questions of the science, — Sir William Thomson's interesting speculations, founded upon physical phenomena, respecting the probable size of the atom; and Helmholtz's discussion of the relation of electricity and chemical energy; and the theory of the vortex-ring constitution of matter, thrown out by Sir William Thomson, and lately worked out, from a chemical point of view, by J. J. Thomson of Cambridge.

Another branch of chemistry which has recently attracted much experimental attention is that of thermo-chemistry, — a subject upon which, in the future, the foundation of dynamical chemistry must rest, and one which already proclaims the truth of the great principle of the conservation of energy, in all cases of chemical as well as of physical change. But here, although the materials hitherto collected are of very considerable amount and value, the time has not yet arrived for expressing these results in general terms; and we must therefore be content to note progress in special lines, and wait for the expansion into wider areas.

In conclusion, Professor Roscoe spoke of the part English chemists had played in the past, and of the marked difference between the data-gathering German work, and the systematizing of the facts known, which is going on in England. He also referred to what he considered the best method of educating chemists, — by giving them as sound and extensive a foundation in the theory and practice of chemical science as their time and abilities will allow, rather than forcing them prematurely into the preparation of a new series of homologous compounds, or the investigation of some special reaction, or of some possible new coloring-matter, though such work might doubtless lead to publication, — and called attention to the prominence of English industrial chemistry.

THE CORRELATION OF GEOLOGICAL FORMATIONS.[1]

THIS address was devoted to a consideration of a few remarkable exceptions to the rule that similarity of faunas and floras in fossiliferous formations throughout the surface of the world implies identity of geological age. Some interesting contributions have been made to this question by the geological survey of India, where Mr. Blanford's experience has been chiefly derived, and by the geologists of Australia and South Africa; and he first noticed a few typical instances, several of them Indian, in which the system of determining the age of various formations by the fauna or flora has led to contradictory results, and then showed where the source of error appears to lie. The famous Pikermi beds of Greece, a few miles east of Athens, contain a vertebrate fauna nearly always quoted as miocene; but they overlie strata with well-proved pliocene marine Mollusca. The Siwalik beds that flank the Himalaya north of Delhi are still classed as miocene by most European writers, but are regarded as pliocene by the Indian survey, on evidence found by tracing them west and south into Sind. The Gondwána system of central India, a great sequence of fresh-water beds probably of fluviatile origin, over 20,000 feet thick, is of unusual interest on account of the extraordinary conflict of paleontological evidence it presents to the observer. Its subdivisions are numerous, and vary in almost every place of occurrence. One (the Tálchir beds) contains rounded bowlders chiefly of metamorphic rocks up to six feet across, embedded in fine silt: others are characterized by an intermingling of floras and faunas that give rise to a mass of contradictions; beds with a Triassic fauna overlying others with Rhaetic or Jurassic floras. The Australian coal-measures and their associated beds present even a more remarkable instance of homotaxial perversity, a Jurassic flora being of the same age as a carboniferous marine fauna. Some of these beds (Hawkesbury) again contain transported bowlders, which occur once more in the lower members (Ecca beds) of the Karoo formation of interior South Africa. The latter presents a striking likeness to the Gondwána system of India. In both countries, a thick fresh-water formation occupies a large area of the interior of the country, whilst on the coast some marine Jurassic and cretaceous rocks are found; and as in India, so in South Africa, the uppermost inland mesozoic fresh-water beds are capped by volcanic.

Other examples of discrepancies in paleontological evidence might be given, but he would add merely a mention of the single case known to him in which the discordant records are both marine, namely, Barrande's 'colonies' in Bohemia; but here the discordance is much less than in the cases before cited, and moreover Barrande's conclusion is disputed by other observers.

In most of the cases he had named, the conflict is between the evidence of marine and terrestrial organisms. Manifestly one or the other of these leads to erroneous conclusions; and in making choice between the two, most geologists accept evidence of the marine fossils. The reason is not far to seek. So far as he was aware, no case is known where such an anomaly as that displayed in the Gondwánas of India has been detected amongst marine formations of which the sequence was unquestioned. Further, if we compare the distribution of marine with that of terrestrial and fresh-water animals and plants at the present day, we shall find a very striking difference; and it is possible that this difference may afford a clew to the conditions that prevailed in past times.

Wanderers into what they fancy unexplored tracts in paleontology are likely to find Professor Huxley's footprints on the path they are following. In his paper on the Hyperodopedon, he says: "It does not appear to me that there is any necessary relation between the fauna of a given land and that of the seas on its shores. . . . What now happens geographically to provinces in space, is good evidence as to what, in former times, may have happened to provinces in time; and an essentially identical land-

[1] Abstract of an address to the geological section of the British association at Montreal, Aug. 28, 1884, by W. T. BLANFORD, F.R.S., Sec. 7, G.S., F.R.G.S., president of the section.

fauna may have been contemporary with several successive marine faunae. At present our knowledge of the terrestrial faunae of past epochs is so slight that no practical difficulty arises from using, as we do, sea-reckoning for land time. But I think it is highly probable that sooner or later the inhabitants of the land will be found to have a history of their own."

When these words were written, more than twenty-four years ago, scarcely one of the geological details to which Mr. Blanford called attention was known. He need not point out how wonderful a commentary such details have afforded to Professor Huxley's views. But there is, he believed, an additional distinction between land and marine faunas, that requires notice. At the present day the difference between the land-faunas of different parts of the world is so vastly greater than that between the marine faunas, that if both were found fossilized, whilst there would be but little difficulty in recognizing different marine deposits as of like age from their organic remains, terrestrial and fresh-water beds would in all probability be referred to widely differing epochs.

Our present knowledge of the distribution of terrestrial and marine faunas and floras can be only briefly treated. Among mammals and reptiles, the marine forms are generally the most widely diffused. Fishes give better illustration: eighty families are typically marine, and twenty-nine are confined to fresh water; of the first, fifty are universally, or almost universally, distributed; while of the second, only one (Cyprinidae) is found in five of Wallace's regions, and not one is met with in all six. It is impossible to conceive a greater contrast. The distribution of land and sea Mollusca leads to a similar conclusion as to the relatively narrow range of the land forms. Throughout the marine invertebrata, but few generic types are restricted to particular seas: the majority are found in suitable habitats over a large portion of the oceans. Indeed, the marine provinces that have been hitherto distinguished are founded rather on specific than on generic distinctions. Botany offers a still more remarkable example: so uniform is the marine vegetation of the world, that no separate regions can be established in the ocean, while Drude makes fourteen on the land.

Mr. Blanford alluded to the evidence of the existence of land-regions in past times. Proofs are already accumulated of differences between the fauna of distant countries in tertiary times. The eocene, miocene, and pliocene Vertebrata of North America differ quite as much from those of Europe as do the genera of the present day; and there was as much distinction between the mammalia of the Himalayas and of Greece when the Siwalik and Pikermi faunas were living as there is now. The reptiles of the American Jurassic deposits present wide differences from those of the European beds of that age. But there is no reason for supposing that the limits or relations of the zoölogical and botanical regions in past times were the same as they now are. It is quite certain, indeed, that the distribution of land-areas has undergone enormous variations, whether the great oceanic tract has remained unchanged in its general outlines or not; and the migration of the terrestrial fauna and flora must have been dependent upon the presence or absence of land communication between different continental tracts: in other words, the terrestrial regions of past epochs, although just as clearly marked as those of the present day, were very differently distributed.

The idea that marine and terrestrial faunas and floras were similar throughout the world's surface in past times, is so ingrained in paleontological science, that it will require many years yet before the fallacy of the assumption is generally admitted. No circumstance has contributed more widely to the belief than the supposed universal diffusion of the carboniferous flora. The evidence that the plants which prevailed in the coal-measures of Europe were replaced by totally different forms in Australia, despite the closest similarity in the marine inhabitants of the two areas at the period, will probably go far to give the death-blow to an hypothesis that rests upon no solid ground of observation. In a vast number of instances it has been assumed that similarity between fossil terrestrial faunas and floras proves identity of geological age; and by arguing in a vicious circle, the occurrence of similar types, assumed without sufficient proof to belong to the same geological period, has been alleged as evidence of the existence of similar forms in distant countries at the same time.

It may perhaps have surprised some, that Mr. Blanford scarcely alluded to any American formations, and especially that he had not mentioned so well-known and interesting a case of conflicting paleontological evidence as that of the Laramie group. His reason was simply, that there were probably many present who were personally acquainted with the geology of the American cretaceous and tertiary beds, and who were far better able to judge than he of the evidence as a whole. To all who are studying such questions in America, he thought it would be more useful to give the details of similar geological puzzles from the eastern hemisphere, than to attempt an imperfect analysis of difficult problems in the great western continent.

THE PHYSIOLOGY OF DEEP-SEA LIFE.[1]

THE physiology of the deep-sea life has, until lately, received but little attention from professed physiologists. No one has yet set forth the numerous difficulties which are encountered, when the attempt is made to comprehend the mode in which the ordinary physiological processes of Vertebrata and other animals are carried on under the peculiar physical conditions which exist at great depths.

A knowledge of the conditions under which gases occur in a state of absorption in the ocean-waters

[1] Abstract of an address to the biological section of the British association at Montreal, Aug. 28, 1884, by H. N. MOSELEY, Esq., M.A., F.R.S., Linacre professor of human and comparative anatomy in the University of Oxford, president of the section.