of insect life. These remains consist solely of fragments of wings and a few segments of the abdomen ; why the other hard portions of these animals are not mixed up with the rest is a mystery. They were probably the spoils of the land through which the ancient river flowed, by means of occasional overflowings. This is the more probable as the Purbeck series is generally recognized as an estuary deposit.

Amongst the most interesting of the fossils are those of the crustaceous order *Isopoda* (well represented by a single species, the *Archæoniscus Brodiei*, Milne Edw.), which are very rarely met with in the fossil state.

(To be concluded in our next Number.)

IV.—ON THE GLACIAL EPOCH OF GREAT BRITAIN.

BY JOSHUA WILSON.

IT must be admitted that if during the Glacial period an arctic current, similar to that which now sweeps along the east coast of North America, were to pass over the submerged portions of our island, there is no reason why the climate of this country should not assimilate to that of Labrador, where there is now perpetual frozen ground in the latitude of Liverpool. The question then is, what evidence have we that such a current existed at the commencement of the Glacial epoch? Have we not the evidence of the striæ on the rocks and mountains of the Scandinavian peninsula, as well as on those of our own country, to show that, during the period of the submergence of these districts, icebergs were driven by an arctic current from the north-east to the south-west?—that the Polar Sea extended from the White Sea to the entrance of the Baltic, spreading southward over Germany to the confines of Switzerland, which can be traced by the deposited boulders and other ice-transported materials? Then, as to the cause of this return current. It must be evident that the Gulf-stream at that date could not have flowed in its present direction. The arctic current coming down the Baltic must have thrown it further to the west, so that in all probability in its northern progress it would impinge on the east coast of Greenland and the Island of Spitzbergen ; then being deflected by the polar ice, it would return by the way of the White Sea and the Baltic, so completing the circuit.

As the land was gradually upheaved, we may conclude that in the first instance the larger icebergs would be detained ; but there might be a considerable quantity of polar ice transported, until at length there might be only the cold current left. And when, by the upheaval of the land, this was finally stopped, the Gulf-stream would be diverted to its present channel, and by its genial warmth would speedily terminate the Glacial period. The next question is, at what geological date did this change take place? On this I agree with A. Geikie, F.R.S., in his "Scenery of Scotland" (page 320), where he mentions a raised beach, about 40 feet above high-water mark, in which arctic shells have been found, which he considers to have dated from the latter part of the Glacial period. The next

upheaval, of about 20 to 25 feet, took place after this island was inhabited and probably covered with forests, showing the amelioration of the climate, as several canoes have been found imbedded in it, which have been hollowed out from large trees.

In order to show that the alteration of the set of the Gulf-stream occurred subsequently to the elevation of the 40 feet beach, I may remark that it is situated on the west coast of Scotland, where it fronts the Atlantic Ocean, and that if the Gulf-stream had impinged on that shore previous to the elevation of this beach, as it now does, nearly at a right angle, it would have been by its off-set under-current swept away into the depths of the ocean. To explain my position, I may refer to what I term the *offshore* current of the *onshore* gale. It is a well-ascertained fact that the effect of an onshore gale is to give a sea-beach a seaward direction; the cause of this movement we need not go far to seek. If I am not mistaken, Mr. Coode mentions, in his account of the Chesil Bank, that in a heavy south-west gale the level of the water in front of it will be raised three feet above that of the Fleet behind it. This is the result of the friction of the wind on the surface of the water, causing an inshore upper current. This inshore drift must be counterbalanced by an under-current in an opposite direction, a movement similar to a web passing horizontally over two rollers inshore above offshore below. Although this offshore current may not have sufficient velocity to move sand or shingle when at rest upon the beach, yet in unison with the back sweep of the wave it will give a preponderating direction seaward to the beach: hence the millions of tons washed down from that bank in a south-west gale, to be returned again next day when the wind has changed to say west-north-west, the Atlantic swell still continuing. An ocean current impinging on a coast at an angle approaching to a right angle will have a similar effect, with this difference—that this action will be constant; hence we must not be surprised that under the influence of the impinging action of the Gulf-stream, the sea-beach is absent. As, for example, we can trace the action of the Gulf-stream from the neighbourhood of Brest to the south-west coast of England as far north as the Bay of Carnarvon in Wales, the south-west and west coasts of Ireland, the west coast of Scotland, to the north of Ireland, the Orkney and Shetland Islands, etc., and the coast of Norway to the north of the latitude of Scotland; as far as the North Cape. It is to be remarked that in Norway to the south of the latitude of Scotland the land is not so deeply indented as to the north, while the warmth of the Gulf-stream is not felt at Christiania; for the winters are colder there than at Bergen, which is so much further north. I may remark how much the west coast of England is incumbered by sands to the north of Anglesea, and also that the shores of the Bay of Biscay are quite sandy in the neighbourhood of Bordeaux, although exposed to the full Atlantic swell. To this action of the Gulf-stream may we not attribute the encroachments of the sea, of which there exist so many traditions as having occurred from the coast of Brittany to the Bay of Carnarvon? I may remark that the west coast of Patagonia

presents a not dissimilar coast-line, which may be attributable to a like cause—the impinging action of an ocean current. So we may conclude that if the 40 feet beach mentioned by Mr. Geikie had not been upraised before the Gulf-stream impinged on that coast, it would have been swept down into the depths of the ocean, as I cannot find any traces mentioned of the 20 feet beach where it is not protected by intervening land from the action of the Gulf-stream. On the rising of the land between the White Sea and the Baltic above the sea-level, the return current appears to have been deflected into its present channel by Nova Zembla, then west by the north coast of Iceland, which is now colder than formerly (GEOL. MAG., Vol. VIII. p. 394), down Baffin's Bay, etc., and it would thus force the Gulf-stream to the southward to its present position.

NOTICES OF MEMOIRS.

I.—PROCEEDINGS OF THE BATH NATURAL HISTORY AND ANTIQUARIAN FIELD CLUB. Vol. II. No. 4. (1873.)

TWO Geological papers are contained in this work:—(1). *Devonian Fossils from the Sandstones on the N.E. of the Quantocks*, by the Rev. H. H. Winwood. The author draws attention to the occurrence of a series of fossils in the dense hard grey sandstones near Holford and Alfoxden, which Mr. Etheridge has determined to be as follows:

<i>Favosites cervicornis.</i>	<i>Fenestella plebeia.</i>
<i>Petraia celtica?</i>	<i>Actinocrinus.</i>
<i>Atrypa desquamata?</i>	Plant-remains?
<i>Tentaculites.</i>	

These organic remains determine the beds to belong to the Middle Devonian Sandstones on the same horizon as Hangman, and all the country from Ilfracombe to North Petherton, and corroborate the first impressions which Mr. Winwood formed from his examination of the beds. Further, near Dodington Church, limestone bands, containing *Cyathophyllum cæspitosum*, occupying a higher position than the sandstones of Alfoxden and Holford, were identified by Mr. Winwood as corresponding in time with the calcareous bands or lenticular masses which, in the North Devon area, follow the "Hangman grits" in geological succession.

Having also examined the beds at St. Audries, he considered that they belonged rather to the Middle Devonian than to the Lower Devonian according to Etheridge, or to the true Old Red Sandstone according to Jukes. In the words of Mr. Winwood, we can only add that "there is much yet to be learnt of the geology of these hills."

(2). *The Geographical Position of the Carboniferous Formation in Somersetshire, with Notes on Possible Coal Areas in adjoining Districts of the South of England.* The Somersetshire Coal-field presents many features of great interest, which have been treated of largely by Buckland and Conybeare, G. C. Greenwell, and J. McMurtrie: more recently, an exhaustive memoir on the same subject appeared