understand, is included under the head of chlorides, and calculated into common salt would furnish 43 per cent. of the 16,657 tons. It is cyclic of long period, and not available for Professor Joly's calculation.

Fluctuations.—An inverse relation undoubtedly exists between the soluble contents of a river (including, of course, sodium compounds) and the amount of water in it in Summer and Winter. In all the great rivers subject to flood the variation must be enormous; in the case of the Nile it amounts to 400 per cent. As far as I can learn, these fluctuations have not been taken into account.

Coming once more to the numerator: Mysteries hang over it. The composition of the sea is not what one would expect with the precise conditions of solvent denudation required by Professor Joly's speculations. For instance, one looks for huge proportions of nitrate in it; sea analyses show practically none. Again, the chlorine in it multiplied by a known factor is a measure of its sodium contents, but the same factor does not apply to average river water. These are not matters of opinion but of fact. What becomes, then, of Dr. Joly's "constancy in the *nature* and *rate* of solvent actions going on over the land surfaces" (Trans. Roy. Soc. Dublin, ser. II, vol. vii, p. 24)?

Too much space and time would be required for me to deal with the second half of Professor Joly's November article. I may, however, be permitted to observe that he appears to me to tilt at an irrefragable law of solution, and then only saves his lance from being utterly shattered by an adroit swerve.

NOTICES OF MEMOIRS.

I.—Note on the Cambrian Fossils of St. François County, Missouri. By Professor C. E. Beecher.[1]

THE small collection of fossils submitted to the writer by F. L. Nason, for identification, is interesting, especially as it determines the geological horizon of an extensive series of limestones, sandstones, conglomerates, etc., in south-eastern Missouri, the age of which has hitherto been somewhat in doubt. Also, since these strata are intimately associated with the lead-bearing rocks of this region, the identification has considerable economic value.

It is stated by Arthur Winslow, in a paper on "The Disseminated Lead Ores of South-Eastern Missouri"[2] (p. 11), that although these rocks are placed in the Lower Silurian "The possibility still remains that there may be a faunal break which will admit of some of the lower strata being classed as Cambrian, though there is nothing in

[1] Reprinted from Silliman's American Journal of Science for November, 1901, pp. 362–366.

[2] Bulletin No. 132 of the United States Geological Survey, 1896.

the stratigraphy to suggest it. This must, therefore, be left to the palæontologists, and owing to the dearth of fossils the problem is not an easy one for them to solve." In volume ix of the Missouri Geological Survey (pt. iv, p. 52, Keyes, 1895) the Fredericktown dolomite (=St. Joseph limestone) is referred to the Upper Cambrian on account of the presence of *Lingulella Lamborni* (Meek), but since this species is peculiar to the horizon, and the genus has a much wider range, this correlation is not established. A general statement is made by Keyes regarding this region (l.c., p. 44) that "No strata younger than the Cambrian are believed to be represented. But few fossils have been found in the rocks of the area, so that the faunal evidence as to geological age is somewhat meagre." The present collection of fossils, made by Mr. Nason, indicates that the entire series is older than the Lower Silurian (Ordovician), and that at least the upper portion probably belongs to the Upper Cambrian. All but one species of the fossils were obtained from the lower members of the Potosi limestones, and since this is the topmost formation of this region its correlation is of the first importance. The fossils occur abundantly in the limestone and conglomerate beds, and more sparsely in the sandstones. They consist chiefly of fragments of trilobites, with a few brachiopods and other forms. Lithologically, there is a very close resemblance between these fossil-bearing beds and those of a similar horizon in the Black Hills of South Dakota. Limestones, limestone conglomerates, and sandstones of the same appearance are found in both sections. Faunally, there is a suggestion of affinity with the Potsdam fauna of Wisconsin and Texas. A careful comparison, however, reveals that these resemblances are more general than specific, and that the species seem to be distinct. Nevertheless, the facies of this fauna seems to indicate Upper Cambrian, though further studies with additional material may show it to belong to the middle member.

Owing to the small number of specimens in the present collection, the number of species is necessarily limited. It will doubtless be considerably increased by future collections. Among the trilobites the genera *Ptychoparia*, *Ptychaspis*, *Chariocephalus*, and *Crepicephalus* are more or less clearly identifiable. A species of *Chariocephalus* closely agrees with the *C. onustus* of Whitfield.

The species of brachiopods seem to be fairly abundant, especially an orthoid shell resembling in some respects *Billingsella*. It occurs in the shaly partings between the layers of limestone. A species of *Acrotreta* and *Lingulella* are common both in the limestones and arenaceous beds.

Hyolithes primordialis, Hall, and a small species of *Platyceras* also occur in the limestones, together with segments of cystidean or crinoidal columns.

Abundant remains of a linguloid shell are found on the lower, or La Motte, sandstones constituting the basal member of the clastic rocks of the section. Making allowances for different conditions of preservation, this species may be identified with the *Lingulella Lamborni* of Meek, which occurs in some green shales of the same

age in Madison County, a little further south. In the absence of other evidence the diagnostic value of this brachiopod is very slight, and it is impossible to say whether the Bonne Terre, or St. Joseph, limestones and the La Motte sandstones represent Lower Cambrian terranes or whether they with the Potosi all belong to the Middle or Upper Cambrian.

The important point of this correlation is that, upon palæontological evidence which has hitherto been largely wanting, an extensive area and thickness of sedimentary rocks are definitely placed in the Cambrian.

II.—Discovery of Eurypterid Remains in the Cambrian of Missouri. With an Illustration. By Prof. C. E. Beecher.

THE wonderful development of Merostomes in various parts of the world at about the close of the Silurian has long been recognized, and the suddenness of their appearance out of an apparently clear Palæozoic sky has been a matter of considerable speculation. Almost at the same instant of time there appeared on the geologic horizon a marvellous assemblage of these ancient arthropods. A very few scattering forerunners are known from older rocks, but most of them are small and strange creatures, little resembling the characteristic *Eurypterus* and *Pterygotus* of the Upper Silurian, and in fact belonging to other orders than the Merostomata.

In North America the known genera and species of the order Eurypterida belong almost exclusively to the Waterlime group (Rondout) above the Salina beds. Dr. John M. Clarke[1] has recently announced the discovery, by Mr. C. J. Sarle, of a new Eurypterid fauna at the base of the Salina, which carries this peculiar biologic facies one comparatively brief stage further back. Evidences of still older forms are very meagre. A single species of *Eurypterus* (*E. prominens*, Hall) is referred to the Clinton beds of the Silurian with considerable doubt. The next indication of a greater antiquity of this order consists of a fragment of an abdominal segment and a single jointed limb, from the Utica slate of New York, described by C. D. Walcott[2] as *Echinognathus Clevelandi*.

It is therefore of considerable interest and importance that a new and much older horizon for the Eurypterida can now be chronicled.

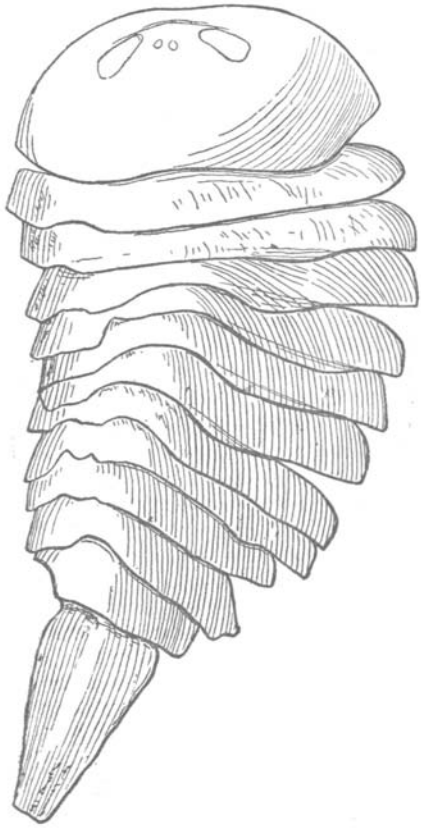
Mr. Arthur Thacher, President of the Central Lead Company of Missouri, formerly a professor in Washington University, found a nearly entire specimen of a new Eurypterid in the Potosi limestone of St. François County, and through his generosity and the kindly interest of Mr. Frank L. Nason the specimen was transmitted to the Yale University Museum. Owing to the supposed scarcity of fossils in the Potosi and St. Joseph terranes of Missouri, their

[1] Notes on Paleozoic Crustaceans. N.Y. State Museum, Report of the State Paleontologist for 1900. 1901.

[2] Description of a new genus of the Order Eurypterida from the Utica Slate. Silliman's Journal (3), vol. xxiii, 1882.

correlation was long a matter of uncertainty, until Mr. Nason described certain horizons bearing an abundant and characteristic Cambrian fauna.

The specimen here described at once suggests the familiar and well-known genus *Eurypterus*, and only when its characters are studied in connection with its geological occurrence is it apparent that its differences are of sufficient importance to warrant its generic separation. The specimen represents nearly the entire dorsal test of the animal, and consists of the cephalothorax with the abdominal segments, including the telson or tail-spine.



Strabops Thacheri, Beecher.—Dorsal aspect of type-specimen, ½. Potosi Limestone (Cambrian): St. François County, Missouri. Original in Yale University Museum.

The cephalothorax is comparatively shorter and wider than in *Eurypterus*, the eyes are further forward, nearer together, and more oblique, and besides the telson but eleven abdominal somites can be determined on the dorsal side, instead of twelve as in *Eurypterus*.

These differences are considered as indicative of a new genus, and it is proposed to recognize this type under the name *Strabops*, nov. gen., with *Strabops Thacheri*, n.sp., as the type species. The generic name is in allusion to the inward turning or squinting of the eyes (*στραβός* 'squinting' and *ὄψις* 'face').

Doubtless many generic differences will appear when the appendages of this type are obtained. The differences in the characters available for comparison are quite as great as between *Eurypterus* and *Dolichopterus*, *Stylonurus*, *Anthraconectes*, or *Eusarcus*. This, taken with the fact that practically all the Cambrian genera, especially the more highly organized types, became extinct long before the Upper Silurian, lend support to the conclusion that *Strabops* is generically distinct from any hitherto known form.

STRABOPS THACHERI, gen. et sp. nov.

Body broadly ovate in general outline exclusive of the telson, slightly convex in the specimen, though probably quite arched both transversely and longitudinally in life, as indicated by the outline of the separate segments.

Cephalothorax short and broad, length less than one-half the width, anterior and lateral margins regularly rounded, posterior margin gently curved in the middle and turning obliquely forward toward the genal extremities, which are obtusely angular.

Eyes medium-sized, ovate, narrow ends pointing obliquely inward, situated in the middle of the anterior half of the cephalothorax, distant about the length of one eye, connected anteriorly by a distinct arched line or fold. The eye tubercles are mostly exfoliated, and their convexity and surface cannot be determined. *Ocelli* indicated by two spots midway between the eyes.

Abdomen. The dorsal side shows eleven segments exclusive of the telson. The axis in the specimen is slightly convex, and slopes off into the nearly flat pleural region without any line of demarkation. The greatest width is across the third segment. The extremities of the segments are rounded anteriorly and on the sides, and terminate behind as a simple angulation. The first six segments are quite uniform in length, while the three following are somewhat shorter, and the last two are a little longer.

Telson a broad flat spine, obtusely elevated along the middle.

Surface smooth, with an indication of a row of minute crenulations or scale-like markings near the posterior edge of each segment.

Dimensions.—Greatest length of specimen 110 mm., length exclusive of telson 82 mm.; greatest width, allowing for compression on left side, 60 mm.; length of cephalothorax 20 mm., width 49 mm.; greatest width of telson 17 mm.

Formation and locality.—From the lower members of the Potosi limestone, Flat River, St. François County, Missouri.

The only known genus of merostomes besides *Strabops* occurring in the Cambrian is *Aglaspis*, Hall, represented by two species (*A. Barrandi* and *E. Eatoni*, Whitf.). But since *Aglaspis* belongs

to the order Synxiphosura, it leaves *Strabops* as the present sole representative of the Eurypterida.[1]

III.—On the Anatomy of *Todea*, with an Account of the Geological History of Osmundaceæ. By A. C. Seward, F.R.S., and Miss Sybille O. Ford.[2]

THE anatomical structure of the genus *Osmunda* has been dealt with by several writers, and more particularly by Zanetti in an able paper published in the *Botanische Zeitung* for 1895, but the other genus of the Osmundaceæ has not received equal attention at the hands of anatomists. Our work, which was undertaken with a view to discover in what respects *Todea* differs from *Osmunda*, includes the examination of *Todea barbara* and *T. superba*, as well as the investigation of series of microtome sections of young plants. The family Osmundaceæ is usually regarded as to some extent intermediate between the Eusporangiate and Leptosporangiate ferns, and in many respects the two genera *Osmunda* and *Todea* are of interest in regard to the phylogeny of the various divisions of the Filicinæ.

The stem of *Todea barbara* is traversed by a single stele composed of xylem groups surrounding a central pith and separated from one another by medullary rays: these groups vary considerably in shape and number at different levels. There may be as few as two or as many as eight xylem strands in one transverse section of the stem, while in *Osmunda regalis* the number is considerably greater. The xylem strands are surrounded by parenchyma, and the sieve-tube zone occupies the same position as in *Osmunda*. This zone, which is continuous in *O. regalis*, is occasionally discontinuous in *Todea* opposite some of the xylem strands. The comparatively large sieve-tubes occur in triangular patches at the outer end of each medullary ray. A characteristic band of tangentially elongated elements succeeds the sieve-tube zone, and this is followed externally by a parenchymatous band, the outermost layer of which constitutes the endodermis. The paper deals with the phyllotaxis of *Todea barbara*, the origin of the leaf-traces, and the gradual alteration in structure which the collateral leaf-trace undergoes as it passes out from the stele of the stem as a horseshoe-shaped strand with one protoxylem group, and gradually assumes the form of the broadly U-shaped concentric stele of the petiole with its numerous protoxylem groups. The anatomy of 'seedling' plants of *Todea* is found to agree with that of *Osmunda regalis* plantlets as described by Leclerc du Sablon. As bearing on the questions of relative

[1] Although *Aglaspis* was compared with *Limulus* by Professor Hall, and its affinities were distinctly stated as with the Merostomata, yet most subsequent writers have overlooked its true relationships and have included it in their lists of trilobite genera. The family named Aglaspidæ was first employed in 1877 by S. A. Miller in "The American Palæozoic Fossils," p. 208, and the restoration of the family to the Merostomata was first made by the writer in a paper entitled "Outline of a Natural Classification of the Trilobites" (Silliman's Journal (4), vol. iii, p. 182, 1897).

[2] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

antiquity and phylogeny of the members of the Filices, we have endeavoured to give an account of the geological history of the Osmundaceæ.

IV.—Plants and Coleoptera from a Deposit of Pleistocene Age at Wolvercote, Oxfordshire. By A. M. Bell, M.A., F.G.S.[1]

PLANT remains of Pleistocene time are of great rarity in England. The two most important series which have been described are from Hoxne, in Suffolk, obtained by Mr. Clement Reid, F.R.S., and Mr. H. N. Ridley (Geol. Mag., 1888, p. 441), and from North London by Mr. Worthington G. Smith.

There is in these remains a singular difference. Of twenty-eight plants obtained at Hoxne three are Arctic (*Salix polaris* and *myrsinites*, *Betula nana*); seventeen range to the Arctic Circle. At Stoke Newington, on the contrary, Mr. W. J. Smith obtained the elm, the chestnut, clematis, and perhaps the vine. Only three out of eleven plants reach the Arctic Circle. The pine, the alder, birch, and yew, with the royal fern, were more in harmony with the present and the past floras. In the author's opinion the Stoke Newington flora represents a much later age of Pleistocene time than the Hoxne flora. The conditions were continental, and the flora of the south was gaining, while the Arctic flora was disappearing.

The plants as yet identified, by the kindness of Mr. Clement Reid, from Wolvercote resemble those found at Stoke Newington more than those at Hoxne. This is in harmony with the writer's view that the Wolvercote deposit is of late Pleistocene age, nearer to the Stoke Newington than to the Hoxne deposit.

Eighteen plants obtained by the author are given. All of them are found in Oxfordshire to-day. Eight only have an extension to the Arctic Circle. Four mosses have been obtained, one of which is certainly recent. A considerable number of the wing-cases of beetles have also been found. These are difficult to identify, but the genus of one, remarkable by its rows of hairs, has been named by Mr. Waterhouse, of the Natural History Department of the British Museum. Only one of the genus is now found in England, and that is different from the Wolvercote species. On the other hand the genus is common on the Continent.

These facts, coupled with those from Stoke Newington, tend to the conclusion that in late Pleistocene time the climate of the Thames Valley was more continental than it is at present.

V.—Recent Discoveries in Arran Geology. By William Gunn, of H.M. Geological Survey of Scotland.[1]

(Communicated with the permission of the Director of the Geological Survey.)

IN the last ten years very important additions have been made to our knowledge of the geology of Arran both in the aqueous and in the igneous rocks of the island.

Among the older rocks a series of dark schists and cherts has been discovered in North Glen Sannox. They are probably of Arenig

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

age, though no organic remains have been found in them, are closely related to the rocks of Ballantrae in Ayrshire, and similar beds occur in various places along the Highland border, where they have been described by Messrs. Barrow and Clough. In the Isle of Arran these rocks are intimately connected with the Highland schists.

The Old Red Sandstone of Arran has been found to comprise two subdivisions, and in North Glen Sannox the upper division lies unconformably on the lower. This formation is not confined to the ground north of the String road, as generally supposed, but extends in places three miles to the south of that road, being well developed in the Clachan Glen, where it is much metamorphosed by intrusive igneous rocks. No fossils have been found in the Old Red Sandstone of Arran except *Psilophyton princeps*, specimens of which have been obtained from the lower division in Glen Shurig.

The Carboniferous formation, fine sections of which occur on the shore at Corrie and at Laggan, is now known to occupy but a small portion of the area of the island. Near Brodick Castle and in Glen Shurig its width of outcrop is not much more than 200 yards, and it does not reach the western shore, being overlapped in the interior by unconformable beds of New Red Sandstone. Beds probably of Coal-measure age with characteristic Upper Carboniferous fossils have been recognized at Sliddery Water Head, Corrie, The Cock, and in various other places, but these have no great thickness and contain no seams of coal. They represent apparently the basement beds of the Coal-measures.

The stratified rocks of the southern part of the island, consisting of red sandstones, conglomerates, and marls, have been proved to repose unconformably on the Carboniferous formation, and in places they contain derived pebbles with Carboniferous fossils. All the evidence points to their being of Triassic age, and they may easily be divided into two series, the lower of which probably represents the Bunter Sandstone and the upper the Keuper marls. These Triassic rocks occupy the whole of the coast from Corrie southwards, around the south end of the island, and the west coast up to Machrie Bay, where they appear to lie conformably on the Old Red Sandstone. They also form a small area in the north-eastern part of the island near The Cock.

That still more recent formations once existed in the island, whence they have been removed by denudation, is proved by the presence of fragments of Rhætic, Liassic, and Cretaceous rocks in a large volcanic vent which is probably of Tertiary age. These fragments occur on the western side of the island in the district of Shisken, on the slopes of Ard Bheinn, and they have yielded a considerable number of characteristic fossils which have been examined and determined by Mr. E. T. Newton.

Some of the most important of the discoveries are those connected with the old volcanic rocks of the island. A series of interbedded lavas and tuffs is found in North Glen Sannox associated with the schists and cherts previously mentioned. Like them they are probably of Arenig age, and closely related to similar rocks at

Ballantrae in Ayrshire. Two distinct volcanic platforms have been found in the Old Red Sandstone of the island. One set of basic lavas is intercalated in the lower division on the west side of the island, and another occurs in the upper division of the North Glen Sannox. In addition to the volcanic series previously known in the Lower Carboniferous rocks two others have been discovered in the upper part of the formation. That the island was the seat of volcanic activity in times still more recent is proved by the recognition of a large volcanic vent in the Shiskin district, which must be of post-Cretaceous age, as shown by some of the fragments it includes. From these facts we conclude that the island has been the scene of volcanic action at no less than seven different periods.

Much has also been learned with regard to the distribution and age of the various intrusive igneous rocks. Two masses of a somewhat intermediate character found in Glen Rosie and in Glen Sannox are probably of Old Red Sandstone age, but nearly the whole of the varied igneous rocks of the island must now be assigned to the Tertiary period, not excepting the well-known granite mass of the northern part of the island. The finer granite which occupies the interior of the nucleus has a tortuous boundary. It is clearly intrusive in the coarse granite which surrounds it, but both belong practically to the same period, as they have one and the same system of jointing.

The ring of granite, granophyre, and quartz diorite which surrounds the large volcanic vent was previously little known, and the other numerous and varied intrusive masses, both acid and basic, which occur in the island were but poorly represented on existing maps.

VI.—On the Crystalline Schists of the Southern Highlands; their Physical Structure and Probable Manner of Development. By Peter Macnair.[1]

THE area under notice is defined as that lying immediately to the north-west of the great boundary fault which crosses Scotland from the Firth of Clyde to Stonehaven. An account is then given of the various opinions that have been held concerning the structure of this region since the time of Macculloch up to the present day. The author then proceeds to show that the schist zones traverse this region in roughly parallel bands, and described a series of sections at right angles to the strike of the principal foliation of the area. The following is a summary of the author's conclusions regarding the stratigraphy, physical structure, and the manner of development in this part of the Scottish Highlands:—

1. The sedimentary schists of the Highlands proceeding from the margin inwards may be divided into the following zones:—Lower Argillaceous zone, Lower Arenaceous zone, Loch Tay Limestone zone, Garnetiferous Schist zone, Upper Argillaceous zone, Upper Arenaceous zone. Associated with these are schists of igneous

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

origin. It is probable that these zones are capable of still further subdivision, but this is not attempted as yet.

2. From an examination of the relationships of these different zones, the order as given above appears to be an ascending one, proceeding from the margin inwards, the well-marked zone known as the Loch Tay Limestone forming a sort of datum-line, from which one can recognize the positions of the lower and upper schists.

3. It is supposed that the movements which plicated the rocks of the Highlands were directed from the centre outwards, or from the north-west towards the south-east. This is shown by the fact that where the bedding can be traced the overfolding is generally towards the south-east. Also the foliation, where it has been observed, faces in the same direction.

4. In the eastern part of the region we suppose that the beds have been folded into a series of isoclines facing the south-east, and that foliation has been developed roughly parallel to the axes of the folds in the bedding, thus making the foliation appear to be roughly coincident with the original planes of stratification. At Comrie, in Perthshire, the axes of the isoclines in the bedding are nearly vertical, but with a slight hade towards the north-west. The axes of the isoclines get gradually lower and lower as we proceed towards Loch Tay. In the same way the foliation planes are nearly vertical along the frontier, but get flatter and flatter as we proceed northwards.

5. In tracing these rocks towards the south-west an increasing crumpling and folding of the foliation planes, accompanied by more intense metamorphism, is seen to take place: this is made evident in approaching the shores of Loch Katrine and Loch Lomond, but it seems to have reached its maximum in Cowal.

6. In Cowal, along the Firth of Clyde, the position of the foliation planes has been reversed, now dipping towards the south-east. Between the Firth of Clyde and Loch Fyne the foliation planes have been much crumpled, and still later divisional planes have been developed in them, this being a region of the most intense metamorphism.

VII.—The Source of Warp in the Humber. By W. H. Wheeler, M.Inst. C.E.[1]

IT has frequently been stated that the mud or warp in suspension in the Humber is derived from the erosion of the cliffs on the Yorkshire coast, and the object of the paper is to show that it is physically impossible for the detritus eroded from those cliffs to be carried into the Humber, and that the material in suspension in the water is derived from detritus washed off the land drained by the Humber and its tributaries or eroded from their banks. The drainage basin of the Humber covers 10,500 square miles, and embraces strata of various kinds of rocks, including estuarine deposits, glacial drifts, chalk, sandstone, and oolites.

The water in the zone extending around the junction of the Trent

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

and the Ouse with the Humber, extending over a length of thirty-five miles, is very highly charged with solid matter in suspension, the maximum quantity being attained in the Summer, when the downward flow of the fresh water is at a minimum, the quantity then in suspension amounting to as much as 2,240 grains, or nearly the third in a cubic foot of water. Above and below this zone the quantity diminishes to 262 grains up the river Trent and 202 grains near the Albert Dock at Hull, while off Spurn, at the entrance to the river, there is no mud in suspension, but only a few grains of clean sand. The floor of the North Sea at the entrance is covered with clean sand and shells, the beach up to Grimsby also being covered with sand.

The solid matter in suspension is derived from the detritus washed off the land and poured into the river when freshets occur, or from the erosion of the banks of the river and its tributaries. The greater quantity that prevails in the more turbid zone is due to the material being kept in a state of oscillation by the ebb and flow of the tides when the quantity of fresh water flowing down is not sufficient to carry it out to sea.

The average quantity of solid matter contained in thirteen other English rivers when in flood is 200 grains in a cubic foot. The average rainfall within the watershed of the Humber is 29·60 inches, of which 10 inches may be taken as the quantity due to such rains as produce freshets. With these figures the normal total quantity of solid matter placed in suspension in floods may be put at three million tons in a year. A portion of this is carried out to sea in heavy freshets, and the rest remains in the river in a state of oscillation.

The tendency in all rivers, whether fresh or tidal, is for material to work downward under the laws of gravity. The same quantity of tidal water that flows into the river has to flow out again, but its capacity for transporting material downwards is reinforced by the discharge of the fresh water.

The flood current in the Humber runs at the rate of four miles an hour, and its duration varies from six hours at Spurn to two and a half at Goole. It may be taken, therefore, that a particle of solid matter entering the Humber at Spurn Point would not be carried by the flood tide more than 20 miles up the river, or 25 miles below the point where the greatest amount of solid matter is held in suspension. On the turn of the tide it would be carried back again. Allowing for the greater time the ebb current is running above the junction of the rivers as compared with the flood, the material carried down on the ebb is 73 per cent. greater than that carried up on the flood.

Taking the length of the Holderness Cliffs as 34 miles, the average height at 12 yards, and the mean annual loss at $2\frac{1}{4}$ yards, the mean quantity falling on the beach is about $1\frac{3}{4}$ million cubic yards a year, of which about 40 per cent. consists of stones, gravel, and coarse sand, leaving less than a million cubic yards to be washed away. The foot of the cliffs is only reached for about four

hours at high-water of springs, that is, by 260 tides in a year, the average quantity of alluvial matter for each tide being 3,728 cubic yards.

The drift of the tidal current towards the Humber lasts $3\frac{1}{2}$ hours, and runs at a velocity of $2\frac{1}{2}$ miles an hour; the greatest distance a particle of solid matter put in suspension at the point of mean distance, 20 miles from the Humber, could be carried southward is $8\frac{3}{4}$ miles; when this distance is reached the tide would turn and the particle would be carried northward for 16 miles, or 28 miles away from the Humber.

It is, however, quite improbable that a particle of matter placed in suspension at the foot of the cliffs could ever reach the main current going to the Humber. Owing to the Yorkshire coast being in an embayment the main tidal current does not approach nearer the coast than the 6-fathom line, or a mile away from the coast. The current of the flowing tide sets into the embayment towards the coast. Even if a particle from the cliffs could overcome this shoreward set and traverse the water contained in this mile of water in an opposite direction, so as to be brought into the main southerly-going current, the quantity of solid matter brought into suspension would only be sufficient to supply one grain to 14,000 cubic feet of water.

It is evident from the above facts that it is not possible for the detritus from the Yorkshire coast to reach, much more to be carried up, the Humber.

VIII. — The Artesian Water in the State of Queensland, Australia. By R. Logan Jack, LL.D., F.G.S.[1]

THE western interior of Queensland is a vast area of magnificent pastoral country, but is not endowed with a sufficient rainfall. In 1881 the author had reason to suspect that the Cretaceous rocks of the Western Downs afforded conditions favourable for the discovery of artesian water. Subsequently, in 1885, the author (then Government Geologist) and Mr. J. B. Henderson, hydraulic engineer, made a study of the area, and an experimental bore was put down which proved a success.

From Mr. Henderson's annual report for 1899–1900 it appears that up to June, 1900, 185 miles of boring had been made in search of artesian water in the district, and a large proportion of the bores have been successful; and though the artesian water does not fully compensate for the lack of rain, still the bores have already produced an important change in the conditions of life in the interior.

The greater part of the western interior of Queensland is composed of soft strata of Lower Cretaceous age, consisting of clay-shales, limestones, and sandstones. These strata are so disposed that the lower members of the series crop out on the western flanks of the coast range, where not only is the elevation of the surface greater than in the downs to the west, but the rainfall is also comparatively abundant.

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

Along the eastern margin of the Cretaceous area there is a porous sandstone of great thickness, the 'Blythesdale Braystone,' and owing to low dip the outcrop of this permeable stratum occupies a belt from five to twenty-five miles wide; but the Braystone finally disappears beneath the argillaceous and calcareous upper members of the series which forms the surface of the downs to the west. Several rivers disappear while crossing the outcrop of the Braystone, and the water must be carried in it beneath the clay-shales of the downs.

The outcrop of the Braystone is concealed over part of the area by nearly horizontal tablelands of the 'Desert Sandstone,' an upper member of the Cretaceous formation lying unconformably on the lower divisions. It is, however, also of a permeable nature. The author gives an estimate of the water which should penetrate the Braystone, and suggests the probability that much of it finds an outlet under the sea in the Great Australian Bight and the Gulf of Carpentaria.

The artesian water basins are, in fact, broken basins, and the break gives rise to leakage either on land or beneath the sea. In places, therefore, the water rises in a bore, but does not reach the surface owing to the site of the bore being higher than the head of pressure. This is termed 'sub-artesian water,' and the author gives illustrations of both artesian and sub-artesian water in the district in question.

REVIEWS.

LES VARIATIONS DE LONGUEUR DES GLACIERS DANS LES REGIONS ARCTIQUES ET BOREALES. Par CHARLES RABOT. (Extrait des Archives des sciences physiques et naturelles, 1899–1900.) pp. 230. (Geneva and Bale: Georg & Co.)

THIS is the latter part of a treatise of which the former was published in 1897. Since that date much additional information has appeared, of which a summary is given, together with the conclusions to which the author has been led. These are:—(1) Prior to the eighteenth century the glaciers, as proved by documentary evidence in Norway and Iceland, and made highly probable also in Jan Mayen and Spitzbergen, were much less extensive than they are at the present day, and this minimum condition had lasted for centuries. (2) During the eighteenth century, as well as in the earlier years of the nineteenth, a very great extension (*une crue enorme*) occurred, which was general throughout the Northern Hemisphere. In the course of this the glaciers invaded regions which had been free from ice during historic times. Of this, in Greenland, Jan Mayen, Iceland, Norway, and Alaska, in some cases there is documentary proof; in others it is made highly probable by less direct evidence. (3) The remainder of the nineteenth century has been a period of uncertain movements. In some places a considerable advance has been followed by a slight retreat; in others the latter set in after a pause at the maximum which had been reached in the earlier years. At the present day the Greenland