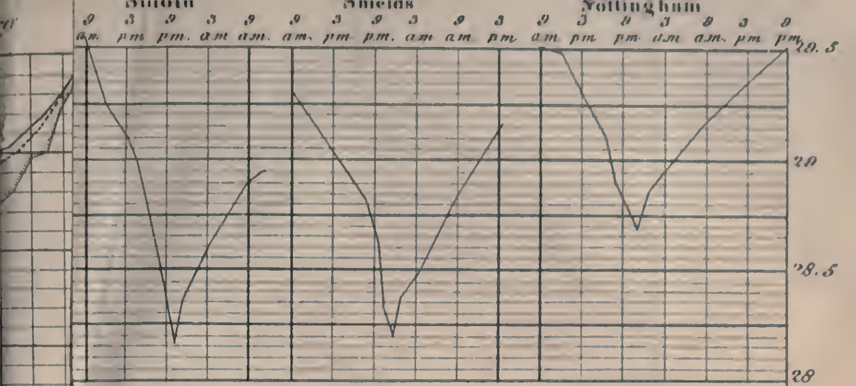

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