Before the upheaval it would seem almost certain that a vast prairie plain stretched from the Carpathians and the Vistula as far as the Yenissei, with a more or less uniform slope towards the south, and draining itself into the vast sheet of water of which the Black Sea, the Caspian Sea, the sea of Aral, and the Balkhash are four notable relics. When the Urals were upheaved, it doubtless set in motion a portion of the waters of this vast sea, which swept over the low country, and distributed the wide-spread mantle of soft deposits far and wide, as we find it spread quite irrespective and independent of the river-valleys.

In another paper you will perhaps allow me to apply the reasoning here used to the Altai and the great plateau of Mongolia.

III.—INVERTEBRATE PALÆONTOLOGY IN SOME CONTINENTAL MUSEUMS.

By J. WALTER GREGORY, F.G.S., F.Z.S.,
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NATURALISTS who refer to their "Baedeker" for information respecting the Continental Natural History Museums are too often disappointed by finding that if the author does happen to have mentioned them, either that he has confined his attention to the exterior of the building or has summarily dismissed the collection as "unimportant." Hence geologists are dependent upon such papers as those in which M. Cotteau¹ has recapitulated the principal contents of several French and Swiss Museums, or that in which Mr. Smith Woodward² has enumerated the most interesting specimens of many German and Austrian collections. The last paper, as is indicated by its title, "Vertebrate Palæontology in Continental Museums," is restricted solely to the Vertebrata. But as the value of a Museum, as far as the Invertebrates are concerned, is dependent more on the possession of collections than of single famous specimens, the student of this group is more in need of such information than is the Vertebrate palæontologist; every one knows where he must go to see an *Archæopteryx*, a mounted *Iguanodon*, or a Neanderthal skull, but the last resting-place of a local collector's hoard is, as a rule, less known to fame. Hence the following notes may be of some service as a supplement to Mr. S. Woodward's paper.

HAMBURG.

The palæontological collection is at present mostly stowed away in packing cases at the Johanneum, awaiting removal to its new home in the spacious Museum recently erected in the Steinthorwall. But by the kindness of the Curator, Prof. Dr. Gottsche, I was enabled to examine most of the Echinozoa, especially the valuable series, including some well-preserved Ophiuroids, from the glacial deposits of Northern Germany. There are also collections from the limited exposures of the Oligocene and Cretaceous in the same district. The fossils from Lüneberg are less numerous than in some

¹ "Rapport sur les Musées d'histoire naturelle de quelques-unes des villes du Sud-ouest de la France," Ann. Instit. des provinces, 1868. "Notes sur quelques Musées d'histoire naturelle de la Suisse et de l'Allemagne du Sud," Bull. Soc. Sci. hist. et nat. Yonne. xxiii. 1869.

² GEOL. MAG. (3) V. 1888, pp. 395-404.

other Museums, no doubt mainly because the local knowledge of the astute curator has enabled him to detect and reject all the specimens imported into that town to make the limited supply more equal to the demand. There are some interesting teratological specimens from the glacial beds of the neighbourhood of Hamburg, one of which, a deformed *Galerites*, has a considerable influence on the true systematic position of that genus. The same drifts have yielded a good series from the Danien of Faxøe, while the large collection from the Upper Cretaceous of South Africa reminds the visitor of Prof. Gottsche's travels.

The contents of the Godeffroy Museum have already been removed to the new building, where the Director, Dr. Kraepelin, and his assistants, have temporarily arranged most of the zoological collections. The Echinoderms, including an extensive series from West Africa, have been classified by Dr. Pfeffer. Dr. Meiklesohn is engaged upon an index collection similar to that at the Natural History Museum, and several of his preparations are of especial interest to palæontologists.

BERLIN.

The "Museum für Naturkunde" (at 43, Invalidenstrasse, just outside the Neue Thor) is that which will probably first attract the attention of the visitor. The Palæontological Department contains a fine series of type collections, many of which are associated with the work of the members of the staff. Thus it includes the collection of Prof. Dr. Beyrich, the present head of the Department, and many of the specimens described in the memoirs of Prof. Dr. Dames and Dr. E. Koken. Amongst other collections there are those of Leopold von Buch, and of Schlotheim; Fischer of Munich's great collection of Alpine fossils; many of Goldfuss's Corals and Bivalves and Mojsisovic's Triassic Cephalopoda; the best of the originals of Eck's *Trichasteropsis senfti* from the Saxon Muschelkalk, and half of the collection of Bundenbach Asteroidea, described by Herr Stürtz in his earlier monograph. The Museum seems also rich geographically; thus among the Echinozoa, in addition to the ordinary Continental localities, Greece, Persia, Egypt, Texas and others of the United States, Australia, etc., are all represented. There is too a good collection—as collections go—of the Echinoidea of the Alpine Trias, including a perfect specimen of the remarkable genus *Tiarachinus*; as the only hitherto recorded specimens are the two in Vienna, the opportunity for the examination of this was a very pleasant surprise. The greatest treasure of the Museum, it need hardly be remarked, is the second specimen of *Archæopteryx*.

Immediately adjoining the "Museum für Naturkunde" is that of the "Geologische Landesanstalt und Bergakademie," in which is preserved a large stratigraphical series from Prussia and the Thuringian States. Amongst others it contains the collections of Koch and Dannenberg from the Devonian of the Rhine valley and the Tertiary of the Mainz basin: of Richter from the Silurian and Devonian of Thuringia: of Menzel from the Silesian Muschelkalk: of Schlömbach, Braun and Lasard from the Jura and Kreide of Bremen and

Hanover: of Becks from the Westphalian Kreide: of Zeigler from the Gault of Ahaus: of Speyer from the Hessian Tertiary: of Küsel from the Bukower Tertiary: of Meyn, Kloeden and Gumprecht from the North German "Flachlande": of Kovalevski from the Samland Bernstein; and finally Beinert's Carboniferous plants.

DRESDEN.

In one corner of the Zwinger, in the picturesque old town of Dresden is the Mineralogical and Palæontological collection presided over by Prof. Dr. Geheimrath H. B. Geinitz and Dr. J. V. Deichmüller. The collections (open from 9 till 1) contain most of the types figured in the various monographs of the "Mittheilungen aus dem K. Mineralogischen Museum in Dresden," such as Prof. Geinitz's from the Saxon Dyas, or Dr. Deichmüller's insects from the Solenhofen stone. It also contains a choice series of fossils from the Cretaceous rocks of Saxony. Among the Echinoderms of this collection the gems are certainly the fine set of Asteroidea, the genera of which, however, require re-examination in the light of Mr. Sladen's recent *Challenger* Report; at present they are all included as *Stellaster*; but one at least (*S. albensis*, Gein.) must be included with *Nymphaster*.

At Dresden the geologist need not regret as much as at many towns the shortness of the hours during which the Museum is open. Though the palæontologist may feel little interest in the art treasures of the Zwinger, the geologist can profitably spend a few hours in the study of the landscapes of pre-Whistlerian 17th century impressionists; the unrivalled series of Ruysdael's and several of the rather rare works of his master Albert van Everdingen may be profitably compared with such masterpieces of 19th century realism as Papperitz's gneissose mountains (No. 2240) or Eug. Düncker's boulder bestrewn beach, or the roches moutonnées in Hemming von Kameke's Alpine landscape.

PRAG.

The scenery of Saxon Switzerland, with the deep valley of the Elbe bounded by flat topped hills often crowned with some picturesque old castle, forms a pleasant contrast to the sandy tracts of the North German plain. The geologist certainly should do this section of the journey by daylight; he can join with those whom a philanthropic age has sent to tenant the castles that surmount these historic hills in a philosophic contemplation of the precipitousness which cliffs of ordinary soft "kreide" can maintain when protected by a basalt cap.

At Prag the Museum is still in the old building in the Graben and the palæontological collection is displayed in a summer house in the garden. It will however be shortly removed to the colossal Bohemian National Museum now rapidly approaching completion at the end of the Wenzelplatz.

The principles upon which the new museum is to be arranged and the methods by which these are to be carried into effect are fully described in Dr. A. Fric's paper "Principien der Organisation der naturhistorischen Abtheilung des neuen Museums zu Prag."

The two most important collections in the Museum are those of Barrande and Sternberg. The latter is supplemented by a number of Feistmantel's types.

There is a small series of fossils from the minute patch of limestone that represents the Jurassic system in Bohemia. The Cretaceous collection is of course much more extensive; the originals of Dr. A. Fric's memoirs on the Crustacea of the Bohemian chalk are mostly preserved here, including his *Loricula pulchella*, var. *gigas*, the finest of the known fossil Cirripedia. The Museum also contains many of the types of Dr. Novak's admirable memoirs on the Bohemian Cretaceous Echinoidea and Bryozoa.

The second Museum at Prag is that of the German University (Naturwissenschaftliches Institut in Weinberg Gasse), of which the geological department is under the care of Prof. Dr. G. C. Laube. The collection, though not large, is one that well repays a visit, as it contains many types, as, e.g. of the Cretaceous Crustacea, which supplement the series in the National Museum. Most of the originals described in Laube and Bruder's work on the Ammonites of the Bohemian Kreide are to be seen here.

There is yet a third collection, of which Prof. Dr. O. Novak is the curator, at the Bohemian University.

VIENNA.

In the Austrian capital there are three geological collections each of the first importance, those of the Hof Museum, of the University, and of the k. k. Geologisches Reichsanstalt. The first of these is a palatial edifice in the Ringstrasse, and is probably the finest museum building on the Continent. The geological department is under the care of Dr. Fuchs, who has as his assistants Dr. E. Kittl and Dr. K. Wähner. The arrangement of the department is at once both instructive and interesting. The fossils are grouped stratigraphically in table cases: in wall cases around the rooms are collections of the rocks of the same formations, and above are views showing how they occur in the field. Thus the student of the fauna of any horizon can easily refer to the series of sedimentary rocks which illustrate the physical conditions of the period, while the pictures above show the beds in their typical development in the Austrian Empire. For example, above the Miocene rocks is a view of the great quarry of Margarethen in the Leithagebirge, and over the Jurassic is one of Csorsztyn in Galicia illustrating the Carpathian "Klippen."

The palæontological collection is not yet fully arranged, but by the courtesy of Dr. Fuchs it is all available for reference. It includes a fine series of Bohemian and Leithakalk fossils, and of those from the Tertiary of the Vienna Basin; many of the best of Laube's types from the St. Cassian Schichten are to be found here. The foreign collections are extremely rich, and they include those made during the voyage of the "Novara" and the types of Laube's Echinoids from the Murray River beds, the most important historical collection of Australian fossil Echinodermata. The plant collections are especially extensive. The department also includes a most

instructive collection illustrating dynamical geology, and in connection with this are views of glaciers, volcanoes, and other geological agents.

No reference to the Hof Museum would be complete which omitted to notice the meteorite collection, which is claimed to be the finest in the world. Its principal treasures are well known from the description of its curator, Dr. A. Brezina, in the Jahrbuch k. k. geol. Reichsanstalt for 1885. In the same room is the splendid petrographical collection arranged by Dr. Berwerth.

The University of Vienna is also on the Ring Strasse a few minutes' walk from the Hof Museum. Both the Geological and Palæontological Schools have valuable collections. The latter is of especial interest as having been made by the late Prof. Neumayr. The general geological collection is under the care of Prof. Dr. Suess, and it includes much new material, which is being described by Dr. A. Weithofer.

The faunas best represented—at least among the Echinodermata—are those of the Leithakalk and the North Italian Eocenes; several of the types of Bittner and Laube are to be found here.

The third collection in Vienna is that of the Geologisches Reichsanstalt in the Liechtenstein Palace in Razumoffsky Gasse. Here there is a very extensive Austrian collection, including many of the types of the species of the Director, Dr. Stur, and of Dr. Mojsisovics, Dr. Bittner and other members of the staff. The Triassic Cephalopoda, and Vicentin Echinoidea, and the collections from the Tertiaries of the Vienna basin, and of Galicia and Hungary, the Weisser Jura of Maehren, and Laube's types of Corals, Sponges, and Echinoderms, are especially worthy of notice. The type of Neumayr's *Tiarechinus* is one of the gems of the Museum. General geology is not neglected, and there is a good series of rocks and specimens illustrating the stratigraphy of the Austro-Hungarian Empire.

MUNICH.

The Museum of the "Akademie der Wissenschaften" in Munich is probably that which will tempt the palæontologist to linger longest; for not only is the collection itself remarkably complete, but it includes a series of most important historical specimens, and by the courtesy of Prof. von Zittel it is available for study from 8 a.m. till 6 p.m. Foremost among the special collections is that of Baron Münster, including many of the specimens figured in Goldfuss and nearly all of those in the "Beiträge zur Palæontologie." Schafheuti's Bavarian collection, with all the Kressenberg types, also contains some very valuable material. Among the Echinodermata the following are especially worthy of notice: the Echinoidea from the Stramburger Schichten described by M. Cotteau: many of the best of the Asteroidea of Dr. E. Fraas' monograph: the *Echinopsis pusilla* redescribed by Dr. Ebert: a few of the types of Quenstedt's "Der Jura": of Prof. Dames' memoir on the Echinoidea of the Juras of the North-west of Germany, and most of the specimens from which were made the original illustrations in Prof. von Zittel's

great "Handbuch." The Solenhofen Echinoidea are represented by a series in the Haberlein collection and by the types of Bohm and Lorie's "Die Fauna des Kehlheimer Diceras Kalkes."

In other groups, the type series are not less important. Thus, in the Medusidæ, there are the specimens figured in Oppel's Beiträge, and in the memoirs of Häckel and von Ammon. The collection of Annelida include the most important of those described in Prof. Ehler's monograph, besides many types from the various general collections. The Crustacea are represented by an extensive series of important specimens: amongst others there are those described by Münster in his "Beiträge" and by Oppel in his "Mittheilungen," including some fine Isopoda and Cirripedia; also the Xiphosura used by Van der Hoeven in his "Recherches sur Limulus." The Sponge collection need hardly be mentioned, as Prof. von Zittel's work has for ever made it famous. The Brachiopoda and Mollusca include a miscellaneous series of types, as, e.g. many of those of Oppel's memoir "Ueber die Brachiopoden der unteren Lias," and of the various monographs of the "Geognostische Palæontologische Beiträge." The Cephalopoda include some remarkably fine specimens of the Belemnoteuthidæ and Chondrophora.

In addition to the general collection, which is classified zoologically, there is a supplementary stratigraphical series.

The Museum of the Bavarian Oberbergamt at 16, Ludwigstrasse, contains a collection illustrating the geology of that kingdom. The petrological collection is the most important feature in the Museum, containing as it does the rock specimens described by the Director, Prof. von Gümbel, in his "Die paläolithischen Eruptivgesteine des Fichtelgebirges," and his "Geognostische Beschreibung des Königreichs Bayern."

STUTTGART.

The Museum of the Würtemberg capital is especially famed for its Vertebrate treasures, and there is nothing among the Invertebrates that can equal in interest the great slab of *Aetosaur*. Nevertheless it is well worthy a visit, as it contains an extensive collection from the Jurassic and Triassic rocks of the neighbourhood. Here are to be seen many of the types of Quenstedt's last work "Die Ammoniten des schwabischen Jura," besides a few of those of the "Petrefactenkunde Deutschlands," as, e.g. his interesting *Ophiura ventrocarinata*. Some of the Crustacea figured by Oppel, the finest of the *Plicatocrini* that illustrate Prof. von Zittel's memoir, Eck's *Trichasteropsis cilicia*, and Münster's *Asterias wissmanni*, are among the most important of the Invertebrates. There is also the extensive collection made by the Director, Prof. Fraas, in Syria and Egypt, and including the types of Prof. Dames' memoir on the Crustacea. African palæontology is represented by the collections made by Baron Ludwig, Dr. Krauss, and Dr. Holub.

TÜBINGEN.

On the brow of the central hill of Tübingen, where the steep slope that rises from the Neckar passes into the platform that bears

the Stiftkirche and commands a wide view over the Jurassic rocks of Suabia, is the Museum that will ever remain as a monument to the memory of the late Prof. von Quenstedt. The collection is a most interesting one, and even Baedeker remarks that it "deserves attention," though he only mentions the big 24-foot long *Ichthyosaurus*, a fossil, however, which is dwarfed into insignificance by the clump of 70-foot *Crinoids*. It is unnecessary to refer to the special features of the Museum, as its contents may be summarized as the collection of Prof. Quenstedt, including the majority of the originals of the illustrations of his various works. To examine these every student of Jurassic palæontology must visit Tübingen, while the physical geologist cannot fail to learn much from a study of this, probably the best collection ever made to represent a fossil fauna.

HEIDELBERG.

Though there is little or nothing among either the Invertebrates or Vertebrates that would induce a palæontologist to visit Heidelberg, he may well be excused if he turn aside to see the great petrographical collection of Prof. Rosenbusch. Certainly, no geologist who goes to Southern Germany should fail to examine it. The collection illustrating rock metamorphism and the origin of the crystalline schists is especially noteworthy; all phases of this controversy are illustrated, from the Norwegian mica-schists with *Trilobites*' tails, to the disputed Nufenen Schiefer and the "spotted rocks" of Scopi.

BONN.

Like so many of the German Museums, that of Bonn has recently changed its quarters. The collections have been moved from the Poppelsdorf to the University, and they were still in the packing cases at the time of my visit. Goldfuss's collection and the second half of Sturtz's first series of Bundenbach Echinoderms are preserved here.

The stock of Herr Sturtz (No. 2, Riesestrasse) always contains some novelties, and is well worthy of examination.

In conclusion, it remains to again express my warmest thanks to those whose unvarying courtesy and kindness rendered my visit to the Museums under their care as enjoyable as it was instructive.

IV.—ON THE STRUCTURE AND STRATIGRAPHICAL RELATIONS OF RHOELL FAWR.

By GRENVILLE A. J. COLE, F.G.S., and

THOMAS H. HOLLAND, A.N.S.S., Berkeley Fellow of the Owens College.

IN a paper dealing with some phases of volcanic action in North Wales,¹ it was urged that contemporaneous eruptive rocks occurred on Cader Idris at lower horizons than the acknowledged base of the Arenig, although the actual vents from which they had arisen were lost and concealed under later accumulations. It was

¹ Cole and Jennings, "The Northern Slopes of Cader Idris," *Q.J.G.S.* vol. xlv. (1889), p. 437.