THURSDAY, APRIL 25, 1889.

THE SURFACE OF THE EARTH.

Das Antlitz der Erde. Von Eduard Suess. Mit Abbildungen und Kartenskizzen. Erste Abtheilung, 1883: Zweite Abtheilung (Schluss des I. Bandes), 1885. (Prag: F. Tempsky. Leipzig: G. Freytag.) Zweiter Band. Mit 42 Text-Abbildungen, 1 Tafel, und 2 Karten in Farbendruck. (Prag: Wien. Leipzig: F. Tempsky, 1888.)

THE varied attainments of geographers have enabled them to express emphatic views on the scope of their subject. Each in turn has augmented knowledge of the earth's surface till it has become difficult to distinguish the contributions of mathematician and astronomer, physicist and physical observer, geologist and naturalist. Many geologists have been eminent as geographers, and Lyell and Humboldt gave the subject an enduring scientific importance by teaching the effects of geological causation in shaping the earth's surface. Every geologist is aware how the light of geological structure illuminates the problems of mountain form, position, and relation to surrounding land; but never till now has an author attempted to narrate the geographical story and history of the earth's surface from a geological point of view. Prof. Suess has brought to the subject the qualifications of a great teacher, who realizes that science has a duty to make itself available to the unlearned, no less than to aid the researches which are yet to be made; and he has conceived of the earth's surface in a new, forcible way, which stimulates alike imagination and thought, and lays before the reader a wide knowledge of fact. This work, which we know has occupied the author for the past twelve years or more, can scarcely be judged of as a whole, because the third volume, whose subject gives a title to the treatise, is unpublished; but we may say that a more luminous and profound endeavour to place the elements of scientific geography before the general reader has not been made. We may perhaps think the subjects discussed need the aid of more figures to enable the reader to think as the author thinks, and attain a similar command of his facts. The aim of the work is to lead the reader through a consideration of the movements in the outer layers of the earth's crust which are manifested at the present day, and in the first half of the first volume the more striking phenomena are narrated, which are associated with volcanic disturbance and earth movements. The second part of the volume examines the structure and construction of mountain chains. The author naturally takes the Alpine system first, as nearest to the Austrian people, and then treats of the depressions, like the Adriatic and Mediterranean, associated with the prolongations of the Alpine system. Successive chapters tell the story of the mountain structure of Southern Africa and the Sahara, of Central Asia and the Malay Islands, and of the mountain systems of America and the West Indies. Thus, by raising the mountain chains, the author leads up, in the final chapter of the first volume, to a discussion of the nature and origin of continents, no less than of their relations to the seas from which they emerge.

The introduction is an introductory lecture, not written like a syllabus, for that is given in the table of contents, but designed to introduce the reader to conceptions of a large kind on which the scientific aspects of geography are based. The distribution and forms of land masses and depths of the oceans are shown to be effects of movements of the earth-rind which have varied through successive geological ages and so changed the distribution of life.

The work begins with an exposition of the Flood and ancient Babylonian cosmogonies, and the author states that the Deluge was connected with the lower Euphrates and flooding of the low land of Mesopotamia, owing probably to an earthquake combined with a cyclone from the south. The interest of the unlearned reader is thus insured. An excellent account is given of earthquake phenomena, followed by a chapter on "Dislocations," which are defined as resulting from decrease in the volume of the earth, and as comprising horizontal and vertical movements. The crumpling, contortion, and folding of the rocks of mountain masses is classified as consequent on tangential thrust, sinking, and the combined effects of these actions. Volcanic phenomena occupy the next chapter, and are regarded as dependent on the formation of radial fissures. These general studies completed, we turn in the second part of the first volume to the mountains of the earth. The Russian table-land is described as consisting of granite in Finland, on which rest Silurian and Devonian, and successively newer rocks stretching under the Carpathians; but it is uncertain whether the newer rocks of this plain extend under the Bug. The Sudetic Alps are described as closely linked in origin with the Russian table-land and the Carpathians. The Franconian-Suabian basin follows, and leads to a discussion of the system of the Alps, which is regarded as beginning with the Carpathians, as curving south with the Jura, being prolonged south-east with the Apennines, and then continued west through North Africa to the pillars of Hercules. The plain of Hungary is compared to the eastern half of the Mediterranean. The Adriatic basin is closely connected with the Plain of Lombardy, both being defined by the Apennines, which, though at one time independent of the Alps, have now become connected with them. These mountains rise in an unbroken, steep curve facing those depressions, and looking like an outer border of the Alps thrust up above the level of the deep-lying basins. The history of the Mediterranean Sea is illustrated by the newer Tertiary deposits and the life which they contain. At first the sea reached the central plateau of France, the valley of the Rhone, Styria, Switzerland, Hungary, and Transylvania, stretching east to the source of the Euphrates and Northern Persia. The second phase of the Mediterranean was excluded from Switzerland and the valley of the Danube, and extended over the Russian plateau to Kherson and into Asia Minor. Later still it filled the valley of the Rhone, and approximated to its present outline, being excluded from Asia Minor; but the Ægean Sea was a fresh-water lake. The distribution of these deposits in North Africa is shown by means of a map in the chapter on the Sahara and Egyptian deserts; and evidence of the antiquity of the fauna of the Nile is found in the distribution of its life in Syria and Arabia. The author now passes to South Africa, the Indian peninsula, and Madagascar, which have the characters of a table-land which was once continuous, and from their geological history the sediments are derived which constitute the Cretaceous and Tertiary rocks of the Sahara and Arabia. The high land to the north of India is fully described, chain by chain, in the details of geological structure which govern their forms and continuity, leading to the volcanic regions of Java and Sumatra. There appear to be four great curves southward, seen in the Iranian chain, Hindu Kush, Himalayas, and the Malayan chain. The connection between the mountains of Central Asia and Europe is traced on the basis of the distribution of Tertiary strata : all the European mountains are regarded as continuations of chains which extend from the Thian Shan group. The continuity here sought to be established would appear to depend not less on the evidence of denudation than upon stratigraphical proofs of contemporary folding. The author, for example, carries the line of Cyprus through Crete into the Dinaric Alps, while the chain of the Caucasus passes through the Crimea and Balkans by Ovsova into the Carpathians ; but these curved lines seem to us rather the results of denudation of folded rocks than an indication of the directions in which the lines of folding were prolonged.

Three chapters are devoted to North and South America and the West Indies, treating of the rock-structure and folding of the earth-rind in the same way as in other parts of the globe. The rind appears to the author as more plastic or more symmetrically bent than we have been accustomed to regard it, insomuch that he everywhere finds the chains curved, whereas we often find them extending at angles to each other. The volcanoes of the West Indies are found to have the same relation to the main chain as have those of the Apennines and Carpathians, being on the inner side of the arch. And the Caribbean Sea is further compared with the western part of the Mediterranean.

The second volume is devoted to the oceans, and commences with an historical account of views held by successive investigators on the displacement of the shore-line. Three lines of investigation suggest themselves : first, the changing distribution of the seas in successive periods of time, which may be furnished by evidence of shore-lines and sea-margins ; secondly, by comparing the areas of deposition of sediments in past time, some idea is obtained of the ancient oceans ; and thirdly, by studying existing shores, evidence is found of oscillations in level. Beginning with the great waters of the present time, a detailed history is given of the Atlantic. Its shores are described, especially in the northern regions, and the mountains which extend towards the European coast are traced, and said to be paralleled by chains on the other side of the Atlantic, so that the old rocks of Ireland, Cornwall, and Brittany, appear to extend beneath the ocean. The west coast of Africa, and shores of Central and South America, are similarly described and compared in the light of their geological structure. The Serro do Mar in South America is regarded as comparable with the Appalachian chain, and hence it follows that the entire American continent is the consequence of a tangential thrust towards the Pacific Ocean. The history of the Pacific Ocean begins with the shores of New Zealand and Australia, but the author avails himself of the fossil floras and other evidences to indicate ancient relations of the strata with the corresponding rocks of Europe, India, and other localities. The line is followed on through New Ireland, New Caledonia, Borneo, Cochin China, Tonquin, the Philippines, and Japan, and so by the Kurile and Aleutian Islands to the west coast of America, everywhere dwelling on the light thrown by the geological structure of those countries upon the variations in extension of the sea. The Atlantic and Pacific are compared with each other, and found to have many points of structure in common. The foregoing evidences of change in ancient oceans furnished by the rocks seen on their borders, necessitate a history of geological changes in the Palæozoic, Mesozoic, and Tertiary periods of time. In a chapter on Palæozoic oceans, it is stated that they make us aware of two continents which now only remain in fragments. The first occupied the North Atlantic Ocean, furnished the ancient sediments of Europe and America, and its remains persist as Greenland. The second continent is first recognizable at the end of the Carboniferous period. Its relics persist in Africa, India, and Australia. As the former is known as Atlantis, so the latter is named Gondwanaland. No seas of the Mesozoic period have left sediments which indicate great depth of water. The chalk alone may be evidence of a deep ocean, which stretched from Europe towards the West Indies in a yet earlier time. Towards the close of the Cretaceous period the seas became smaller. In North America the prairie lands from Canada to Texas and Alabama emerged from the water, and similar upheaval is seen in Europe, and especially evidenced in the freshwater strata of the Pyrenees and Southern France, which make a transition from the Cretaceous to the Tertiary, like that shown by the Purbeck beds in early strata.

These earliest shallow conditions in Tertiary Europe were succeeded by a central sea which reached far to the east, and is estimated to have spread from London to Khartoum, and from Kiew to the Indian Ocean. And the author sketches with a bold hand the succession of physical conditions changing the breadths of water which have resulted in the contours of existing shore-lines in America and the Old World.

Evidences of the changes which have occurred in the contour of existing shores are found in detailed study of the coasts of Norway, and the inland terraces, which mark earlier extent of the sea and glacial action. Other evidences of instability of the shore-line are recorded with similar detail on the coasts of Italy. And the history of the Baltic and North Sea emphasize the mutability of shores. The historical records of the Mediterranean shores supply, especially in its eastern parts, striking proofs of oscillation in Greece, Syria, Egypt, and Asia Minor. The northern shores of the world supply many proofs that at the close of the Glacial period the shore-line was more elevated than it is now. An examination of the shores of the equatorial and southern seas demonstrates the former wide spread of deposits in which the life is substantially the same as in the nearest oceans, though there is sometimes, as in South America, a larger number of European species.

Finally, a summary is given of the characteristics and geological history of the oceans which have been described. The southward direction of peninsulas is attributed to folding of the earth's crust, and to depression of the ocean floor, which has caused the water to predominate towards the south, so that they are always in relation to areas of depression. It will thus be seen that, in simplicity of conception, largeness and continuity of the ideas dealt with, amplitude and detail of the knowledge and inductions brought together and correlated, this work promises to be one of the most valuable contributions to the history of the earth which we possess. From the time when Godwin-Austen planned his work on the ancient physical history of Europe which geology supplies, data have been accumulating with a rapidity which has made the task almost hopeless, of writing a history of the earth's surface which should be at once exact in details and large in ideas. But Prof. Suess does not so much trench on geological history, which can only be told intelligibly when supported by masses of technical facts; for his aim is to impart vitality to learning and teaching of those phenomena with which the geographer is concerned. It may be too much to say that he attempts to do for the surface of the earth what Darwin did for the distribution and classification of life, because so much had been previously contributed with which his own work is in perfect harmony; but we may say that henceforth no geographical teacher can neglect to place before his pupils the methods and results which the author's work brings to his hand. And we may anticipate that much as Lyell's treatise, the "Principles of Geology," has laid the firm foundations of geological thought and of scientific observation in geographical science, so this treatise appears likely to mark a similar epoch in the history of geography, becoming a guide to its principles for students and readers.

It is significant that it is the outcome of long experience, first as Professor of Palæontology, then as Professor of Geology, on the part of one who has given many of the best years of his life to the endeavour to make practical application of geological knowledge in improving water-supply and navigation of the earth's surface which surrounds Vienna. The same thoroughness and devotedness with which these earliest of his public works were done are seen in this latest contribution to education; and we cannot but see that geography, as Prof. Suess teaches it, is a science based upon the sciences which he has himself professed, though expanding in its ultimate developments to include that knowledge which the naturalist and the observer of Nature record. Every chapter is followed by a long bibliography, in which the reader finds the more important original sources of information with which the writer has refreshed his memory; and the beautiful drawings and engravings scattered through the volumes will be not less welcome to the earnest student as presenting typical examples of the geological foundations of geographical truths seen on the earth's surface.

H. G. SEELEY.

NATURAL INHERITANCE.

Natural Inheritance. By Francis Galton, F.R.S. (London: Macmillan and Co., 1889.)

IT is related that, when some boastful patriot was once describing the trees in his country as so high that a man could hardly see their tops, a stranger retorted: "That is nothing to the trees in my country, which are so high that two men are required to see the top of them; one man looks as far as he can, and the other begins where the first stops." A similar division of labour would be required in order to survey adequately the imposing scientific edifice which Mr. Galton has constructed; based as it is on a foundation of geometrical reasoning, and culminating in the clouds of biological hypothesis. The parts which are nearest to *terra firma* are most within our ken. The mathematical foundation and the structure which rests immediately thereupon appear to us solid and elegant. The author has restated the law of error in a form adapted to sociological investigations. He says truly and happily:—

"This part of the inquiry may be said to run along a road on a high level, that affords wide views in unexpected directions, and from which easy descents may be made to totally different goals to those we have now to reach."

Mr. Galton reads a useful lesson to statistical practitioners, when he complains that they limit their inquiries to averages, without taking account of those deviations from the average which are the subject of the theory of errors.

"Their souls seem as dull to the charm of variety as that of the native of one of our flat English counties, whose retrospect of Switzerland was that, if its mountains could be thrown into its lakes, two nuisances would be got rid of at once."

Mr. Galton is not dead to the charms of "normal variability." Statistical theory illustrated by him becomes in a high degree fascinating:

"Not harsh and crabbed as dull fools suppose."

He may well say:

"Some people hate the very name of statistics, but I find them full of beauty and interest."

Some of his riders on the law of error may be interesting even to physicists. The following problem is not so familiar to astronomers, but that Mr. Galton's solution of it may deserve attention. Given three or four observations relative to an unknown quantity; and again another small group of observations made on some other quantity by the same instrument or method of observation; and so on, each of the different little groups not in general comprising the same number of observations: find from the residuals, or apparent errors, presented by the respective groups, the true "probable error" incident to the method of observation. Mr. Galton gives four solutions of this problem, of which two involve data which are special to his subject; two may be described as general. Neither of the latter coincides with the theoretically best possible method; but the consilience of their results with each other and with the other two methods is interesting.

We have worded the problems in terms of *errors*. The form in which it presents itself to Mr. Galton relates rather to the deviations of individuals from their common type. He is determining the "probable error" or dispersion of the heights of brothers compared with their mean. It proves to be much less than the corresponding constant for the adult population generally. The question arises in the course of an inquiry whether the mean height of brothers and sisters deviates from the general average of adults less than the height of their parents. There is a little difficulty in stating the question owing to the difference in the mean stature of the sexes. Mr. Galton gets over this difficulty by multiplying all his female data by a proper constant—pushing them up, so to speak, to the male standard. Upon this understanding, suppose that the mean height of the father and the "transmuted" mother—the stature of the "mid-parent" in Mr. Galton's phraseology—differs from the mean height of the general population by say three inches. Then the mean height of the sons and "transmuted," or pushed up, daughters, is most likely to be not three inches, but two inches. The constant of "regression" is determined with equal precision for other relationships. A general idea is obtained of the extent to which the peculiarities of an individual are likely to be shared by his kith and kin.

It is not easy in a few words, or perhaps in any number of words unaccompanied by symbols, to do justice to the cogency and precision of this anthropometrical reasoning. The manipulation to which Mr. Galton's materials have been subjected by one of his mathematical coadjutors, Mr. Hamilton Dickson, fully attests their consistency and strength. Some additional corroboration may be afforded by the following considerations. The probable error or dispersion for the statures of adult men, which Mr. Galton has extracted from the family records submitted to him, is identical with, or differs only by a fraction of an inch from, the constant furnished by many other sets of measurements. The value here obtained for this constant is 1·7 inch. The same value is obtainable from the measurements made by Mr. Galton for the British Association. The same value has been obtained by Signor Perozzo for the whole of Italy, and for each of its provinces. The agreement of observations made under such different circumstances is calculated to give us confidence in the higher theory of anthropometry. The result which has been thus verified may be used to confirm Mr. Galton's reasoning at several points. Any scruples which he may suggest as to the discrepancy in the values of mean stature determined from his different records are removed by a consideration of the error or diversity to be expected among these results. Again, consider those tables in which Mr. Galton compares the heights of a number of persons with the mean height of their children or brothers, in which it is shown, for instance, that men of the height 71·5 inches have brothers averaging 70·2. That all the entries point in the same direction—namely, that of "regression"—is in itself adequate evidence of that fact. But not only are the faggots strong in their union, but also each individually is possessed of considerable strength. Thus, the discrepancy which we have just noticed between the height of a man and the mean height of his brethren, namely, 1·3 inch, is founded on eighty-eight instances. The chances against this degree of divergence occurring by accident are some hundreds to one. The odds that the appearance of law which the tables present is not accidental are immensely increased by this consideration. We should be curious to know whether Mr. Galton's experiments on the "regression" of sweet peas would admit of this sort of corroboration.

The human stature is a subject particularly well adapted to Mr. Galton's exact methods of measurement. Length admits of more exact gradation than the so-called secondary qualities. To arrange in a regular scale the colours of eyes which are variously described as dark blue, blue-green, hazel, and so forth, is a delicate task. How far Mr. Galton has triumphed over this imperfection of his data, it must be for specialists to decide. The student of probabilities cannot doubt that the correspondences between his observations and his calculations are indicative of a real law. The coherence of the table in which he compares fact and theory as to the number of light-eye-coloured children born to parents of various eye-colours cannot possibly be accidental. Ill-adapted as eye-colour may be to exact measurement, it is a more satisfactory quality to deal with than "the artistic faculty." Can we suppose that the compilers of the different family records which Mr. Galton has analyzed have employed at all similar standards, when they applied the epithets "artistic" and "non-artistic" to their relations? Our misgivings increase when we go on to apply the calculus to the returns as to disease which are obtained from the family records. To arrange parents and children in a graduated scale of "consumptivity," upon the testimony of unprofessional relatives, seems precarious. The author himself abandons the use of the more delicate methods when he goes on to consider "good and bad temper." He has not, however, shrunk from dividing into five degrees or classes some sixty shades of temper ranging from "amiable" and "buoyant" to "surly," "uncertain," "vicious," and "vindictive."

We ascend into a region of hypothesis when we speculate on the causes of the phenomena which have been evidenced. The attention of biologists should be called to Mr. Galton's views on "particulate inheritance," "latent characteristics," and the stability of organic forms. The conceptions which he has formed as to the processes of heredity are placed by him in a variety of lights, and illustrated by many happy analogies. "Appropriate and clear conceptions," it has been well said, are essential conditions of science. Mr. Galton has done much to make his abstract ideas clear, but are they also appropriate? This is a question upon which, perhaps, only a few specialists are competent to advance an important opinion; and their authority is liable to be impaired by the prejudices incident to an exclusive line of research. We shall be slow to accept adverse criticism from any whose studies may not have qualified them to appreciate the support which Mr. Galton's theories receive from his masterly use of the calculus of probabilities.

F. Y. E.

NATURE'S HYGIENE.

Nature's Hygiene: A Systematic Manual of Natural Hygiene, containing a Detailed Account of the Chemistry and Hygiene of Eucalyptus, Pine, and Camphor Forests, and Industries connected therewith. By C. T. Kingsett, F.I.C., F.C.S. Third Edition. (London: Baillière, Tindall, and Cox, 1888.)

THIS book aims at being a systematic manual of natura hygiene. The introductory chapters deal in a popular manner with chemical principles and chemical changes, leading up eventually to questions affecting the chemistry and hygiene of the atmosphere, of water, of sewage, and of numerous other subjects supposed to be included within the domain of natural hygiene. The second part of the book is devoted to what are called the sanitary properties of Eucalyptus-trees, of pine-trees, and of camphor forests. At first sight the general character of the work impresses the reader favourably. He is disposed to read it for the sake of acquiring information on subjects which force themselves on public notice in every large town. These are: the purification of water; the relations existing between micro-organic life and the so-called infectious or contagious diseases; the measures to be adopted for the disposal and treatment of sewage, and the relative value of certain antiseptics and disinfectants. The author devotes to these subjects numerous pages of information more or less relevant to them. At p. 217, however, the author arrives at the matured conclusion that "the only disinfectant which, while possessing all these characters, also acts upon anaërobic and aërobic forms of life alike, of which I have knowledge, is that known as ——, for the existence of which I am proud to take credit." Besides this disinfectant, there is an equally good "fluid," an equally good "oil," and an equally good "powder," for all of which, no doubt, the writer has also pride in taking credit. There are in all some thirty references to these specifics.

The concluding chapters, in which *Eucalyptus globulus* and other species of Australian gum-trees are credited with wonderful powers as "fever-destroying trees" on account of "the aromatic vapours which emanate from the trees, and the preservative powers of the branches and leaves which fall on the ground," repeat a well-known but scarcely established doctrine of hygienists. It is probable that any fast-growing tree, suited for swampy districts, would produce exactly the same or similar results. But, granted for the moment that the essential oil given off in a vaporous condition from Eucalyptus or pine-trees is disinfectant in character and conducive to health, we fail entirely to see how this can apply also to camphor-trees. Yet we are told that "the natural history of camphor forests affords us another and remarkable feature of Nature's hygiene; . . . that atmospheric oxygen is constantly being absorbed by the essential oils that are continuously evolved into the air, and this simple process gives rise to the production of a number of active chemical substances, including peroxide of hydrogen and soluble camphor, all of which purify the air and enhance the healthful influences of the climate." Those who are at all acquainted with camphor-trees will admit that this is a very fanciful picture indeed. In common with most members of the *Laurineæ*, the emanations from camphor-trees are neither agreeable nor balsamic. The author brings no evidence whatever to establish his position, and we beg leave to doubt the healthful influences of camphor-trees on the grounds stated until we have something more tangible than the mere assertion of the author of this work.

OUR BOOK SHELF.

Elementary Inorganic Chemistry. By A. Humboldt Sexton, F.R.S.E., F.I.C., F.C.S. (London: Blackie and Son, 1889.)

THE chief part of this manual of 320 pages is specially prepared for students who are guided by the elementary division of the Syllabus of the Department of Science and Art. In addition there are twenty-five pages about the metals and their compounds, a chapter of nine pages on what is called "Organic Chemistry," twenty-three pages of "Experimental Illustrations," a chapter on "Chemical Arithmetic," a series of questions, an "Elementary Course of Qualitative Analysis" occupying thirty pages, and a few less important matters.

The main part of the book is pretty much what one is accustomed to in elementary treatises: it is clear and calculated to be useful; but the chapters on the metals and on organic chemistry are obviously meagre to a degree. The organic part deals with those substances mentioned in the alternative course of the above-mentioned Syllabus, but it would have been much better for the book and the students who use it if these few pages had been omitted. The analytical course refers to eight metals and four acids. It is not stated why these substances are specially favoured.

It is a pity that those who write on a subject like elementary inorganic chemistry, which has been so prolific of text-books that practically speaking no exertion or thought is needed in the selection of topics or the manner of their treatment, should not more often concentrate a little attention upon the exactness of their expressions. The statement, for example, that "If hydrogen and oxygen or air be mixed, and a light be applied, they will combine with a violent explosion," is open to much censure. Do hydrogen and air ever combine? Will a mixture of hydrogen and oxygen as a matter of course explode under the circumstances described? Again, the statement that "Potassium and sodium only expel one-half of the H from water" may be legitimately described as untrue. The equation "$Na + H_2SO_4 = NaHSO_4 + H$" is more likely to deceive than instruct the student. These are not isolated examples.

A Class-book of Geography. By C. B. Clarke, F.R.S. (London: Macmillan and Co., 1889.)

THIS is a new and revised edition of Mr. Clarke's well-known class-book of geography, which was first published in 1878. The populations of towns have been brought up to date, as also the political geography of Egypt, Turkey, &c. The names of places which have lately become of importance in consequence of commercial enterprises, such as Baku, have also been added. Perhaps the most important addition, however, is a chapter on astronomic geography, which is very clear, though necessarily not very detailed. An excellent outline of chartography has also been added. The particulars given relating to each country are of the usual character. They include an historical sketch of each country, manufactures, minerals, animals and plants, languages, religions, and forms of government. At the end of each section is a condensed statement of the principal features of each country. A short description of the different races of animals might have been given with advantage, as at present the student can only gatner the meanings of such terms as "Pachyderms" and "Chiroptera" from the examples quoted. The omission of the word "species" in such a sentence as: "England possesses one *dormouse* and one *squirrel*," is rather apt to make one inquire as to the location of those favoured animals.

There are eighteen excellent double-page maps, but of course they are not so full of detail as is necessary for a complete study of the subject. This, however, is no great drawback in these days of cheap atlases.

Travel-Tide. By W. St. Clair Baddeley. (London: Sampson Low, 1889.)

THE writer of this volume has visited many different parts of the world, and here he sums up the impressions produced upon him by the most remarkable of the scenes with which he has made himself familiar. There is nothing of strictly scientific interest in the book; but we may say that Mr. Baddeley has the great merit of always trying to see things with his own eyes, that in his judgments of men and places there is no trace of any kind of British prejudice, and that his style is fresh and interesting. Among the subjects of which he has something to say are Bulgaria, Buenos Ayres, Constantinople, and Tunis.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Large Fireball.

ON the night of Monday, April 15 last, at 12h. 26m., a meteor of very exceptional proportions was observed from many parts of the country. The full moon was shining at the time, and near its meridian passage, but the brilliancy of the fireball was such that it vividly illuminated the sky and landscape with a flash which many people mistook for sheet lightning. Several observers describe the meteor as larger and considerably more brilliant than the moon, and at Swindon and Ramsbury a detonation was heard. At the former place the meteor "appeared so close that people thought it descending upon the town; it startled the rooks out of the trees, and suddenly illuminated the country round like the electric light."

At Worthing the meteor is described as falling almost perpendicularly from west-north-west to due north. At Clapham it seemed to take a slanting course from the south towards the west. At Bath the meteor was seen in the east moving horizontally, at a considerable altitude, from right to left. Probably therefore the body was situated over the region of Berks, but the data are altogether too imperfect to admit of trustworthy inferences either as to its position or height above the earth's surface.

It will be important if other observers can furnish accounts in which the position and direction of this fireball are more definitely given. The phenomenon was clearly one of uncommon character, but its apparition occurred at such a late hour that comparatively few persons must have witnessed it.

Bishopston, Bristol, April 20. W. F. DENNING.

Variable Stars and the Constitution of the Sun.

IN NATURE of March 21 (p. 492), Mr. A. Fowler has given an excellent account of my theory of the constitution of the sun, but he has not succeeded so well in describing my theory of the variable stars. I may here draw attention to some of the cardinal points not sufficiently noticed by Mr. Fowler:—

(1) The proof that the chemical combination at the external layers of the stars must be intermittent with regular intervals. This proof, pp. 8, 9, and 10, is mentioned as the very basis of my theory of the sun and stars.

(2) The fact that the intermittent eruptions of heat, if produced in this manner, cannot become visible through some perceptible increase of the heat of the star.

(3) The high probability that in the case of some red stars the vapours, noticed by the spectroscope in their external layers, are cooled to their dew-point, and so, with the smallest radiation of heat, are made ready to change into clouds, which suddenly withdraw the invariable inner light from our view.

(4) The high probability, too, that only those stars will be variable in which the external layers are cooled down to their dew-point, and that the intermittent eruptions of heat become visible because at intervals they cause the evaporation of the clouds, which surround the invariable inner light of the star during the minimum.

Therefore only those stars of Class III. will be variable, whose external vapours are cooled to their dew-point. The others also have their periodical eruptions of heat, but these are inperceptible to our eye.

The changes of the variable stars, therefore, are never associated with important changes of temperature. It would be possible for them to take place without the least change of temperature if the calories produced by an eruption of heat were entirely used for the evaporation of the clouds. And so even an increase of temperature of 1° would be sufficient to make a seemingly extinguished orb glitter again as a new star, whilst a similar decrease of temperature would suffice to restore the veil, which, steadily growing thicker, would make it invisible again, perhaps for centuries together.

Mr. Fowler is mistaken in saying that I do not seem to be aware that Algol is one of the hottest stars in the heavens, and that its spectrum is the same at maximum as at minimum. On the contrary, on p. 15, I have stated the exceptional case of Algol, and, seeing the impossibility of making it agree with my theory as in the case of those Algol-stars which are red at minimum, I ascribed the variability of Algol to the periodicity of its spots. Moreover, I added that this seeming contradiction to my theory was only a physical peculiarity of little importance. For the spots, too, are caused by periodical eruptions of heat in clouds. The only difference is that the clouds—I mean on the sun and Algol—are photospheric, and by vaporization cause dark spots which diminish the light, whilst in the cooler red stars, the clouds form a dark veil round the star, and therefore by vaporization increase its interior light.

In this defence of my theory, gradually passing from the variable stars by means of Algol to the sun, I must observe that my theory by no means suggests, as Mr. Fowler thinks, that the sun should have more spots in the Polar regions than near the equator. I only say that the spots must be found in parallel zones; of the breadth of those zones I say nothing. The spots can only be produced in places where the temperature and the chemical compositions work together to produce eruptions of heat. As the places of equal chemical composition and of equal temperature are only possible in the photosphere in two parallel zones of equal latitudes on opposites sides of the equator, it is plain that the spots must be produced there.

I conclude with an expression of gratitude to the Editor of NATURE and to Mr. Fowler for the trouble they have taken in noticing my theory. A. BRESTER, Jz.

Delft, April 1.

IN reply to Dr. Brester I have to remark, in the first place, that I made no attempt to give all the details of the theory, limitations of space not permitting. One of my principal arguments against the theory was that, if it were true, *all* cool stars should be variable, and I still see no reason to alter my views. The observations of the red stars by Dunér show that the spectra of some of the stars which are not variable are identical with some of those which are. For example, the spectra of 120 Schj., and D.M. $+47^{\circ}2291$, which are not variable, are exactly like those of χ Cygni and R Leonis. The *compositions and temperatures* of the gaseous surroundings of these bodies are therefore similar, and there is no reason, from Dr. Brester's point of view, why one should be variable more than another, since, if they are cooling, they all start cooling under exactly equal conditions. (It may fairly be assumed that the spectra of the variables have been generally taken at maximum.) The cooling to dew-point is therefore not in question in the variable any more than in the apparently invariable stars.

The high probability that by far the greater number of variables are uncondensed meteor-swarms which are increasing in temperature, as demonstrated by Mr. Lockyer, is also obviously against any theory of variability which assumes a state of cooling.

The same objections which apply to the red stars apply also to the "unimportant" case of Algol; there are many other stars with identical spectra, and therefore temperatures, which exhibit no variability at all.

With regard to the sun, I remarked that the theory would suggest that spots should be most numerous at the poles, for the reason that it would be there where the atmosphere in the neighbourhood of the sun would be coolest, and where, therefore, chemical combinations would be most likely to take place. To this Dr. Brester replies that his theory only requires that spots should be formed in equal zones on opposite sides of the equator, and says nothing about the breadth of the zones. Of course, if it be assumed that the substances present in Polar regions are not such as to form combinations competent to produce spots, the difficulty is overcome, but an explanation depending upon such an assumption is far from satisfactory.

London, April 5. A. FOWLER.

Tertiary Chalk in Barbados.

In a previous communication (Nature, February 14, p. 367) we called attention to the series of oceanic deposits in Barbados, of which the well-known Radiolarian earth (or Polycistina marl) forms a part. We stated that these deposits had a wide extension, and were of variable composition, some being much more calcareous than others; and further that they formed an independent series, resting unconformably on the older clays and sandstones which are supposed to be of early Tertiary age.

Since the date of our former note, we have examined many sections along the outcrop of the deposits, and find that the varieties which we had noticed fall into a natural succession, the calcareous earths lying principally at the base, though in the northern part of the island there is a development of similar beds at the summit. The total maximum thickness is about 200 feet, and the series contains many interesting varieties of rock. We hope to describe these at length, and to lay our results before the Geological Society, but as some time must elapse before this can be done, we write at once to place on record the fact that some of the beds have all the essential characteristics of typical (Cretaceous) chalk.

We have samples which consist of from 80 to 90 per cent. of calcium carbonate, which give the usual white streak of chalk, which contain Foraminifera in abundance, and have a minute structure which can hardly be distinguished from that of certain portions of the English chalk. A thin slice examined under a 1-inch objective shows many Foraminifera distributed through a matrix which under this power appears to be amorphous; the Foraminifera are chiefly Globigerinæ of the thick-shelled type similar to that figured in Carpenter's "The Microscope and its Revelations," sixth edition. Examined under a higher power the matrix can be resolved into definite particles, among which can be distinguished many forms identical with the so-called crystalloids of the chalk. Our friend Mr. W. Hill, to whom we sent a specimen of this Barbadian chalk, says it presents a very close analogy to our English chalk. Other samples combine the characters of chalk and Radiolarian earth having a calcareo-siliceous matrix containing a mixture of Radiolaria and Foraminifera.

We believe that the Barbadian deposits were formed on the floor of the Atlantic previous to the upheaval of the Caribbean Islands, and this conclusion is strengthened by the fact that similar Radiolarian earths occur in Trinidad and Hayti. We find too that the late Dr. Carpenter remarked that if the modern oceanic oozes were uplifted they would form deposits similar to the Barbados earths ("The Microscope and its Revelations," sixth edition, p. 602).

We wish to correct one paragraph in our former letter, in which we tacitly assumed that the Caribbean Islands were originally part of the American continent, and were therefore continental islands; we are now disposed to regard Barbados at any rate as an oceanic island, and believe that it has never been connected with South America since its upheaval as an island. Colonel Feilden has collected some evidence on this point which we hope he will shortly publish. We may state that the nearest island to Barbados (St. Vincent) is one hundred miles to the west, and that the intervening sea is more than 1000 fathoms deep.

But whether classed as an oceanic or a continental island, the rocks of Barbados are equally interesting to the physical geologist, since they give proof of a complete interchange of continental and oceanic conditions in Tertiary times; for the underlying sandstones and shales imply the close proximity of a continent during their formation, while the chalky series proves the subsequent conversion of this shallow sea into an oceanic area. Moreover, the existence of both sets of rocks now at the surface is entirely antagonistic to the prevalent theories respecting both continental and oceanic islands.

A. J. Jukes Browne.
J. B. Harrison.

April 22.

A New Mountain of the Bell.

I have just returned from a journey of four weeks in the desert of Mount Sinai, made with the especial object of studying the *Jebel Nagous* in connection with the joint researches of Dr. Alexis A. Julien and myself on "musical sand." The "Mountain of the Bell" is situated on the Gulf of Suez, about four and a half hours from Tor by the roundabout camel route. It was first described by Seetzen in 1808, since which time it has been visited by Ehrenberg, Gray, Wellstedt, Rüppell, Ward, Newbold, and the late Prof. Palmer, as well as by large numbers of pilgrims. My observations confirm in the main their accounts of the acoustic phenomena heard, but my measurements differ widely from those of all the travellers save Prof. Palmer.

The name Jebel Nagous is given by the Bedouins to a mountain nearly three miles long and about 1200 feet high, composed of white sandstone bearing quartz, pebbles, and veins. On the western and northern sides are several large banks of blown sand, inclined at high angles. The sand on one of these slopes, at the north-west end of the mountain, has the property of yielding a deep resonance when it slides down the incline either from the force of the wind, or by the action of man. This bank of sand I distinguish from the others by calling it the *Bell Slope*. It is triangular in shape, and measures 260 feet across the base, 5 to 8 feet across the top, and is 391 feet high. It has the high inclination of 31° quite uniformly. It is bounded by vertical cliffs of sandstone, and is broken towards the base by projecting rocks of the same material. The sand is yellowish in colour, very fine, and possesses at this inclination a curious mobility which causes it to flow when disturbed, like treacle or soft pitch, the depression formed being filled in from above and advancing upward at the same time. The sand has none of the characteristics of sonorous sand found on beaches. When pulled downwards by the hands or pushed by the feet a strong vibration is felt, and a low note is plainly heard resembling the deep bass of an organ-pipe. The loudness and continuity of the note are related to the mass of sand moved, but I think that those who compare it to distant thunder exaggerate. The bordering rocky walls give a marked echo, which may have the effect of magnifying and prolonging the sounds, but which, as I afterwards demonstrated, is not essential. There are no cavities for the sand to fall into, as erroneously reported. The peak of Jebel Nagous rises above the Bell Slope to the height of 955 feet above the sea-level, as determined by a sensitive aneroid.

After studying the locality and phenomenon for several days, I formed the opinion that it could not be unique as hitherto supposed, and accordingly I tested every steep slope of blown sand met with on the caravan route northward to Suez. On April 6 I examined a steep sandbank on a hillock only 45 feet high, and was rewarded by the discovery of a second Nagous. This new Nagous is in the Wadi Werdan, only five minutes off the regular caravan route, and one and a half days, by camels, from Suez. The hillock is called by the Bedouins *Ramadan*, and forms the eastern end of a range of low hills about one quarter of a mile long; being the only hills in the Wadi, the locality can easily be found by travellers. The hills consist of conglomerate and sandstone, and to the west of gypsum; they slope up gradually from the north and end in bold cliffs on the south side. Sand blown by the north wind is carried over the cliffs, and rests on the steep face at two inclinations, 31° above, and 21°, or less, below. By applying the usual tests with the hands to the fine-grained sand, I found that wherever it lies at the requisite angle to produce mobility (31°), it yielded the bass note, though not so loud as on the Bell Slope of Jebel Nagous. In one instance, my friend and fellow traveller, Mr. Henry A. Sim, of the Madras Civil Service, who kindly aided me in my investigations, heard the sound while standing 100 feet distant. The Nagous sand occurs at intervals throughout the 500 yards of low cliffs; the main bank at the east end being 150 feet wide and 60 feet high measured on the incline. I stirred up the mobile sand pretty thoroughly on this slope, and the next day it failed to give the sounds, not having recovered its properties. The intervening night was very cold (53°). I feel confident that this phenomenon is not very rare in the desert, though the spontaneous production of sounds by sliding of the sand without man's agency, as at Jebel Nagous, may be. Whether the *Rig-i-Rawan*, north of Cabul, is caused by similar conditions remains to be determined, but I fear that the peculiar relations existing between England and Russia will prevent my visiting Northern Afghanistan. The Bedouins who accompanied us were greatly astounded at my discovery of a new Nagous, and I fear that their faith in a monastery hidden in the heart of Jabel Nagous has received a severe shock. It is interesting to note that the Nagous or modern gong is in daily use in the Monastery of St. Catherine, Mount Sinai.

I made photographs of Jebel Nagous and vicinity, as well as of the new Nagous, and collected specimens of the rocks, sand, &c. This communication must be regarded as a preliminary notice, full details being reserved for the work on "Musical Sand" in preparation by Dr. Julien and myself.

I shall be obliged if those who have opportunities of examining banks of dry and fine sand inclined at 31° will report through your columns whether they yield deep sounds when disturbed.

Cairo, April 10. H. CARRINGTON BOLTON.

AIR-TIGHT SUBDIVISIONS IN SHIPS.

THE last two months have been unfortunate ones for shipping generally, and more particularly for the navies of at least four of the great powers. France has lost two torpedo boats under such circumstances as to involve the condemnation of a whole class of vessels. Germany and the United States of America have each lost a small fleet in a hurricane of unusual violence. Besides the material loss of ships these three nations have to bemoan the loss of a considerable number of men. Only little more than a month ago one of the largest ships of the British Navy stranded in waters rightly assumed to be perfectly safe, and has become a total wreck. Fortunately in this case there was no loss of life. Another of her H.M. ships only just escaped the disaster which overwhelmed the German and American fleets at Samoa, and the circumstances attending her escape are worthy of a moment's attention.

The storm approached not without warning, and it is evident that the captains of all the ships set about making preparations for meeting it as best they might. They appear all to have got up steam, so as to ease their cables by steaming to their anchors, in case it should be impossible to get out. The only ship that did get out was H.M.S. *Calliope*, and without in any way detracting from the merits of her captain and those under his orders, it is evident, from the brief accounts to hand, that all would probably have been unavailing had she not been provided with very powerful machinery. In the Navy List her tonnage is given as 2770, and her horse power as 4020, or one and a half indicated horse power per ton of displacement. The most powerful of the other ships was the German corvette *Olga*, which apparently had considerably less than one horse power per ton of displacement.

The other ships, especially the American ones, were so deficient in power that they were unable to make any front to the storm at all. Even with her great power the *Calliope* was only able to attain an effective speed of half a knot per hour in the teeth of the storm. All praise is due to the men who were able to make such good use of this very meagre margin as to have saved a costly ship and many valuable lives for the further service of their country.

The Samoan disaster has thus, in a dramatic and even tragic way, shown the uses of steam power in saving a vessel by propelling her against a storm. Reflections on the loss of the *Sultan* lead us to ask if steam power cannot be made more useful in succouring and saving a ship after she has struck a rock, or in any other way received such damage to her hull as to render her loss by foundering imminent.

According to convention an engine is working at the rate of one horse power when it is lifting a weight of one ton against gravity at a velocity of 14·74 feet per minute. If, then, a ship is fitted with engines indicating one horse power per ton of displacement, these engines would, if their whole power could be usefully applied and directed against gravity, be able to keep the ship afloat so long as she did not sink at a greater rate than 14·74 feet per minute. The *Vanguard* took seventy-two minutes to sink. The practical question comes to be, How can the ship's power, of engines or men, be best applied so that the greatest proportion of it may be made available for keeping her from sinking?

Hitherto it has been usual to fit all ships with suction pumps, capable of being worked, some by steam and some by hand power. To use such pumps with effect it is necessary that they should be worked at such a rate as to throw overboard more water than can enter the ship in a given interval of time. The lower they bring the water in the hold of the damaged ship, the greater is the facility offered for the water to enter, and the harder becomes the work of lifting it. If the damage to the ship's hull is in any way serious, dealing in this way with its effect is almost always hopeless, unless it is possible to get at the leak and reduce its dimensions or close it altogether. The bottom of a ship at sea is very inaccessible. If she remains fast on the rock it is usually impossible to get at the leak either from the outside or from the inside. If she is afloat, and will keep afloat long enough, the leak can often be efficiently dealt with by passing a tarpaulin or sail under her bottom. But this is by no means a simple or easy operation, even when performed as a matter of drill with plenty of time, and in the absence of excitement or danger.

When a ship is sinking, she does so because water has got into her either from above or below, and has displaced the air with which she was charged. In order to stop her sinking and to raise her to her original level, it is necessary to reverse the operation and replace the water again by air. If the water has come in from above, by shipping seas, this can be effected by suction pumps, which throw it overboard again. If it has entered and is entering through a hole in the bottom of the vessel, it is necessary not only to remove the water which has entered, but to stop any further entry, and this is achieved by any means which enables us to thrust the water out again by the same way as that by which it entered.

If we consider a ship's hold, and assume that the deck covering it above, and the bulkheads shutting it off fore and aft, are all sufficiently strong and air-tight, then, if the whole bottom were allowed to drop out, her stability being otherwise assured, she would be very little the worse; the water would rise in her hold only until it had so far compressed the air that its tension exactly balanced the pressure of the column of water outside, and matters might safely remain in this condition of equilibrium almost indefinitely. Thus, by making the main deck of a modern ship, to which the water-tight bulkheads are carried up, air-tight, she would be practically proof against all risk of sinking from damage to her bottom.

I do not think that there would be any difficulty in making the compartments of a ship perfectly air-tight, or more properly, in fitting them so that the rise of tension quickly produced by the entry of water through a serious leak, would at once close any joints or small openings, in the same way as the door of the air lock giving entrance to a submarine caisson is kept closed and air-tight by the pressure of the air within. But inasmuch as the smallest leak of air, whether through the deck or through the bulkheads, would represent an equivalent of water entered and of buoyancy lost, it is necessary to be able to make good the loss by mechanical means. The more carefully the decks and bulkheads have been fitted in the first instance, the less will be the amount of air which will be required to be supplied by engine or man power in order to keep the water out in the event of serious damage to the ship's bottom.

Dealing with leaks in this way is equivalent to transferring the leak from the ship's bottom to her deck, and dealing with it there in the shape of an escape of air in place of an entrance of water.

In order to make successful use of this method it is necessary that the ship's deck and bulkheads should be not only air-tight, but also sufficiently strong to resist a pressure which, in the case of even the largest ships, would not exceed one atmosphere, or 15 pounds per square inch. Each compartment would have to be about as strong as an old low-pressure marine boiler.

Modern men-of-war are built in such a way that they require nothing but the air-tight hatches, and air-forcing pumps to make them quite secure against the most extensive damage to their bottoms. Indeed, as regards the stoke-holds, they are already fitted with the air-tight hatches in order to be able to used forced draught for the furnaces. Modern merchant ships are built with an iron deck, so that there is no difficulty about providing the strength. Their hatchways are, however, always very large; but, on the other hand, there is little traffic through them, so that they could be treated in a more substantial way than the smaller hatchways of a man-of-war with her large complement of men. The bulkheads which subdivide the hold into compartments always profess to be water-tight, and to be able to resist the pressure exercised by the water filling the compartment. There should therefore be no difficulty about them. Indeed, if ships were built to withstand air pressure, a very simple method would be provided for testing the efficiency of the bulkheads without the disagreeable process of filling the compartment with water. It would be only necessary to close the legitimate openings and get the air in it up to a pressure equal to that of the ship's draught of water, and the result would be unequivocal. It is proper to observe that the construction of an air-tight bulkhead would differ slightly from that of a water-tight bulkhead, inasmuch as it will be exposed to the maximum pressure over its whole surface, whereas the water-tight bulkhead is exposed to a graduated pressure, being greatest at the keelson, and least under the deck.

A further advantage of fitting a ship with air-tight subdivisions is, that it not only gives her greater security against foundering, but it affords a means of largely insuring her against risks of fire. This has more especial reference to merchant ships. If the contents of a ship's hold catch fire, the easiest way of putting it out is to stop the supply of air, and this can be done if the hold is air-tight.

So far the damage to the ship is supposed to be a rent in the bottom. If it is not in the bottom, but somewhere above it, then the air can only expel the water down to the level of the breach, when the air will begin to escape through its uppermost part. It will now depend on the supply of forced air available, how large a hole can be kept continuously filled by a stream of air rushing out. The area so occupied is necessarily closed to the entrance of water, and if the machinery can supply air at a sufficient rate, the whole rent can be filled by a current of air, which, so long as it is kept up, is as efficient a leak stopper as a plate of iron would be, and meantime the bottom of the hold can be cleared by the ordinary bilge pumps.

Rents in a ship's side, such as are produced when she is run down, or rammed by another, are usually so extensive and serious that, unless the ship is protected by an inner skin, immediate destruction ensues before there is time to take any measures for rescuing her. But with an inner skin the damage may be so far reduced as to make it possible to deal with it as above indicated. The higher up on the ship's side is the damage the less suitable is the pneumatic method for dealing with it, if it is of a really extensive character; but, on the other hand, the more easy is it (given the time) to get at it, and deal with it from the outside. In all cases where the ship has been damaged by touching the ground, or by torpedo explosion under the bottom, and not involving the destruction of the ship, the pneumatic method affords the readiest means of combating the results.

It must be remembered that a ship's hold when filled with compressed air will be *habitable;* that is, if an air lock is provided, men can descend into it and repair the damage, just as they can descend into a caisson and dig out the foundations for the pier of a bridge.

The pneumatic method is however not only adapted for keeping damaged vessels afloat, it is also useful for raising sunken or stranded ships. For this purpose the salvage steamer must be provided with air-forcing pumps as well as the suction pumps which she usually carries. Having closed, and if necessary strengthened the deck, by means of divers if below water, she then pumps air into the holds of the ship, and at once restores a large proportion of her original buoyancy to her. If she does not rise, the other methods of salvage can be applied in addition, and with much increased chance of success.

The principle of this method is not new. A very old device in endeavouring to float, or to keep afloat, ships, is to fill as much of their damaged hold as possible with empty casks. A later modification of this method is to use inflatable india-rubber bags. It may be remembered that after the *Vanguard* sank Admiral Popoff of the Russian Navy sent a large apparatus of this kind in order to render assistance in trying to float her. Both these appliances are cumbersome. A ship's hold is seldom quite empty when she sinks, and even if it were, it is not easy to fill it under water with casks full of air, or even with inflatable air bags; and in any case it is difficult in this way to fill more than a fraction of the hold with air. The simple and efficient way of dealing with the matter is to treat the ship's hold itself as the vessel to be filled with air.

Compressed air is every day occupying a wider field as a means of transmitting power. It is already used as a substitute for gunpowder in the guns for firing shells with high explosives. It seems to me that if it can be used for largely increasing the safety of life and property at sea it is right that the fact should be brought as prominently forward as possible, in the hope that it may receive practical application in the hands of the shipbuilder and the engineer. J. Y. BUCHANAN.

NOTES ON STANLEY'S JOURNEY.

I HAVE watched every footstep of Stanley for the past twenty years, had constant intercourse with him during his short visits to this country, and have unbounded confidence in him as a pioneer, for I cannot but admire the noble efforts he has made to open up Africa to civilization. Wherever he has travelled he has left his mark behind him; others may follow his example without fear of being molested, and he has given us such vivid descriptions of the regions mapped by him that, for all practical purposes, no traveller need supervise his work. Some say he has been too high-handed with the natives, but I may be allowed to think that his power of influencing those over whom he holds command has proved him to be the most trusted and successful traveller of the age. If his explorations be quickly and judiciously followed up, the native inhabitants will feel security against all oppression, and the traders in slaves will be expelled from the country.

Brilliant is scarcely the name to give the exploit of Mr. Stanley, as given in his recently published letters. What instance in travel can excel such devotion? Is there a schoolboy who does not admire a man with his indomitable pluck and dogged perseverance? His latest journey to relieve Emin Pasha has outstripped, if possible, all his previous explorations in the "Dark Continent." Those 160 days of toil, from June 28 to December 12, 1888, through starvation, desertion, mutiny, savage dwarfs and cannibals, thorny thickets, darkness, and swamps, were enough to try the patience of any human being; but, thank God, his British pluck never failed him; on and on he pressed, while his native followers were in utter despair, and broke out into mutiny. He used every persuasion with them: all failed. What was he to do? He felt that his duty was to relieve Emin Pasha—his countrymen expected this—and, with his accustomed sense of what was just and right, the two ringleaders of the mutinous band were hung in the presence of his camp followers. This wholesome example proved to be the saving of his expedition. He emerged from the poisoned atmosphere of the forest, and says that he was amply rewarded when his remaining native followers kissed his hands in grateful acknowledgment of being delivered from death.

The party proceeded on, moving with great glee across the grassy slope amidst villages and cultivation, soon standing upon the brink of the crags which overhang the western shores of the Albert Nyanza of Baker. Here fresh difficulties arose; the suspicious natives would give them no canoes, would hold no intercourse with him. Emin Pasha's steamer was not in sight, and, after consulting his officers, Stanley retired to an entrenched position, sent Stairs, R.E., for his English-built boat, and, terrible though this journey has been in every form, the heroic Stanley won his point, and shook hands with Emin Pasha on April 29, 1888, 465 days after leaving Charing Cross to his relief.

It is quite possible that he may return to England by the end of May, but there are several reasons which may delay him. The difficulty of providing for so large a party as ten thousand followers belonging to Emin Pasha—this is a most anxious charge. Again, Stanley's thirst to solve the problem of the unexplored country south of the Albert Lake may lead him there, and I really feel more anxious about him since the arrival of his letters than I felt before we heard of his safety, for he is so fearless, he never sees a difficulty.

The marvellous growth of vegetation upon Stanley's route is not to be wondered at, as we know that in similar latitudes, such as Uganda, Borneo, and the Amazon, the same density of undergrowth and forest exists. A band of moisture encompasses the world at the equator, extending three to four degrees of latitude on either side; the vertical rays of the sun beat down with great intensity, and vegetation is almost seen to grow. In Uganda I have seen the banana trees, after being felled, shoot up from their centres immediately after their stems had been cut across; the roots of the trees are surrounded by spongy soil laden with moisture from the daily fall of misty rain, and the powerful sun completes the formation of the great forests of banana trees, without the aid of cultivation, beyond the help of the decayed leaves. We see the same process in the great belt of forest called in India the "Terai," which extends along the bases of the southern spurs of the Himalayas. Here the rains which fall upon these spurs, ooze out over the lands of the "Terai" and feed the roots of the magnificent forest trees, forming food and shelter for the wild elephant, boar, and swamp-loving creatures; but the atmosphere is almost certain death to all human beings except the inhabitants. We cannot, therefore, feel any surprise that Stanley and all his party suffered from sickness, and wonder how any of them escaped alive.

"Ugarrowa or Ulede Balyuz, a tent-boy of Speke's," an "Arab slave-dealer," is constantly mentioned in Stanley's interesting narrative. I am able to give some information about this person if he be the same "Ulede," one of "Speke's faithfuls," represented in the *Illustrated London News* of July 4, 1863, as "Ulede Senior," in a photograph taken by Royer in Cairo. He told me that he was a native of Uhiao, was captured by the Watuta in infancy, and sold as a slave to a Zanzibar trader. He was engaged by Speke as a load carrier, and became my valet, which he continued to be till our arrival in Cairo. He was thoroughly trustworthy, as many of his race are, and more intelligent than most of our men. He could name accurately every march in our journey, most of the trees and plants, and could tell a capital story. His career has been deservedly successful, and though from circumstances he has become a well-known dealer in slaves, I might ask what career is open to any young man of African origin who has never received the slightest education. Ulede Balyuz (*i.e.* the Consul's boy) has done good service in sheltering Stanley's sick, and in transmitting the graphic despatches which we have all read with profound interest, therefore he ought not to be condemned too hastily, but rather be utilized by the Congo Free State Government as the head of a district.

The dwarfs mentioned by Stanley must be very numerous, as he came upon one hundred and fifty villages of them. One specimen alone was seen by Speke and myself in Unyoro, and at least one perfect skeleton has been received from Emin Pasha by Prof. Flower. They seem very proficient in hunting, and used every conceivable device to poison the men of Stanley's party by placing staked pitfalls on the path, in the manner they would trap an elephant or antelope, and it appears they were only too successful.

We must wait for Stanley's return to hear more of the race of Manyema. I believe this race to be the Nyam-Nyam described thirty years ago by Mr. Petherick, but without knowing their tribal marks and arms, this cannot be decided. Meantime, these daring cruel savages have shot down poor Major Barttelot, and are engaged by the slave-dealers of Zanzibar to plunder, capture, and kill the inhabitants, and reduce the country to a wilderness; so that, through Stanley's brave deeds, we have our work of civilization before us. J. A. GRANT.

FURTHER NOTES ON THE GEOLOGY OF THE EASTERN COAST OF CHINA AND THE ADJACENT ISLANDS.

TWO years ago some notes were published in NATURE (vol. xxxvi. p 163) on the geology of a portion of the coast of China, compiled from a report forwarded by Surgeon P. W. Bassett-Smith, R.N., of H.M.S. *Rambler*, to the Hydrographical Department of the Admiralty. Since then Mr. Bassett-Smith has extended the area of his investigations both to the north and south of the coast-line dealt with in this report, so as to embrace the whole eastern coast from Shanghai and Hong Kong; and has embodied his observations in two further reports to the Hydrographical Department. These documents, with the specimens referred to in them, having been submitted by the Hydrographer to the Director-General of the Geological Survey, Dr. Hatch, of the Petrographical Department of the Survey, has drawn up the following abstract of the reports and notes regarding the specimens:—

Speaking generally, the whole coast between Shanghai and Hong Kong consists of granite; the high mountain-ranges, especially in the south, present chiefly this rock. Flanking the granite on various parts of the coast are vast masses of crystalline schists (gneiss, mica-schist, &c.), parts of which are rich in metallic ores, even auriferous quartz occurring, as at Chinsan, and more plentifully in the Shangtung province, where it is profitably worked by the Chinese. A curious conglomerate, found at Sharp Point Islands, River Min, at Davis Island, Yangtse-kiang, and also in the Shangtung province, is overlain by slates, probably of Cambrian age, but for the most part unfossiliferous, although some fish-remains and Algæ have been found in the Shangtung province.

In the northern part of the coast (Chusan to Shanghai) there are many traces of ancient volcanic activity. The older volcanic rocks consist of porphyritic felsites (Chusan Island, Davis Island, Elliot Island, Bonham Island, and Side Saddle Island) and basalts (Changtau), both of which are intrusive in the granite and crystalline schists. More recent volcanic tuffs and breccias were obtained in a quarry near Ningpo.

The Chusan Archipelago.—Of this group of islands, situated at the mouth of Hang-chow Bay, south of Shanghai, the northern members have a marked volcanic character, the rocks composing them being volcanic conglomerates, breccias and tuffs, together with felsitic, trachytic and basaltic lavas, the more acid types of which show well-marked flow-structures. The vents from which these lavas were erupted are situated chiefly in the large island of Chusan; another focus of emission is probably represented by Changtau Island.

One of the most noticeable features of the group is presented by the vast stretches of land that have been rescued from the sea. Many islands formerly isolated have been united; and broad plains of rich alluvial ground have been reclaimed, are now highly cultivated, and support a dense population. This has been chiefly brought about by the construction of strong embankments and sea-walls from point to point across the bays, after the latter had been allowed to become partly silted up by the mud brought down from the Yangtsze River and Hang-chow Bay. This difficult work testifies to the marvellous energy and industry of the Chinese.

Details are given of the geology of the following islands of the Archipelago:—

Video Island, the outermost of a long chain of islands, extending in a west-south-west direction, has a conical shape, with steep cliffs, and consists of a pinkish quartz-trachyte, penetrated by numerous dykes of basalt.

Tripod Island, an elongated island, about 600 feet high, sloping moderately to the west, but descending on the east almo t perpendicularly into the sea, is composed of a volcanic breccia, frequently penetrated by dykes of basalt.

Keusan Island, a high island of irregular elongated shape, separated from Changtan Island by a narrow channel of 5-7 fathoms, with a good anchorage, presents, at its north-eastern end (Radstock Point), a coarse volcanic breccia ("trachyte-conglomerate"), with which are associated well-banded acid lavas (trachyte). In other parts of the island a greenish tuff occurs, which is abundantly penetrated by an interlacing system of basaltic dykes.

Changtau Island, a rugged island with a double-peaked summit, shows, along its west coast, cliffs consisting of a stratified green tuff and trachyte-breccia, with dykes of basalt and flows of a well-banded trachytic lava.

Taeshan Island, a series of high hills attaining to a height of 700 feet, connected by broad alluvial plains, consists on its north-east coast of a grey quartz-porphyry, weathering blood-red, and salmon-coloured felsites, penetrated by numerous dykes of basalt.

Show Island is formed entirely of a coarse trachyte-breccia, containing large angular fragments. This rock is much quarried, the stone being conveyed away in junks.

Volcano Island, the most westerly of the chain, is composed of the same volcanic breccia, associated here with felsitic lavas.

North-East Islet, off Chusan Island, and Nine-Pin Rocks are composed of a compact dark-coloured felsite, with a marked bedded character. In places the rock shows distinct flow-structure.

Poo too Island consists of a high peak, separated from a number of smaller ones by deep gullies, filled with blown sand. The summit of the hill is formed of a compact white trachyte, which has been erupted through the granite forming the base of the hill.

Chusan Island, the largest of the group, being twenty-two miles long and ten miles wide, consists of a long range of mountains, many peaks of which are over 1000 feet high. Between the numerous spurs given off from these mountains lie tracts of highly fertile land, the lower parts of which have been recently reclaimed, and are protected by a series of embankments. Outside the outermost of these the mud-flats are used for the collection of salt, to obtain which the mud is scraped up, filtered, and the brine evaporated in wooden trays. The old cliff-line now stands far back from the present coast; and former islands appear now as isolated hills. This island is less bleak than the smaller ones of the group, owing to the protective influence of the small fir-trees that are encouraged to grow on the hill-sides. Other trees here met with are the camphor, tallow, maple, and numerous evergreens in the neighbourhood of the villages. The rocks are quartz-porphyries and felsites.

Lateo Island consists of a coarse volcanic breccia, containing large angular fragments of quartz-felsite. This stone is extensively quarried.

Ketsu Island.—A small rugged double island off Chusan, consisting of dark-banded felsite with small porphyritic crystals of red felspar.

Blackwall Island.—A large well-cultivated island, with hills of dark-coloured felspar-porphyry and felsite. Volcanic breccia also occurs, penetrated here and there by basalt dykes.

Kintang Island.—A large island near the mainland, presenting a fine, pointed summit of red felspar-porphyry. Along its cliffs are highly contorted volcanic breccias and felsites.

Taoutse Island.—A small narrow island of red felspar-porphyry (red felsitic ground-mass embedding small bright red crystals of felspar).

Changpih Island.—A large island with much reclaimed land; red felspar-porphyry.

Chinhai Island.—A small rock in the mouth of the Ningpo River, composed of the same red porphyry.

Rambler Island, Hang-chow Bay.—A rounded mass with steep smooth sides, composed of volcanic breccia and brown felspar-porphyry.

Mr. Bassett-Smith adds that no traces now remain on the China coast of the volcanic activity that gave rise to the enormous accumulations of lava and tuff referred to in the above notes, with the exception of a few scattered hot springs. He is of opinion that after the eruptions ceased, a subsidence must have taken place, but that the ground is now probably rising.

WHICH ARE THE HIGHEST BUTTERFLIES?

THE following extracts from a letter received a few weeks back from Mr. W. H. Edwards, of Coalburgh, touch on this question, and may be of interest to lepidopterists. Having now for many years ceased to give attention to this subject, I cannot express any opinion, but I think Mr. Edwards's facts are very curious, and the conclusion expressed in his last paragraph not far from the truth.

ALFRED R. WALLACE.

"In a recent part of my vol. iii. I have figured one of the high Alpine Colorado Erebias, *E. Magdalena*, found on the extreme summits, among nothing but rocks. I have also succeeded in breeding another of the Alpine Erebias, *E. epipsodea*, from egg to imago, and have a full set of drawings for plate. Have also had *Chionobas chryxus* (also Colorado) and imago, and have all the drawings there. Connected with these Alpine species is a matter I talked over with you, and of which I now write. There must be many genera of Satyridæ in which the larvæ are thick-bodied, inert creatures, very much like many of the Noctuidæ. I have twice raised *Arge Galatea* from egg to imago. This larva is remarkably like a Noctuid in shape, inertness, in the manner it lies on the ground—curled up so that head touches tail, in a ring, or like a *d*. The pupa is so like a Eudamus, that when I sent one to Mr. Scudder to ask what it was, he replied, 'Some Hesperid probably, very near to *E. tityrus*.' It is made loose on the ground or in the sod, there being no outer case, and no attachment. The usual hooks of the cremaster are not bent, but straight out and few. Now the *Erebia epipsodea*, and the three Chionobas which have been bred in this country, *C. chryxus*, *semidea*, and *jutta*, are like the *A. Galatea* in larval habits and appearance, and the pupa is unattached, and has actually no hooks at all. I read in Buckler, that *Satyrus Semele* actually makes a case underground (like some of the Sphingidæ), and is inside that like a Hesperid. It is to be supposed that many genera of the Satyridæ pupate unattached, or in cocoons. Mr. Scudder says the eggs of Satyridæ are very like the Hesperidæ, and has to admit the resemblances I have spoken of in the other two stages. But he passes over all this as a mere trifle, and insists that 'in the prime features,' as he calls it, of the imago, the Satyridæ 'out-rank all others.' Now what are the 'prime features' he tells about? They are two: one is that the pupa hangs by the tail, and that there is a regular progression from the Hesperid style of attachment through the Papilionidæ, the Lycænidæ and the Satyridæ; and that the flat ventral side of pupæ in what he calls the higher families, the Suspensi, is an evidence that once they or their ancestors were attached by a girdle, like the Papilionidæ. The other is the atrophied condition of the fore-legs, which is more extreme in the Satyridæ than in any other family, and reaches the last degree in Chionobas. He, in his 'Butterflies of New England,' now issuing, puts *Chionobas semidea* at the head of the North American butterflies, the top rung of the ladder, beyond which we can go no farther! This is what I call your attention to.

"When we used to study 'Euclid,' we sometimes proceeded by an apparently correct mode of demonstration, till we came to 'which is absurd,' and I hold that this conclusion of Mr. Scudder is absurd on its face. Here is a butterfly on the top of the White Mountains of New England. Its species is found nowhere else than in Labrador and in Colorado, in the latter on the loftiest summits. There is no difference between the three butterflies from the three regions, and yet they cannot have had any communication for untold ages. It is considered as a relic of pre-glacial times in the White Mountains. This butterfly lives in a semi-torpid condition through its short season, lies about on the rocks, has but a trifling power of flight, and dodges the high winds in crevices of rocks. To say that an insect which for perhaps 50,000 years has lived this sort of life, and has not changed in all that time, is the most advanced in the scale of North American butterflies, and so of all the world, is absurd and ridiculous! The wonder is that it has not lost the use of its wings. Therefore the argument is wrong somewhere that leads to such a conclusion. If the premisses are allowed to be correct, then the reasoning has a flaw.

"I do not believe there ever was any derivative progression from one family of butterflies to another. And we cannot say that the Papilionidæ are derived from the Hesperidæ (either because of six legs, or the epiphysis, or any other reason), or the Papilionidæ from the Lycænidæ, or the four-legged families from the six-legged. There is not in the rocks a particle of evidence of such a progression, and the whole thing is the merest fancy. Any differences between families are not owing to derivation, but to the development of each independently, like the rays of a fan. "W. H. EDWARDS."

NOTES.

WE regret to have to record the death of Mr. Warren De la Rue, F.R.S. He was born in 1815, and died on Good Friday, after a short illness, from pneumonia. Mr. De la Rue was a most devoted observer and munificent patron of astronomy, and in him and Balfour Stewart solar physics has lost its chief founders.

THE death is announced of Dr. Paul du Bois-Reymond, Professor of Mathematics at the Technical High School of Berlin, and formerly at the Universities of Freiburg and Tübingen. He was the author of two well-known mathematical works, and brother of the eminent physiologist of the same name. He was born on December 2, 1831, and died at Freiburg in Baden, on April 7.

THE Rev. J. H. Thomson, Vicar of Cradley, whose death is announced, had made what is described as an extensive and valuable collection of European plants, and it is understood that he has bequeathed them to the Worcestershire Naturalists' Museum.

THE National Union of Elementary Teachers has been holding its twentieth annual conference this week at Birmingham. The conference was opened in the Town Hall on Monday afternoon, when an address was delivered by Mr. R. Wild, the President-elect, on the report of the Education Commission, and on the latest edition of the Code. The defects of the existing system of national education were discussed at a crowded meeting on Tuesday evening. Mr. Chamberlain, in addressing this meeting, spoke of payment by results, in the sense in which the expression is now used, as a method which everyone condemns. "We want you," he said, "to show us a better way, and it is through such conferences as those which are now being held that Parliament and the Government may hope to find, tested by your practical experience, a substitute for a system which we desire to alter."

THE picture of Sir William Bowman, by Mr. Ouless, R.A., has, by special permission, been exhibited to subscribers in the Marsden Library of King's College, and has now been sent to the Royal Academy. The list of subscribers numbers 420, and will be closed on June 1.

SIR ROBERT BALL, the Royal Astronomer of Ireland, has just been elected an Honorary Fellow of the Royal Society of Edinburgh.

PROF. CORFIELD, M.D., has been elected a Corresponding Member of the Italian Association "Dei Benemeriti," and awarded a gold medal for his contributions to hygiene.

DR. SCHWEINFURTH arrived at Aden on March 23, on his return from a three months' stay in Central South Arabia. He has started for Europe, bringing a very interesting botanical collection with him.

THE *Japan Weekly Mail* says that Mr. W. Gowland, who has occupied a prominent place in the Imperial Mint at Osaka, has retired from the Japanese service. In 1872, Mr. Gowland was selected by Dr. Percy, of the Royal School of Mines, London, as Chemist and Metallurgist to the Japanese Government. His first task in that country was the organization of the metallurgical department of the Copper Mint and the establishment of chemical and metallurgical laboratories. He subsequently filled the posts of Technical Adviser and Assayer, and as such was directly responsible for the accuracy of the coinage. Amongst other reforms at the Imperial Mint he introduced a novel process by which crude copper could be converted into bronze coinage bars at one operation, and also elaborated processes for the coinage conversion. His investigations into the effect of bismuth on the ductility of silver are well known. He made many interesting discoveries amongst the tumuli and shell-heaps in the interior. The Emperor conferred several distinctions on him before his departure.

THE Berlin Academy of Sciences has lately been presenting various sums of money to promote scientific research. Dr. Franz-Stuhlmann, assistant at the Würzburg Zoological Institution, has received £50 (Mk. 1000) to enable him to proceed with his investigation of the fauna of Zanzibar, where he has been since last spring. A sum of £60 (Mk. 1200) has been sent to Dr. Gustav Weigand to help him in his linguistic and ethnographical researches in the Balkan peninsula; and Dr. Pomtow has received £25 (Mk. 500) towards the publication of his work on Delphi.

A CORRESPONDENT in Paris writes to us that the British Section of the Paris Exhibition is nearly ready, and is much in advance of most other parts of the Exhibition.

THE following are the dates of some of the Exhibition Congresses which are to be held in Paris:—Technical Education, July 8 to 12; Bibliography of the Exact Sciences, July 16 to 26; Chemistry, July 29 to August 3; Ballooning, July 31 to August 3; Pigeons, July 31 to August 3; Hygiene, August 4 to 11; Higher Education, August 5 to 10; Physiological Psychology, August 5 to 10; Geography, August 6 to 11; Photography, August 10 to 17; Criminal Anthropology, August 10 to 17; Primary Education, August 11 to 19; Horticulture, August 16 to 21; Prehistoric Man and Remains, August 19 to 26; Electricity, August 24 to 31; Chronometry, September 2 to 9; Mines and Metallurgy, September 2 to 11; Applied Mechanics, September 16 to 21; Meteorology, September 19 to 25; River Utilization, September 22 to 27; Commerce and Industry, September 22 to 28; and Hydrology and Climatology, September 30 to October 15.

LECTURES will be delivered in Gresham College, on April 30, and May 1, 2, and 3, by Dr. E. Symes Thompson, on the medical aspects of life assurance.

AT a recent meeting, the Liverpool Geological Society appointed a Committee to report on the boulders occurring in the glacial deposits of Liverpool and district. This Committee, after full discussion, has reported that the investigations would be better carried out if extended over the whole of Lancashire and Cheshire, and by a larger Committee, consisting of representatives from all parts of the two counties. The objects of the enlarged Committee would be to examine and record the occurrence, nature, and facts bearing on the mode of transport, of erratics in the glacial deposits of Lancashire and Cheshire. If this suggestion meets with general approval, a meeting of all interested in the question will be held at some convenient centre at an early date.

IN a paper reprinted in NATURE (vol. xxxiv. pp. 220, 239), M. A. Blytt gave his views on variations of climate in the course of time. Believing that periodical variations of climate are to be attributed to changes in the strength of ocean-currents, he finally traced back their origin to the precession of the equinoxes and the eccentricity of the earth's orbit. He has now issued a paper, with two supplementary notes, in which he seeks to explain the displacement or alteration of beach lines, by changes in the tidal-wave, caused by variations in the eccentricity of the earth's orbit. Referring to his former conclusions, that dry periods should be marked by chemical deposits, and rainy periods by mechanically-formed sediment, he passes on to consider the character of the Tertiary strata in the Paris and Hampshire Basins. In the author's opinion, the alternation of sediments of different nature indicates periodical variations in climate; and he endeavours to correlate these variations with particular phases in the eccentricity of the earth's orbit, the period or duration of which has been calculated in years. The author also believes that the lengthening of the sidereal day has had much influence on the form of the globe. This lengthening has been caused mainly by the tidal wave, and as the centrifugal force diminishes under such circumstances, strain accumulates in the solid earth, until the limit of resistance is reached. Hence, in the author's opinion, arose vertical displacements of beach-lines.

A REPORT from Sumatra states that the volcanic crater on the west coast of the island, which has been quiet for several centuries, was active during the middle of February.

SEVERE shocks of earthquake, lasting for eight seconds, were noticed at Zvornik in Bosnia, on April 2. The direction was from south to east.

WE have received from the Deutsche Seewarte, the second part of the *Deutsche Ueberseeische Meteorologische Beobachtungen* (see NATURE, vol. xxxvii. p. 444) containing complete observations made at six stations in Labrador during the year 1885, and at one station in Walfisch Bay (south-west coast of Africa) during the year 1887. Both sets of observations are carried on under considerable difficulties; in Labrador the rain-gauges are frequently inaccessible on account of drifting snow-storms, and the ordinary hygrometers are unmanageable during very low temperatures. In Walfisch Bay the thermometers are often choked by sand, or are liable to be affected by the intense radiation from the ground. Nevertheless the work supplies very valuable materials from remote regions where little is yet known about the peculiarities of the climate.

A CARBOHYDRATE of the empirical composition $C_6H_{10}O_5$, and possessing properties very closely resembling those of the arabin of "gum arabic," has been artificially prepared by Prof. Ballo, of Buda-Pesth. This achievement is the outcome of an attempt to reproduce the conditions under which the acids of the vegetable world are reduced by chlorophyll. It was assumed that the iron of chlorophyll is present in the ferrous state, and tartaric was the acid upon which operations were commenced. About equal quantities of tartaric acid and ferrous sulphate were dissolved in a minimum bulk of water, and the solution was warmed upon a water-bath. In a short time a greyish-yellow precipitate began to separate. The whole was then evaporated until it completely solidified on cooling. The cold mass was next extracted with alcohol and the extract again evaporated. The residue thus left by volatilization of the alcohol was neutralized with milk of lime, and the filtered solution again placed on the water-bath. It was now noticed that as the water was gradually expelled the contents of the evaporating dish became more and more viscid, until, finally, a sticky mass was left, reminding one most forcibly of gum arabic. Knowing that this familiar article of commerce chiefly consisted of the calcium and potassium compounds of arabin, the likeness was felt to be somewhat indicative of the formation of an arabin-like substance. On allowing the concentrated syrup to cool, a calcium salt readily crystallized out, yielding on analysis numbers pointing to the formula $(C_6H_9O_5)_2Ca + 9H_2O$. From this the free carbohydrate was obtained in two ways, either by precipitation of the solution in water with lead acetate and subsequent decomposition of the lead salt with sulphuretted hydrogen, or by addition of the calculated quantity of oxalic acid. The syrup of "iso-arabin," as it is provisionally termed, was further purified by repeated treatment with alcohol and ether and subsequent re-evaporation. It was then allowed to stand over sulphuric acid, some specimens for a month and others so long as a whole year. Each of these specimens, on combustion, yielded numbers indicating the empirical formula $C_6H_{10}O_5$. Iso-arabin is an almost colourless syrup, readily mixing with water. It does not reduce Fehling's solution, but rotates the plane of polarization to the right. It behaves, in short, exactly like the carbohydrates of the $(C_6H_{10}O_5)_n$ group. The potassium salt, obtained by decomposing the calcium salt with potassium carbonate, also crystallizes well in large anhydrous crystals. In addition to iso-arabin itself, a small quantity of its hydrate, $C_6H_{10}O_5 + H_2O$, is also formed by the action of ferrous sulphate upon tartaric acid, and separates out in crystals from the alcoholic washings of the crude iso-arabin.

Natural arabin itself forms a similar hydrate, the precipitate formed by addition of hydrochloric acid and alcohol to a solution of gum-arabic, when dried at 100° C., possessing this composition.

MR. FLETCHER, of Warrington, has recently put in the market a new and very cheap sensitive flame. It consists of a special arrangement of the small Argand bunsen, and differs from other sensitive flames inasmuch as any considerable sound completely extinguishes it. An interesting point in connection with it is that its sensitiveness is not constant, but apparently varies with the atmospheric conditions. The circular issued with the burner particularly states that the transparency of the flame renders it unsuitable for lecture experiments.

MR. W. A. HOLLIS writes to us from Brighton, describing a dream in which rooms and things in his house seemed to be in their relative positions, but transposed. The displacement extended itself to a servant, who appeared to be dusting some furniture; the cloth she was using she held in her left hand. This experience suggests to Mr. Hollis the question, "Is it possible that in dream-land we see things as in a looking-glass, like our little friend Alice?"

PISCICULTURISTS will read with interest M. Albert Le Play's pamphlet on the rearing of carps. It is entitled "La Carpe," and contains many new facts and suggestions concerning this branch of pisciculture.

AMONG foreign works which have been translated into French during the last two years, and the translations of which have been considered worthy of a reward, we notice two English books. The one is Mr. Green's "Short History of the English People"; the other Darwin's "Life and Correspondence," translated by M. H. de Varigny. The two other works to which, with the preceding, the Prix Langlois has been awarded, are Janssen's "Germany under the Reformation," and Nordenskiöld's "Travels." It is interesting that a book on Darwin should have been rewarded by the French Academy. M. Renan and M. Taine were on the jury, and did much to bring about the result.

WE have received the first three numbers (January to March 1889) of the *Bulletin international de l'Académie des Sciences de Cracovie*. The ordinary transactions of the Cracow Academy, being published in Polish, are not accessible to scientific students unfamiliar with the Slavonic languages. To remedy this inconvenience the Academy will henceforth issue a monthly *Bulletin* containing extracts in French and German of its regular proceedings, as well as summaries of all important memoirs in one or other of these languages at the option of the authors. Besides several historical, philological, and antiquarian papers, the present numbers contain contributions by Prof. Kreutz on the granites of Volhynia containing tourmaline and garnets; by M. Olszewsky, on an improved method for liquefying and solidifying the permanent gases and for studying their spectra; by M. Krzyzanowski, on the liquefaction and solidification of hydrogen in M. Pictet's experiments; by M. Olearski, on the elasticity of zinc and copper alloys; and by M. Sawicki, on the influence exercised by the physical and chemical agents on the electric properties of the nerves.

THE removal of tattoo-marks is a matter of no little difficulty, and many different methods have been tried (blistering, suction, thermo-cautery, counter-tattooing with white powder or milk, &c.). Criminals sometimes pour vitriol on their arms or hands, and letting it act for a few seconds, plunge the limb in water. The following method is recommended by M. Variot (in the *Revue Scientifique*):—The skin is first covered with a concentrated solution of tannin, and re-tattooed with this in the parts to be cleared. Then an ordinary nitrate of silver crayon is rubbed over these parts, which become black by formation of tannate of silver in the superficial layer of the dermis. Tannin powder is sprinkled on the surface several times a day for some days to dry it. A dark crust forms, which loses colour in three or four days, and, in a fortnight or so, comes away, leaving a reddish scar, free of tattoo-marks, and, in a few months, little noticeable. It is well to do the work in patches about the size of a five-franc piece at a time. The person can then go on with his usual occupation.

FROM a report of the Belgian Consul-General in the Congo State, it appears that the efforts made to introduce European vegetables and fruits in that district have been rewarded with very great success. The Government has imported tobacco-seed from Havana and Sumatra, which is cultivated in conjunction with native tobacco. The natives cultivate tobacco badly, but efforts are being made by the Government to teach them better methods. The inhabitants of the Lower Congo have been very successful in cultivating not only the usual African products, such as manioc, sweet potato, &c., but also sorghum, maize, and the "wandu" haricot, called "Boma" by the natives. The cotton-plant grows in its wild state, and the natives manufacture from it hats, wallets, &c. No effort has yet been made to cultivate it for trade purposes.

THE American Commercial Agent at Limoges, in a report on the result of the sanitary investigation as to the effect of plastered wines—that is, wines to which sulphate of lime has been added—says that the practice is very ancient, and one about the evil effects of which the highest hygienic authorities have differed. The Academy of Medicine has held special meetings and discussed the subject at great length. The advantages claimed for the practice are that fermentation is increased very much; that it is more rapid and complete; that the wine keeps longer when it has been plastered, and that the colour is richer and more lasting. It is now settled, however, that plastered wines have occasioned functional troubles, as, for instance, in the Department of Aveyron, where, the doctors report, those who consumed plastered wines suffered from an unquenchable thirst, an insupportable dryness of the throat, and various other troublesome symptoms. The action of sulphate of lime on the bitartrate of potash in ordinary wine produces an acid sulphate of potash; and in wine treated with lime, sulphuric acid in a free state is formed, and sulphate of magnesia; and these combined act as a purgative and sometimes as a caustic. M. Marty, who was appointed by the Academy of Medicine to report on the practice of plastering, examines all the arguments adduced in favour of the process, and, on his recommendation, the Academy condemns the custom as being detrimental to health.

THE British Consul-General in Algeria, in his report to the Foreign Office, says that hitherto the Government have been in the dark as to the habits and natural history of the locusts which now and then work such ravages in Algeria. Last year, however, a distinguished naturalist, M. J. Künckel d'Herculais, President of the Entomological Society of France, was sent to study the question on the spot, and he has published two reports on the subject. The species of locust which has ravaged the country since 1885 is not the same as that which invaded the same district in 1876–77. The former is *Stauronitis maroccanus*, the latter *Acridium peregrinum*. The former is found in most of the countries bordering on the Mediterranean, especially in Asia Minor and Cyprus. Morocco is, however, its original home, where it was observed in 1845, and again in 1867. Specimens of it collected in both those years still exist. Hitherto the accepted theory has been that they are brought from the desert by a strong southerly wind, but M. Künckel says that none have ever been observed in the Sahara, and he believes them to have their origin in the mountainous regions of Hodna. Fortunately the exact moment of their appearance may be predicted, and steps can be taken to destroy them. With this object M. Künckel has made charts of the localities where they laid their eggs last autumn, and has arranged a methodical system of campaign. The destruction of eggs is an uncertain and expensive process, he thinks, whereas one man can destroy a million young insects in a day.

A CHINESE native paper published recently a collection of some zoological myths of that country, a few of which are worth noting. In Shan-si there is a bird, which can divest itself of its feathers and become a woman. At Twan-sin-chow dwells the Wan-mu Niao (mother of mosquitoes), a fish-eating bird, from whose mouth issue swarms of mosquitoes when it cries. Yung-chow has its stone-swallow, which flies during wind and rain, and in fine weather turns to stone again. Another bird when killed gives much oil to the hunter, and when the skin is thrown into the water it becomes a living bird again. With regard to animals, few are so useful as the "Jih-kih" ox, found in Kansuh, from which large pieces of flesh are cut for meat and grow again in a single day. The merman of the Southern Seas can weave a kind of silky fabric which keeps a house cool in summer if hung up in one of the rooms. The tears of this merman are pearls. A large hermit-crab is attended by a little shrimp which lives in the stomach of its master; if the shrimp is successful in its depredations the crab flourishes, but the latter dies if the shrimp does not return from his daily excursions. The "Ho-lo" is a fish having one head and ten bodies. The myths about snakes are the strangest of all. Thus the square snake of Kwangsi has the power of throwing an inky fluid when attacked, which kills its assailants at once. Another snake can divide itself up into twelve pieces, and each piece if touched by a man will instantly generate a head and fangs at each end. The calling snake asks a traveller "Where are you from, and whither are you bound?" If he answers, the snake follows him for miles, and entering the hotel where he is sleeping, raises a fearful stench. The hotel-proprietor, however, guards against this by putting a centipede in a box under the pillow, and when the snake gives forth the evil odour, the centipede is let out, and, flying at the snake, instantly kills him with a bite. The fat of this snake, which grows to a great size, makes oil for lamps and produces a flame which cannot be blown out. In Burmah and Cochin-China is a snake which has, in the female sex, a face like a pretty girl, with two feet growing under the neck, each with five fingers, exactly like the fingers of a human hand. The male is green in colour, and has a long beard; it will kill a tiger, but a fox is more than a match for it.

A SERIES of regulations with regard to patents and designs has just been issued in Japan. All inventors, whose discoveries are beneficial or are calculated to improve existing processes of manufacture, may apply for letters patent. No patents, however, will be granted in the case of articles of food or drink, or in case of medicines. Inventors who do not receive letters patent are powerless to sue in respect of piracy of their inventions. In order to register an invention, application must be made to the Patents Bureau, and if the officials are satisfied as to the genuineness of the invention, it is registered, on certain forms being complied with and certain fees paid. A curious omission occurs in the regulations, but it is not plain whether it is intentional or not. Nothing whatever is said as to the rights of a foreigner to patent an invention, but it is presumed that he will not be able to do so. Nor has any provision been made for advertising applications for letters patent. The Patents Bureau is to be the sole judge of all cases submitted to it, and from its decision there is no appeal; but, in certain cases, two judges sit with the Bureau and assist in deciding whether a patent should be granted or not. The duration of a patent is to be five, ten, or fifteen years, according to the amount paid in fees. The patent, of course, passes by assignment *inter vivos*, or to the patentee's heir, but nothing is provided for the cases of bankruptcy or marriage.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Miss Caroline Newton; a Leopard (*Felis pardus* ♂), a Lesser Koodoo (*Strepsiceros imberbis* ♂) Malindi, East Africa, two White-crested Touracous (*Corythaix albocristata*) from South Africa, presented by Mr. G. S. Mackenzie; a Common Squirrel (*Sciurus vulgaris*) British, presented by Mrs. Arthur Faulkner; an Indian Wolf (*Canis pallidus*) from Afghanistan, five Chaplain Crows (*Corvus capellanus*), an Indian Python (*Python molurus*) from Fao, Persian Gulf, presented by Mr. B. T. Ffinch, C.M.Z.S.; two Slender-billed Cockatoos (*Cacatua tenuirostris*) from Australia, presented respectively by Mr. Walter Bird and Mrs. Hunt; an Eagle (*Aquila* sp. inc.) from Foochow, China, presented by Messrs. J. de la Touche and George Siemosen; two Alligators (*Alligator mississippiensis*) from Florida, deposited; a Wanderoo Monkey *Macacus silenus* ♀) from the Malabar Coast of India, an Indian White Crane (*Grus leucogeranus*), six Rose-coloured Pastors (*Pastor roseus*) from India, three Elliot's Pheasants (*Phasianus ellioti* ♂ ♀ ♀), thre Amherst's Pheasants (*Thaumalea amherstiæ* ♂ ♀ ♀) from China, two Swinhoe's Pheasants (*Euplocamus swinhoii* ♂ ♀) from Formosa, two Vulturine Guinea Fowls (*Numida vulturina* ♂ ♀) from East Africa, two Crested Screamers (*Chauna chavaria*) from Buenos Ayres, two Pochards (*Fuligula ferina* ♂ ♂), European, purchased; two Viscachas (*Lagostomus trichodactylus*), a Vulpine Phalanger (*Phalangista vulpina* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE CONSTITUTION OF CELESTIAL SPACE.—M. G. A. Hirn has recently published an able and interesting work, entitled "Constitution de l'Espace Céleste," in which he inquires into the nature of the medium or agent which establishes and carries on the relationships of the celestial bodies. For all of these, from the most enormous sun to the most infinitesimal meteorite, are in constant relationship to each other, continually attracting each other, continually radiating and receiving light and heat. Newton long ago regarded it as the greatest of absurdities to imagine "that one body might act upon another at a distance, through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another. Gravity," he added, "must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers."

This question, left unsolved by Newton, Hirn answers as follows:—"The thorough analysis of the most diverse facts revealed to us by science to-day allows us to reply to the first question by the most absolute negation. That which fills space and which establishes relations between the celestial bodies is not diffuse matter."

That "ponderable matter in the state of a diffuse gas" does not fill interplanetary and interstellar space M. Hirn seeks to prove by inquiring what effect such a medium would have on the various members of the solar system, and particularly upon their movements. Many of his conclusions are exceedingly striking, and if accepted certainly prove his main proposition given above. Perhaps the most remarkable is that relating to the secular acceleration of the moon. To explain a secular acceleration of 0″·5 in the mean motion of the moon it would be sufficient if 1 kilogramme of gas were distributed over 975,000 cubic kilometres of space; a rarefaction one million times greater than that of a Crookes vacuum of the millionth of an atmosphere. But the effect of the shock of the particles of this rarefied gas against a body like the moon as it moved forward in its orbit would be to raise the gas to a temperature of

38,000° C., and inconceivably attenuated as this interplanetary atmosphere would be, the moon would yet come into contact with 600 kilogrammes of it in each minute of time. On a body like the earth, surrounded by an atmosphere, the inevitable result of this unceasing collision with the interplanetary atmosphere would be the stripping away of the terrestrial atmosphere layer by layer. Arriving at results of a similar unacceptable character from the consideration of the action of a diffuse interplanetary gas on the other members of the solar system, M. Hirn decides that matter exists only in a sporadic state in space; only in the state of distinct bodies—stars, satellites, meteorites, and the like. It exists in a state of extreme diffusion only in nebulæ, but elsewhere space is perfectly empty, or, at least, whatever remains cannot suffice to explain the relations of stars to stars.

COMETS 1888 *e* AND *f* (BARNARD, SEPTEMBER 2 AND OCTOBER 30).—The following ephemerides for these objects are in continuation of those given in NATURE of April 4, p. 546, and are for Berlin midnight:—

	Comet 1888 *e*. R.A. h. m. s.	Decl. ° ′	Comet 1888 *f*. R.A. h. m. s.	Decl. ° ′
April 30	23 25 51	1 28·1 N.	9 31 10	37 39·4 N.
May 4	23 23 34	1 41·6	9 33 48	37 35·8
8	23 20 54	1 54·1	9 36 36	37 30·4
12	23 17 50	2 5·5	9 39 38	37 23·7
16	23 14 18	2 15·7	9 42 50	37 15·8
20	23 10 15	2 24·5	9 46 12	37 6·7
24	23 5 37	2 31·6 N.	9 49 43	36 56·8 N.

α URSÆ MAJORIS.—Mr. Burnham reports from the Lick Observatory that he has discovered this star to be a close double. He gives the following measures of the companion:—

	°	″	Mag.
1889·142	P = 327·0	D = 0·96	11
1889·151	= 325·9	= 0·83	11

Mr. Burnham was not able to see the companion with the 12-inch telescope, and concludes that it is too difficult for such an aperture, the difference in magnitude between the two components being so great.

THE WHITE SPOT ON SATURN'S RING.—M. Terby, writing to the *Astronomische Nachrichten*, reports that he has not been able to see the white spot again which he observed on March 6 and 12 (NATURE, vol. xxxix. p. 497). MM. Knorre, Knopf, Lamp, Struve, and Schiaparelli have likewise failed to detect it. On the other hand, Prof. McLeod, of Montreal, and Mr. Brooks, of Smith Observatory, Geneva, U.S.A., both state that they have seen it; and the latter reports it variable. If it be a real spot, and not a mere effect of contrast with the shadow of the planet, it evidently would only occasionally be seen in the place where it was first discovered, but would be observed from time to time in other parts of the ring, for it would be carried round with it in its rotation.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *APRIL* 28—*MAY* 4.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 28

Sun rises, 4h. 39m.; souths, 11h. 57m. 20·7s.; sets, 19h. 16m.: right asc. on meridian, 2h. 23·9m.; decl. 14° 18′ N. Sidereal Time at Sunset, 9h. 44m.

Moon (New on April 30, 2h.) rises, 4h. 36m.; souths, 10h. 54m.; sets, 17h. 25m.: right asc. on meridian, 1h. 20·3m.; decl. 3° 3′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	4 46	12 12	19 38	2 38·6	15 42 N.
Venus.....	4 9	12 7	20 5	2 33·2	20 42 N.
Mars	5 8	12 51	20 34	3 17·9	18 30 N.
Jupiter....	0 15	4 11	8 7	18 35·9	22 55 S.
Saturn....	10 59	18 38	2 17*	9 5·7	17 51 N.
Uranus ...	17 15	22 43	4 11*	13 11·7	6 54 S.
Neptune..	5 44	13 30	21 16	3 57·3	18 49 N.

* Indicates that the setting is that of the following morning.

April.	h.	
29	23	Venus in conjunction with and 10° 15′ north of the Moon.
30	12	Mercury in conjunction with and 5° 8′ north of the Moon.
May.		
1	2	Venus in inferior conjunction with the Sun.
1	3	Mars in conjunction with and 4° 21′ north of the Moon.
1	21	Mercury at least distance from the Sun.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5	81 17 N.	May 1,	2 12	*m*
U Monocerotis	7 25·5	9 33 S.	,, 3,		*m*
δ Libræ	14 55·1	8 5 S.	Apr. 30,	0 17	*m*
U Ophiuchi	17 10·9	1 20 N.	May 1,	1 44	*m*
			,, 1,	21 52	*m*
β Lyræ	18 46·0	33 14 N.	,, 2,	0 0	*M*
U Aquilæ	19 23·4	7 16 S.	,, 4,	0 0	*M*
η Aquilæ	19 46·8	0 43 N.	,, 1,	20 0	*M*
S Sagittæ	19 51·0	16 20 N.	,, 3,	22 0	*m*
R Sagittæ	20 9·0	16 23 N.	,, 3,		*m*
T Vulpeculæ	20 46·8	27 50 N.	,, 3,	2 0	*m*
			,, 4,	4 0	*M*
δ Cephei	22 25·1	57 51 N.	Apr. 28,	4 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near ζ Ursæ Majoris	206	57 N.	Slow; bright.
,, α Serpentis	234	10 N.	Swift.
,, υ Herculis	239	46 N.	May 1. Swift; short.
,, η Aquarii	337	2 S.	Swift; very long.

THE CORROSION AND FOULING OF STEEL AND IRON SHIPS.[1]

THE difficulty of obtaining adequate experimental data, and the fact that nearly everyone who has worked at the subject has had a composition of his own to bring before the public, has so hampered and restrained the free discussion and interchange of ideas on this most important question, that at the present time we have made but scant progress beyond the point reached twenty years ago, and my object in bringing this paper before you is more to excite you to discussion, and to show you the known facts of the case, than to tell you of any very new or startling discoveries.

Corrosion generally precedes fouling on exposed metal surfaces, and it is therefore this portion of the subject that will be considered first, together with the means which have been taken to prevent it and to protect the plates of our vessels from decay.

In a paper which I had the honour to bring before you two years ago, I pointed out that in all processes of rusting carbonic acid gas and moisture played an important part, the iron uniting with the carbonic acid and oxygen of the water to form ferrous carbonate whilst the hydrogen was set free, and that the ferrous carbonate then took up oxygen dissolved in the water, or present in the atmosphere as the case may be, and was decomposed into ferric oxide (rust) and carbonic acid, which being liberated in actual contact with the moist surface of the iron carried on the process of "rusting."

This view of the case was confirmed by a paper read by Prof. Crum Brown before the Iron and Steel Institute, at Edinburgh, last autumn, and is generally accepted as the true explanation of the corrosion taking place on iron or steel surfaces exposed to moist air or fresh water; but the rusting of the metal in sea water has by many chemists been ascribed to a more complex action, in which the salt present plays an important part by first forming oxychloride of iron.

This preliminary stage of corrosion in sea water is, I am inclined to think, a myth. When iron filings or turnings are exposed to the action of sea water, hydrogen gas is evolved, and ferrous oxide and carbonate are formed, and this changes, as in air or fresh water, into ferric oxide, by taking up dissolved oxygen present in the water. At no time have I been able to

[1] A Paper read at the thirtieth session of the Institution of Naval Architects, by Prof. V. B. Lewes, F.C.S., F.I.C., Royal Naval College Associate, on April 12, 1889.

detect the presence of oxychloride, and from the fact that a few drops of alkali added to the sea water stop the corrosion, I am of opinion that the simple rusting of iron in sea water is due to the same cause as in fresh—*i.e.*, the decomposition of the water by the iron in presence of carbonic acid.

The saline constituents of sea water, however, do undoubtedly play an important part in a more active form of corrosion, by helping to excite galvanic action between the iron in the plates and any foreign metal or impurities present, an action which is also materially aided by want of homogeneity in the metal, by particles of rust, by mill scale, by wrought and cast iron or steel in contact with each other; or even by the different amount of work, such as hammering or bending, undergone by different parts of the same plate; and in all of these cases the galvanic action set up causes rapid oxidation of the iron at the expense of the oxygen of the water, hydrogen being evolved.

We may therefore consider that on the skin of a ship two processes of rusting are going on, the simple corrosion on exposed surfaces of the metal, due to the presence of moisture, carbonic acid and free oxygen, which forms a fairly uniform coating of rust on the metal, and the more local corrosion due to galvanic action, which results in pitting and uneven eating away of the plates.

As I pointed out in a previous paper, rust cones are due to the most local form of galvanic action, caused by the presence of a spec of deposited copper, lead, or other foreign metal, or even a small particle of rust, or mill scale, left on the surface of the iron, and covered by the compositions used as protectives and antifoulers; as soon as the sea water penetrates to these, galvanic action is set up, water is decomposed, rust formed, and the escaping hydrogen pushes up the composition, forming a blister, the hydrogen leaks out, the water leaks in, the action becoming more and more rapid, and the blister gradually filling with the result of the action—rust. The blister bursts, but the cone of rust has by this time set fairly hard, and continues to grow from the base, the layers of rust being perfectly visible in a well-formed cone, and when the rust cone is detached, the pitting of the metal at the base of the cone is, as a rule, found to be of considerable depth.

The speck of foreign matter which has caused this destructive action generally clings to the surface of the iron, and, being at the bottom of the pitting, escapes detection and removal, and when the vessel, newly coated with fresh compositions, again goes to sea, the corrosion will again probably be set up in the same spot.

The corrosion of the plates in the interior of a vessel is a subject quite equal in importance to the external action of sea water and dissolved gases on the metal; and from the fact that certain portions of the interior plates, from their position, escape the frequent examination and attention bestowed upon the exterior, it becomes a still greater source of danger.

Corrosion, like all other forms of chemical action, is much accelerated by increase of temperature; and in the bottom of a ship, near the furnace-room and boilers, this has a considerable effect in increasing the rapidity of rusting. Also in the coal bunkers, the mere contact of moist coal with the iron plates sets up galvanic action, carbon being electro-negative to iron, and the coal dust which sifts down into the double bottom lends its aid to the destruction of the plates; whilst, if the coal contains any "pyrites," which is nearly always the case, these double sulphides of iron and copper are gradually oxidised into soluble sulphates of the metals, and these, washing down into the bilge water, would at once cause most serious corrosion, should they come in contact with any bare portion of the plates. Repairs to any portion of the inside plates will loosen rust and mill scale, which, finding its way into the bottom, tends to set up galvanic action: whilst the scale of oxide of copper from copper and brass fittings and pipes is another great cause of danger, as the bilge water would gradually convert it into soluble salts, which will deposit their copper upon the iron wherever a crack or abrasion enables them to come in contact with it; and finally, leakages from stores and cargo are in many cases of a character highly injurious to iron.

In addition to all these sources of danger, we must remember that the interior of the vessel is the part most liable to abrasion from shifting and moving of cargo, coals, &c.

The protection of the outsides of the bottoms of our ships from the destructive agencies of sea water and dissolved gases may be said to have been attempted in two ways, by metallic and by non-metallic coatings.

So far, all attempts at metallic coatings have proved failures, and, as far as it is possible to judge, there is but small likelihood of their ever being made to succeed, because if zinc is used in order to protect the iron of the ship there must be galvanic action, and this action must take place evenly all over the surface of the iron plates, which means that the sheathing must be in uniform metallic contact with the iron, in which case the wasting of the sheathing would be so rapid that it would have to be renewed frequently, which, even leaving out the question of cost, is in many cases impossible.

Zinc is practically the only metal which could be used for this purpose, in order to place the plates of the ship in an electronegative condition, and it is, therefore, to zinc that inventors have turned from time to to time, the chief novelties introduced being the method of attachment. As far back as the year 1835, I believe Mr. Peacock tried zinc plates on the bottom of H.M.S. *Medea*, and in 1867 Mr. T. B. Daft again brought the subject forward; Sir Nathaniel Barnaby, Mr. McIntyre, and others, also suggesting various plans of attachment, whilst as late as last year Mr. C. F. Henwood read a paper at the United Service Institute strongly advocating zinc sheathing as attached by his system.

Where the galvanic contact has been but small there the sheathing has had a certain life, but has afforded but little protection to the iron, and has gradually decayed away in a very uneven fashion; whilst in those cases where galvanic contact has been successfully made the ship has on several occasions returned from her voyage minus a considerable portion of the sheathing.

Another drawback to the use of zinc sheathing is one which was found when it was used to coat wooden ships, and that is that zinc when in sheets, like every other metal, is by no means homogeneous, and that for this reason the action of sea water upon it, leaving out of consideration galvanic action, is very unevenly carried on, the sheathing showing a strong tendency to be eaten away in patches, whilst the metal itself undergoes some physical change, and rapidly becomes brittle.

Attempts have been made to galvanize the iron before the building of a ship; but Mr. Mallet showed as early as 1843 that this coating was useless when exposed to sea water, as in from two to three months the whole of the zinc was converted into chloride and oxide, and that, when, therefore, galvanising is used, care must be taken to protect the thin coating of zinc. This does not, of course, apply to fresh water, in which galvanised iron would answer very well, the rapid action being due to the salts in the sea water; but even in this case the galvanising would have to be done after the plates had been riveted together, as any breaking of the surface would set up rapid wasting of the zinc, and it could, therefore, only be used on small craft.

Copper, tin and lead have been proposed for coating ships, but these metals are electro-negative to iron, and would rapidly destroy the hull, should any abrasion of the coating or damage to the insulating material take place.

The non-metallic coatings which are intended to do away with corrosion have been almost endless. At the present moment there are upwards of thirty in the market; whilst the patent list of the last fifty years contains an enormous number which were practically still-born.

They may be divided for convenience into—

(*a*) Oil paints.

(*b*) Pitch, asphalt, tar, or waxes.

(*c*) Varnishes, consisting of resins and gums dissolved in volatile solvents.

(*d*) Varnishes, containing substances to give them body.

(*e*) Coatings of cement.

And, before going into these in detail, it is necessary to consider the condition of the surfaces to which they will have to be applied, and the effect this will have upon them.

Air has the power of holding water vapour in suspension, the amount so held being regulated by the temperature; the higher the temperature the more can the air hold as vapour, whilst any cooling of the air saturated at the particular temperature causes a deposition of the surplus moisture. When a ship is scraped down to the bare iron in the dry dock, we have a huge surface of metal which varies in temperature much more rapidly than the surrounding air, and cools much more rapidly than the stone walls of the dock; as it cools, so it chills the layer of air in immediate contact with it, and causes a deposition of the surplus moisture on its surface—a phenomenon known as the "sweating of iron "—and on to this moist surface the protective composition has to be painted. If now a rapidly-drying varnish is put on, the rapid evaporation of the volatile solvent causes again another sudden fall of temperature—evaporation being always accompanied by loss of heat—and this fall of temperature again causes a deposition of moisture, this time on the surface of the protective, so that the coating is sandwiched between two layers of moisture, both of them probably acting deleteriously upon the resin or gum in the varnish, whilst the moisture on the iron also prevents adherence of the varnish to the metal. If, instead of a quick-drying varnish, the old-fashioned red lead and linseed oil protector had been used, the second deposition would not have taken place, but the sweating of the iron would have prevented cohesion, and, when dry, any rubbing of the coating would bring it off in strips.

The condition of the outer skin of a ship, when she is being coated with her protective composition, is one of the prime factors in the discrepancies found in the way in which compositions act. It being a very usual thing for a composition to give most satisfactory results on several occasions, and then, apparently under exactly similar circumstances, to utterly break down, and to refuse even to keep on. Too much stress cannot be laid upon the condition of the plates at the time of coating, and it is absolutely essential either to have a perfectly dry ship or else a composition which is not affected by water.

When an old ship is broken up, you will often see on the backs of the plates the numbers which had been painted on them with white lead and linseed oil before the ship was built, and, under the paint, the iron in a perfect state of preservation, the secret being that the paint was put on while the plates were hot and dry.

Boiled linseed oil, mixed with red or white lead, is amongst the oldest of the protective compositions in use, but of late years has been but little employed, since it was proved by M. Jouvin, of the French Navy, and also in this country, that compounds of lead, when exposed by the wasting of the vehicle to the action of sea water, are converted into chloride of lead, and this is rapidly acted on by the iron, depositing metallic lead and forming chloride of iron, the deposited lead carrying on the corrosion of the iron by rapid galvanic action. The drying of boiled linseed oil is due to the fact that it has in it a certain quantity of an organic compound of lead, and the drying properties are given to it by boiling it with litharge (oxide of lead), so that, even when red or white lead is not mixed with it, still lead compounds are present, and this action will go on to a lesser extent. When the boiled oil drys, it does so by absorbing oxygen from the air, and becomes converted into a sort of resin, the acid properties of which also have a bad effect upon iron, so that protectives containing boiled oil are open to objection. Within the last two months a good example of the action of sea water on the bottom of an iron ship, coated with red lead, has been afforded by H.M.S. *Nile*, which, after being painted over with coats of red lead, was allowed to remain for some months in Milford Haven, with the result that her bottom is very seriously corroded, and, on examination of specimens of rust taken from her, the crystals of metallic lead are in many cases easily identified.

If red lead is used, it can only form a ground-work for an anti fouling composition which has to protect the red lead as well as the iron of the ship from the action of sea water, and when the anti-fouling composition and the vehicle perish, then serious corrosion must ensue.

The second class of protectives, consisting of tar and tar products, such as pitch, black varnish, and also asphalt and mineral waxes, are amongst the best protectives, the waxes especially not being affected by the sweating of the plates, and forming admirable coatings for the plates. Certain precautions, however, must be taken in the case of tar and tar products, both of which are liable to contain small quantities of acid and of ammonia salts; but if care be taken to eliminate these, and if it could be managed to apply this class of protectives hot to warm plates, the question of protection would be practically solved, bituminous and asphaltic substances forming an enamel on the surface of the iron which is free from the objections to be raised against all other protectives, that is, that being microscopically porous they are pervious to sea water.

The third class of protectives consists of varnishes formed by dissolving gums or resins in volatile solvents, such as spirit, turpentine, naphtha, fusel oil, &c., and such varnishes are open to several objections—in the first place, they are acted upon by moisture, which causes a deposition of the resins or gums as a non-coherent powder and destroys tenacity of the varnish. The amount of action which moisture has on such a spirit-varnish depends to a considerable extent upon the proportion of resin or gum to spirit, when the solvent is present in large quantities, and the resin in comparatively small; then the moisture has apparently little action; but it must be remembered that the drying of such protectives means the rapid evaporation of the solvent and concentration of the resin or gum, whilst the rapid volatilization which is going on cools the hull of the ship, and causes deposition of moisture on the drying varnish with most disastrous results.

Another point which must be borne in mind is that no such varnish is impervious to gases and liquids. We are apt to think of a coating of varnish as being perfectly homogeneous; but, on examining it through a microscope, it is seen to be full of minute capillary tubes, which become gradually enlarged by the action of water, and finally result in the destruction of the varnish, whilst moisture and dissolved gases find their way to the metal, and carry on corrosion. The application of several coats of varnish tends to diminish this evil, as in many cases the holes in the first coat will not correspond with the holes in the second, and so each succeeding coat will tend to make the protective more and more impervious. In using such varnishes, they must only be applied in favourable weather, and must be allowed to thoroughly harden before being brought in contact with the water.

In the fourth class we have varnishes of this kind to which body has been given by the addition of foreign constituents, generally mineral oxides; and this class is far preferable to the last, if the solvent used is not too rapid in its evaporation, and if care has been taken to select substances which do not themselves act injuriously upon iron or upon the gums or resins which are to bind them together, and are also free from any impurities which could do so.

At present the favourite substance used to give colour and body to such varnishes is the red oxide of iron, the colour of which effectually cloaks any rusting which may be going on under it. In using the red oxide for this purpose, care should be taken that it contains no free sulphuric acid or soluble sulphates, as these are common impurities, and are extremely injurious, tending to greatly increase the rate of corrosion. The finest coloured oxides are, as a rule, the worst offenders in this respect, as they are made by heating green vitriol (sulphate of iron), and in most cases the whole of the sulphuric acid is not driven off as the heat necessary impairs the colour; this acid is often neutralized by washing the oxide with dilute soda solution, but very little trouble, as a rule, is taken to wash it free from the resulting sulphate of soda, which is left in the oxide.

A sample of exceptionally good colour intended for using in protective compositions was sent me a few weeks ago for analysis, and proved to contain no less than 15·3 per cent. of sulphate of soda.

The best form of oxide of iron to use for this purpose is obtained by calcining a good specimen of hæmatite iron ore at a high temperature. When prepared in this way, it contains no sulphates, but from 8 to 40 per cent. of clay; if the percentage does not, however, exceed 12 to 18 per cent. it is perfectly harmless.

Composition manufacturers can easily test their red oxides for themselves, to see if it contains soluble sulphates, by warming a little of it with pure water, filtering through blotting paper, and adding to the clear solution a few drops of hydrochloric acid, and a little solution of chloride of barium (easily obtained at any druggist's). If a white sediment forms in the solution, the sample should be rejected.

In a previous paper[1] on the corrosion and protection of iron and steel ships, I pointed out that when such a varnish perished, the oxide of iron being left in contact with the iron plates, increased the corrosion going on at the surface of the metal, all oxides being electro-negative to the metals from which they are produced, and on that occasion I advocated the use of finely divided metallic zinc, which can be obtained as an impalpable powder, in place of the oxide of iron, pointing out that such a composition would last as long as any varnish of this class, and that, when the varnish perished, as it must do after long exposure to sea water, then the metallic zinc would, on coming in contact with the iron, set up galvanic action; but that, instead of being electro-negative, as in the case of oxide of iron, and causing corrosion of the plates, it would be electro-positive, and in consequence would protect them, being itself slowly oxidized, and so would give a fresh period of protection.

[1] Transactions of the Institution of Naval Architects, vol. xxviii.

I hoped at the time that I had made it perfectly clear that the zinc would in no way act until both the anti-fouling and protective varnish had perished, and had become spongy and porous, and that the idea was a prolongation of the period of protection, the great point which has now to be aimed at; but the remarks made afterwards in several journals which were kind enough to notice my paper showed me that they had mistaken my intention, and supposed that the zinc was put in to at once create galvanic action, and predicted that if by any chance it did act, the hydrogen generated would blow the composition into blisters, and defeat its own purpose. I need hardly point out that nothing was farther from my intention, as zinc in fine powder will be acted on more rapidly than the dense metal in plates, and I have already pointed out that this is destroyed too rapidly by galvanic action to render it of practical use as a protective *per se*.

As to the hydrogen blowing off the composition, no gas could be generated until both the anti-fouling and the protective coatings had been perished and rendered perfectly porous by the action of the sea water, a condition which would have permitted the free escape of the generated hydrogen, which, it must be remembered, will permeate through openings which other gases cannot pass through.

One of the largest firms of composition manufacturers had enough curiosity to try the effect of zinc *versus* oxide of iron, and painted a patch of it upon a ship coated with his compositions, and after a long voyage she returned with her protectives in perfectly good order, and had it not been for the patch containing zinc having had its position fixed by careful measurements, its whereabouts could not have been discovered. This is exactly what one would have expected; as long as the varnish remains intact oxide of iron, zinc, or, indeed, any substance which will not damage the varnish, does perfectly well; but had the vessel been allowed to continue until the varnishes had perished, then I venture to say that the patch containing the zinc would have shown better protection than those parts containing the oxide of iron. My ideas have undergone considerable modification during the past two years, but I still consider the views I put forward in my last paper were perfectly sound, and I am every day more and more convinced that the great object the composition-maker has to aim at is the prolongation of the life and effectiveness of compositions, and not the multiplication of short-lived devices, however admirable in their action.

In the fifth class of protectives we have cement coatings; but these, together with such schemes as the covering the hull of the vessels with vitreous glazes, glass, &c., have of late years, as far as I know, entirely been abandoned. The action of cement on iron, however, must later on be discussed in its important bearing on the protection of the interior portions of the hull, for which it is largely employed, its weight and the difficulty of attachment rendering it unfitted for outside work.

In selecting a protective composition for the bottom of a vessel, one of the second or fourth class should be chosen, attention being given to the points I have indicated, which are that in the bituminous and asphaltic compositions all the original acids must be eliminated, and that in the varnishes of the fourth group quickly evaporating solvents should be avoided, and, if possible, zinc substituted for oxide of iron.

The vessel should have her plates as dry as possible during the application of the protective, and, if feasible, days on which the air is fairly dry should be chosen. The protective should not be too thick, as, if it is, it does not readily fill into inequalities in the plates; and, if in this way any air is inclosed, change of temperature will cause it to expand or contract, thus causing a blister to form, which will fill with sea water and set up rapid corrosion. The composition must either be elastic or else have the same rate of expansion and contraction as the iron; for, if not, the change of temperature will cause cracking and tearing of the composition with disastrous results. The vessel, if she has to be scraped down to the bare metal, must be scrubbed free from all traces of rust, and where a well-adhering coating of composition exists, it should be painted over and not disturbed. In the case of a new ship, she must be pickled with dilute acid, to get rid of every trace of mill scale, and then washed down with some slightly alkaline liquid to neutralize every trace of acidity, the alkali in turn being removed by clean water. Under these conditions, and given a composition with good adhering properties, but little apprehension need be felt as to the ravages of corrosion on the metal of a ship's bottom, the chief risk being from abrasion and other mechanical injury to the composition, coupled with improper constituents in the anti-fouling compositions. The protection of the interior portion of the vessels, where the plates are exposed to the corroding action of bilge water, rendered more active by a high temperature, leakage from cargo, acids and sulphates from wet coals, and the presence of such electro-negative factors as coal dust, scale, and rust, is a matter of quite as great importance as the exterior protection; whilst the great chance of mechanical abrasion during coaling and shifting of cargo, as well as the difficulty of getting at the lower portions of the hold to examine the condition of the plates, renders it a question of the gravest consideration. The corrosion found in the portions underneath the engine-seats, the bunkers, and the water-ballast chambers, especially near the engine-room, is often very serious, and needs most careful watching, which, from the position of these parts of the vessel, it is very hard to bestow upon it.

It must also be remembered that the bilge water in a vessel is in constant motion, and that the air in these parts of the vessel may be expected to be exceptionally rich in carbonic acid gas, which, as I have before shown, is the most important factor in corrosion. Under these conditions any abraded portion would probably be continually washed over, and then exposed to the foul air, a condition of things most conducive to rapid rusting. There are three main classes of protectives for the interior of a ship—

(1) Cements.
(2) Bituminous coatings.
(3) Paints.

The first of these, the cement coatings, have many good points to recommend them, but they also have many serious drawbacks.

The rigidity, firmness of adherence and endurance, are all of them points of the greatest importance, and there is no doubt but that the silicates present in the cement in time, not only bind the cement into a mass of wonderful hardness, but also bind that cement to the iron. A point to which I should like to draw your attention, however, is that a thin coating of Portland cement is highly porous, and that it can be permeated by liquids and gases. Suppose, now, that some copper scale from the interior fittings had fallen into the bottom of the vessel, and had been converted into soluble salts of copper by the saline bilge water, this solution would soak through the capillary orifices in the cement, until it came in contact with the iron below, when the copper would be deposited on the iron, and rapid galvanic action set up, the cement being loosened, and to a certain extent lifted, by the formation of rust, whilst corrosion would gradually extend under the cement, giving on the outside of the coating but little sign of damage taking place below it.

Also the hardness and rigidity of the cement gives it a tendency to crack away from the metal when any strain is thrown upon the plates, or during any expansion or contraction of the metal; whilst any repairs on the outside of the ship, such as making a boring to test the thickness of plate, replacement of rivets, &c., would undoubtedly cause a loosening of the cement coating within, and, wherever a loosening takes place, the space between the cement and the plate will quickly be found to become a starting-point for corrosion, which quickly spreads and loosens the cement, and will only be discovered by chance.

It is for this reason that I consider bituminous or asphaltic varnishes, freed from any trace of acid, and applied hot, or sound tough paint, preferable to cement; as, although they are not so hard, yet if serious corrosion should be set up, it is easily discovered and stopped before much damage results, whilst, being impervious to moisture, deleterious solutions, either from the coal bunkers or cargo, would be prevented from acting upon the skin of the ship.

In approaching the subject of fouling, one is impressed with the apparent hopelessness of obtaining any reliable information from the successes or failures registered by the bottoms of the vessels, in the Service, or in the Mercantile Marine. Hundreds of ships may be examined, and their condition and the nature of the compositions used upon them registered, and just as one begins to feel that the key to the mystery is within one's grasp, a whole series of results so abnormal suddenly comes to light that it seems impossible to reconcile them with one's previous experience. A ship may sail half a dozen times to the same waters, coated with the same composition—on four occasions she will come home clean and in good condition, whilst on the other two voyages she may accumulate an amount of weed and animal life sufficient to knock down her speed from nine knots to five. Moreover, if the compositions with which she was coated be examined, and scrapings taken from her on her return, no cause will present itself that can in any way explain the great difference in her condition. After several years' close observation, however, certain factors begin to make themselves apparent. Ships at sea from March to August show a worse average than those afloat from August to March; one also begins to realize that the amount of fouling increases enormously if the ship has been long at anchor—ships which have been lying at the mouths of rivers, although quite clean in the brackish water, foul much more rapidly on going to sea than the vessels which have been cruising, or even at anchor for the same time in salt water; and finally, certain ports and certain seas seem to exercise a deleterious effect, both as regards corrosion and fouling, which is not to be found elsewhere.

Turning back to the naval history of the past, we find that fouling is no new trouble born with the advent of our present iron monsters; but that it has been the one trouble that the combined engineering and scientific skill of many centuries has been unable to overcome.

With our wooden ships, metallic copper sheathing, if it were of the best kind, answered the purpose fairly well; but then the copper wasted so fast the inferior kinds and alloys were substituted to prevent the rapid loss, and, with the slowing down of the destruction of the copper, at once the trouble of fouling returned.

When iron ships began to replace the wooden ones, as was only natural, attempts were made to utilize the metal which had before given relief; but it was quickly found that the effect of the galvanic action set up by the copper was fatal to the iron plates of the ship, and attempts were then made to sheathe the ship with copper plates in such a way that they should be insulated from the iron of the vessel, a condition almost impossible to attain and attended with great risk, should any accidental injury to the insulation take place.[1] Early in the history of iron shipbuilding the idea was started of using coatings of paint, so prepared as to fulfil the same functions as the copper plates had done; but from 1840, when the first paint of this kind was patented, down to the present day, when there are upwards of thirty-two different compositions in the market, very little progress has been made in their manufacture, and the best of their compounds cannot be relied upon for keeping a ship's bottom even fairly free from fouling for periods extending beyond nine months, and I am personally convinced that the reason of this is to be found in the fact that a start was originally made in the wrong direction.

The idea which originally led to the present class of anti-fouling compositions was that the copper salts formed by the action of the sea water on the metallic sheathing owed a considerable portion of their value as anti-foulers to the poisonous action they exerted upon marine animal and vegetable growths; but, when an observer comes to study the natural history of these lower forms of animal life and vegetation, it is gradually forced upon one that it is only in the early stages of their growth—the germ period—that metallic poisons can affect them. Seaweeds do not take in the constituents they require for their growth by means of their roots, as is, to a certain extent, the case with ordinary plants, but absorb them by means of their pores from the water itself, the root only serving to attach them to the solid they choose for their resting-place; it is also well known that when once a marine plant which has passed the first stages of existence is dislodged or torn from its support, it cannot reattach itself to anything else, whilst most of the mineral poisons have little or no effect upon their life and growth.

In the same way we find that, with the animal life found on a ship's bottom, the under side is used to cling on with only, and not as an extractor of nourishment, and that, therefore, after the seeds and germs have once obtained a foothold on the side of the vessel, no amount of poison which can be put into a composition will have any effect upon them. Metallic poisons undoubtedly do exert an influence upon the germs in their earliest stages; but after that they are perfectly useless as anti-foulers, and only imperil the plates of the vessel.

The germs of both kinds of growth are of necessity more abundant in the surface water near shore than in deep water, and therefore the period when the ship is in port is the time when the germs are most likely to make good their attachment, after which their further development is, unless other methods of getting rid of them are employed, merely a matter of time.

On examining the conditions under which a vessel is placed when coated with a composition which relies for its anti-fouling powers on metallic poisons only, we at once see the reasons which must make such a coating of little or no avail. In the composition we have drastic mineral poisons, probably salts of copper, mercury, or arsenic, which have been worked into a paint by admixture with varnishes of varying composition, and each particle of poison is protected from the action of the sea water by being entirely coated by this vehicle: that this must be so is evident, or the composition would not have sufficient cohesive power to stick on the ship. As a rule, care is taken to select fairly good varnishes, which will resist the action of sea water for, perhaps, two or three months, before they get sufficiently disintegrated to allow the sea water to dissolve any of the poison; whilst, even with the accidental or intentional use of inferior varnishes, three or four weeks will pass before any solution can take place, and any poison be liberated to attack the germs. A ship is dry docked, cleaned, and, her anti-fouling composition having been put on, she goes probably into the basin to take in cargo. Here she is at rest, and, with no skin friction or other disturbing causes to prevent it, a slimy deposit of dirt from the water takes place, and this, as a rule, is rich in the ova and germs of all kinds of growth, whilst the poisons in her coating are locked up in their restraining varnish, and are rendered inactive at the only period during which they could be of any use. After a more or less protracted period, the ship puts to sea, and, the perishing of the varnish being aided by the friction of the water, the poisonous salts begin to dissolve or wash out of the composition; but the germs have already got a foothold, and with a vessel sweeping at a rate of, say 10 to 12 knots through the water, the amount of poison which can come in contact with their breathing and absorbing organs is evidently so infinitesimally minute that it would be impossible to imagine it having any effect whatever upon their growth. If the poison is soluble, it is at once washed away as it dissolves; if it is insoluble, then it is also washed away, but there is just a chance that a grain or two may become entangled in the organs of some of the forms of life, and cause them discomfort. As the surface varnish perishes, the impact of the water during the rapid passage of the vessel through the water quickly dissolves out or washes out the poisonous salts, and leaves a perished and porous, but still cohesive, coating of resinous matter, which forms an admirable lodgment for anything which can cling to it; and by the time the vessel lays-to in foreign waters, teeming with every kind of life, the poison which would now again have been of some use is probably all washed away, and a fresh crop of germs are acquired, to be developed on the homeward voyage, and a "bad ship" is reported by the person who looks after her docking. It is evident that a poison, even if it had the power of killing animal and vegetable life in all stages, could only act with the vessel at rest, unless it were of so actively corrosive a nature as to burn off the roots and attachments of the life rooted to it, and if it did this, what, may I ask, would become of the protective composition and the plates of the vessel? And I think it is also evident that any poison so used must be under conditions in which it is very unlikely to be in a position to act when it might do good.

The lamentable failure of composition after composition of this kind has gradually reduced them in number to some ten or twelve at the present time, and in most cases it is low price alone which keeps them in the market.

The practical proof, given by experience, that poisons alone are unable to secure a clean bottom, soon led many inquirers to the conviction that it was the exfoliation in the case of copper which had acted in giving fairly good results, and in many compositions the attempt has been made to provide a coating which shall slowly wash off, and, by losing its original surface, shall at the same time clear away germs and partly developed growths, and so expose a continually renewed surface, in this way keeping the bottom of the vessel free from life. There is no doubt that, when this is successfully done, a most valuable composition will result, but the practical difficulties which beset this class of anti-foulers must not be overlooked. In order to secure success, the composition must waste at a fairly uniform rate, when the ship is at rest, and also when she is rushing through the water; and this is the more important in the case of Service vessels, as in many cases they spend a large percentage of their existence at anchor, or in the basins of our big dockyards. If a composition is made to waste so rapidly that it will keep a vessel clean for months in a basin, then you have a good composition *for that purpose*; but send the vessel to sea, and under conditions where you have a higher temperature, and the enormous friction caused by her passage through the water exerting its influence upon the composition, and you will find that the coating, which did its work well for six months at rest in the basin, will, in the course of one month under these altered conditions, be all washed

[1] Some copper sheathed vessels still exist, and its revival has been lately warmly advocated in America.

away, and fouling will be set up. Noting this result, the manufacturer renders his composition more insoluble—less wasting—and so obtains a coating which, when the vessel is in motion, scales just fast enough to prevent fouling, and good results at once follow ; the composition is then put on the same or other vessels, and they take a spell of rest in the basin, and, bereft of the aid of the higher temperatures and the friction of the water, the composition ceases to waste fast enough, and bad results at once have to be recorded.

There is no doubt that this is the true explanation of the wide discrepancies which are found between the compositions in the Navy and in the Mercantile Marine : take any of the big lines, their steamers are running at a fairly uniform rate of speed, and the periods of inaction are as short as the desire not to waste the charge on the capital they represent can make them, and under these conditions, by varying the constituents in the varnishes used for anti-fouling purposes, it is fairly easy, given the necessary data, to so constitute a composition as to secure admirable results ; but when you come to apply this same coating to an ironclad running at various speeds, and as often at rest as in motion, then you at once find that the composition you before imagined to be all that could be desired fails just as lamentably as the tribe of anti-foulers which preceded it. It is not so very long ago that I had the honour to serve on an Admiralty Committee under the able guidance of Admiral Colomb, and, after inspecting many vessels in the Mercantile Marine, and watching all the dockings of Service vessels over a considerable space of time, we were forced to the conviction that it was only in very rare cases that the condition of the bottoms of Her Majesty's ships at all approached the freedom from fouling to be found in the ships belonging to the big companies, with the result that some of the most successful of the compositions in the Mercantile Marine were brought into use in the Navy, and I believe the reports of the dockings since they have been adopted will amply prove the existence of the difficulties I have mentioned.

Another factor which is often overlooked, and which tends to give misleading results, is the action of brackish water, which, in many cases, seems to exert a special action in keeping the bottom of a vessel clean, the fresh water having a tendency to disagree with certain forms of marine growth, whilst the salt water is apparently equally unpalatable to the fresh-water forms of fouling.

In most of the compositions now in use, attempts are made to combine strongly poisonous substances with exfoliating and wasting coatings, and this is done by either using metallic soaps, the basis of which is, as a rule, copper, or else by charging a perishable and easily washed-off varnish with poisonous salts, consisting, as usual, of compounds of either copper, mercury, or arsenic, and in some cases all three.

As I have before pointed out, I do not think the presence of these substances exerts any deterrent action upon the fouling, save perhaps when the vessel is at rest ; but they exert undoubtedly an important influence upon the rate of exfoliation, as when the perishing of the varnish exposes them they dissolve, or are washed out, and in this way tend to disintegrate and clear away the surface more rapidly—an important and decidedly useful function, but one which might be more cheaply performed by substances other than high-priced metallic poisons.

The use of metallic poisons of the character indicated throws an increased burden upon the protective composition, as, should the latter become abraded by friction of chain cables, barges alongside, or any other cause, the iron of the vessel will be attacked by the metallic salts, either present in the soluble form in the anti-fouling composition, or rendered so by the solvent action of the saline constituents of the sea water, the action of the metallic salts being to rapidly dissolve portions of the iron, and to deposit the metal which they contain upon the surface of the plates, and these deposits, exciting energetic galvanic action, cause corrosion and pitting to go on with alarming rapidity. Both mercury and copper salts are offenders in this way, but copper is by far the most objectionable, from the fact that the salts formed by the action of the sea water upon the compounds used in the compositions are far more soluble than the corresponding salts of mercury, and are therefore liable to be present in much larger quantity, and so exert comparatively a much more injurious action on the plates.

As an illustration of this, two equal portions of sea water were saturated, the one with copper chloride, the other with mercuric chloride, and into each a piece of steel, planed upon one side, and of about equal weight and size, was placed, and left for four days. At the end of this period the two plates were removed, and, after being cleaned and dried, were again weighed, when it was found that the one exposed to the copper-saturated sea water had lost 22·2 per cent. in weight, while the plate exposed to the mercurial solution had only lost 3·6 per cent., this being due to the much larger amount of the copper salt soluble in the sea water.

On now placing these plates in clean sea water, corrosion went on in each case with extreme rapidity, and after being exposed for a month, they had both wasted to about the same extent—that is to say, when once deposited on the iron, mercury is practically as injurious as copper.

I am quite aware that this experiment is not at all likely to be carried out in practice, and none can have a greater conviction of the inutility of small laboratory experiments than I have, as they lack all the factors of mass of material and atmospheric influence which play so important a part in a question like the present ; but such an experiment gives one a definite and fairly correct idea of the relative rate of action of the two poisons upon the plates.

All the time the ship is in motion, the wash of the sea water will prevent the metallic poisons doing the plates or the marine growths much harm, but there is one phase of this question which I think has been overlooked. I need not point out that in certain ports there is a fashion in compositions, and that most of the homes of the Mercantile Marine have some pet local composition which is largely used at the particular port. If, now, many ships are laying in a basin, taking in and discharging cargo, and if the prevalent compositions contain copper, it is evident that a certain quantity will go into solution in the water, which often does not undergo frequent or rapid change, and under these conditions every ship in the basin will be exposed to the same danger, and wherever an abrasion has taken place in the protectives, there copper will be deposited on the iron, causing corrosion and destruction of the plates ; and it must be remembered that when the vessel is next docked and coated no amount of scraping will remove the fine particles of copper deposited in the pitted and corroded portions of the plate, and so finely divided as to be invisible to the eye, but that they will remain and carry on the destructive work under the new coatings of protective.

It is, I think, a well-recognized fact that, when a vessel coated with a copper compound has become corroded from failure of her protective, or from abrasion, even an entire change of composition does little or no good in stemming the tide of corrosion, until after some considerable period has elapsed, a result which is due to the same cause ; and, inasmuch as copper compositions are a source of danger, not only to the ships coated with them, but to any others which may be at rest in the same basin, I do strongly urge upon the manufacturers to abandon the use of these deleterious compounds, and to use others equally efficacious and free from the grave objections I have enumerated.

At the present time, 15 out of 32 principal compositions rely upon copper in some form or other as the basis of their anti-fouling composition, and in one which has enjoyed considerable favour finely divided metallic copper itself is used, and should vessel coated with it, after the varnishes had commenced to disintegrate, be moored alongside an iron ship by a chain cable, or even by a wet hawser, a big galvanic couple would be formed at the expense of serious damage to any exposed iron.

In the history of anti-fouling many attempts have been made to obtain highly glazed and glass like-surfaces which it was hoped would withstand the action of sea water, and afford no lodgment to marine growths ; but even glass itself is slowly acted upon by sea water, and, when once roughened on the surface, will foul, whilst the rigidity of such coatings, and the straining and cracking consequent on unequal expansion and contraction of the plates and their coating, offers a serious obstacle to any such scheme.

In concluding this long paper, I wish to point out that in the present phase of the anti-fouling question, and until some new principle for preventing marine growth has been advanced and successfully adopted, satisfactory results can only be insured by an intelligent use of the existing compositions.

The protective composition is the important composition, and care must be taken to obtain the best in the market, as, if the protection is good, the plates remain uninjured even if fouling take place. The anti-fouling composition to be used with it must either be elastic, or have the same rate of contraction and expansion as the protective, and must—at any rate in the Navy—be chosen to suit the work to be done, such as contain copper compounds being carefully rejected, whilst preference should be given to those which rely on exfoliation rather than mineral poisons.

If a vessel is to remain at rest for a considerable period, an anti-fouling composition which exfoliates rapidly, and which also contains poisons known to act on germ life, must be used, the amount of such poison depending on the seasons and the waters in which the ship is to be; whilst if a vessel is to be continually running, then a slowly exfoliating composition must be employed, and a very small percentage of poison is all that is required, as skin friction and the comparative absence of the germs and spores in deep water will do the rest.

Our ships represent an enormous capital, and any trouble or care which will prolong their existence is well worth taking and will be amply repaid, and at the present time a heavily corroded and foul vessel means either ignorance or negligence on the part of those who have the responsibility of deciding on the compositions to be used; and, finally, it must be clearly borne in mind that there is no anti-fouling composition which ever has been made, or probably ever will be made, that will answer for all cases, and that, until this is clearly recognized, the present unsatisfactory condition of the question will exist.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 28.—"The Diurnal Variation of Terrestrial Magnetism." By Arthur Schuster, F.R.S., Professor of Physics; with an Appendix by H. Lamb, F.R.S., Professor of Mathematics, Owens College, Manchester.

In the year 1839, Gauss published his celebrated memoir on "Terrestrial Magnetism," in which the potential on the earth's surface was calculated to twenty-four terms of a series of surface harmonics. It was proved in this memoir that if the horizontal components of magnetic force were known all over the earth the surface potential could be derived without the help of the vertical forces, and it is well known now how these latter can be used to separate the terms of the potential which depend on internal from those which depend on external sources.

The use of harmonic analysis to separate internal from external causes has never been put to a practical test, but it seems to me to be specially well adapted to inquiries on the causes of the periodic oscillations of the magnetic needle.

If the magnetic effects can be fairly represented by a single term in the series of harmonics as far as the horizontal forces are concerned, there should be no doubt as to the location of the disturbing cause, for the vertical force should be in the opposite direction if the origin is outside from what it should be if the origin is inside the earth.

In any case, the differences between the two results will be of the same order of magnitude as the vertical force itself. If it were then a question simply of deciding whether the cause is outside or inside, without taking into account a possible combination of both causes, the result should not be doubtful even if we have only an approximate knowledge of the vertical forces.

Two years ago I showed that the leading features of the horizontal components for diurnal variation could be approximately represented by the surface harmonic of the second degree and first type, and that the vertical variation agreed in direction and phase with the calculation on the assumption that the seat of the force is outside the earth. The agreement seemed to me to be sufficiently good to justify the conclusion that the greater part of the variation is due to causes outside the earth's surface. Nevertheless, it seemed advisable to enter more fully into the matter, as in the first approximate treatment of the subject a number of important questions had to be left untouched. I now publish the results of an investigation which has been carried out as far as the observations at my disposal have allowed me to do. My original conclusions have been fully confirmed, and some further information has been obtained, which I believe to be of importance.

I have made use of the observations taken at Bombay, Lisbon, Greenwich, and St. Petersburg. The horizontal components of the diurnal variation during the year 1870 were in the first place reduced to the same system of co-ordinates and to the same units. If we remember that experience has shown the diurnal variation to be very nearly the same for places in the same latitude, except near the magnetic pole, and also that it is symmetrical north and south of the equator, we may for a given time of day assume the horizontal components known over eight circles of latitude, four of which are north and four south of the equator.

From the horizontal components, the potential was calculated in terms of a series of surface harmonics. It was found that in order to represent both the summer and the winter effect with sufficient accuracy thirty-eight terms were necessary. In this calculation the vertical forces were not made use of at all.

From the potential, as calculated from the horizontal components, we can deduce the vertical force, either on the assumption that the variation is due to an outside cause, or that it is due to an inside cause; and compare the vertical forces thus found with the vertical forces as actually observed.

If we put both into the form

$$r_n \cos n(t - t_n),$$

we can obtain an idea of the agreement as regards amplitude and phase for each harmonic term. The following tables give the results for $n = 1$ and $n = 2$—that is, for the diurnal and the semi-diurnal variation:—

TABLE I.

Observed and calculated Values of the Coefficients t_1 and t_2 of Vertical Force, when expressed in the form $r_1 \cos (t - t_1) + r_2 \cos 2(t - t_2)$, on the supposition that the Disturbing Force is *inside* the Earth.

	t_1.						t_2.					
	Calc.		Obs.		Diff.		Calc.		Obs.		Diff.	
	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.
Bombay	23	02	11	13	+11	49	9	55	4	23	+ 5	32
Lisbon	22	35	10	40	+11	55	11	42	5	50	+ 5	52
Greenwich	22	06	8	42	−11	54	11	32	5	56	+ 5	36
St. Petersburg, 1870	21	16	3	10	− 5	54	10	48	7	05	+ 3	43
,, 1878	...		7	05	− 9	49	...		6	12	+ 4	36

TABLE II.

Observed and calculated Values of the Coefficients t and t_2 when expressed in the form $r_1 \cos (t - t_1) + r_2 \cos 2(t - t_2)$, on the supposition that the Disturbing Force is *outside* the Earth.

	t_1.						t_2.					
	Calc.		Obs.		Diff.		Calc.		Obs.		Diff.	
	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h	m.
Bombay	11	10	11	13	− 0	03	3	47	4	23	− 0	36
Lisbon	10	37	10	40	− 0	03	5	46	5	50	− 0	04
Greenwich	10	03	8	42	+ 1	21	5	38	5	56	− 0	18
St. Petersburg, 1870	8	52	3	10	+ 5	42	4	38	7	05	− 2	27
,, 1878	...		7	05	− 1	47	...		6	12	− 1	34

In Table I. the comparison of the observed phases is made with the values calculated on the assumption that the disturbing force is inside the earth. In Table II. the same comparison is made on the alternative hypothesis. There is complete disagreement in Table I. between the observed and calculated values, and nearly complete agreement in Table II. It is seen how both at Lisbon and Bombay the time of maximum displacement agrees within three minutes of time for the diurnal variation, and at Lisbon within four minutes of time also for the semi-diurnal variation. Considering that Lisbon is the most important station, not only on account of its geographical position, but also because the observed vertical forces apply to the same year as the calculated ones, the result is strikingly in favour of the outside force. The results for Greenwich argue in the same direction. As regards St. Petersburg, the results for 1870 neither agree with one nor with the other hypothesis. The observations for 1870 are, however, doubtful, but the results for 1878 agree well with the hypothesis of an outside disturbing force.

The observed amplitudes are found in all cases to be considerably smaller than the calculated ones.

If we then take it as proved that the primary cause of this variation comes to us from outside the earth's surface, we are led to consider that a varying magnetic potential must cause induced currents within the earth, if that body is a sufficiently good conductor. These induced currents might be the cause of the apparent reduction in amplitude. As my colleague, Prof. Lamb, has given considerable attention to the problem of currents in a conducting sphere, I consulted him, and he gave me the formulæ by means of which the induced currents can be calculated. This investigation is given in an appendix to the paper. The result is very interesting. If the earth is treated as a conducting sphere, the observed reduction in amplitude is accounted for, but that reduction should be accompanied by a change of phase which is not given by observation. We can reconcile all facts if we assume, as suggested by Prof. Lamb, the average conductivity of the outer layers of the earth to be very small, so that the reduction in amplitude is chiefly due to currents induced in the inner layers. If the conductivity inside is sufficiently large, a considerable reduction in amplitude would not be accompanied by a sensible change of phase. We have arrived, therefore, at the following result:—

The vertical forces of the diurnal variation can be accounted for if we assume an outside cause of the variation, which induces currents in the earth, and if the earth's conductivity is greater in the lower strata than near the surface.

Prof. Balfour Stewart's suggestion that convection currents in the atmosphere moving across the lines of the earth's magnetic forces are the causes of the daily variation, gains much in probability by this investigation. If the daily variation of the barometer is accompanied by a horizontal current in the atmosphere similar to the tangential motion in waves propagated in shallow canals, and if the conductivity of the air is sufficiently good, the effects on our magnetic needles would be very similar to those actually observed. The difficulty as to the conductivity of the air is partly met by the author's investigation of the behaviour of gases through which electric discharges are passing.

It will be interesting to follow out the investigation, especially with a view of examining the influence of sun-spot variation. The question of magnetic disturbances is more complicated, but as magnetic observatories are being established in many countries, the time may not be far distant when we shall be able to bring the irregular disturbances within the reach of calculation.

The author acknowledges the help he has received from Mr. William Ellis in some of the reductions; he has also to thank his assistant, Mr. A. Stanton, for much labour bestowed on making and checking numerical calculations.

Royal Meteorological Society, April 17.—Dr. W. Marcet, F.R.S., President, in the chair.—The following papers were read:—On the deaths caused by lightning in England and Wales from 1852 to 1880, as recorded in the returns of the Registrar-General, by Inspector-General R. Lawson. The total number of deaths from lightning during the twenty-nine years amounted to 546, of which 442 were of males, and 104 of females. In consequence of their greater exposure, the inhabitants of rural districts suffer more from lightning than those of towns. It appears also that vicinity to the west and south coasts reduces the chances of injury by lightning, and that distance from the coast and highland seems to increase them.—The diurnal range of the barometer in Great Britain and Ireland, by Mr. F. C. Bayard. The author has reduced the hourly records of the barometer at the nine Observatories, Aberdeen, Armagh, Bidston, Falmouth, Glasgow, Greenwich, Kew, Stonyhurst, and Valencia, during the years 1876–80. The curves of inland places are smoother than those of places on the sea-coast, and the curves of places to the westward are more irregular than those of places to the eastward. As we go from south to north the general tendency of the curve is to get flatter with a lessened diurnal range.—Note on a working model of the Gulf Stream, by Mr. A. W. Clayden. The author showed this interesting model at work; it has been constructed to illustrate the formation of ocean currents in general and of the Gulf Stream in particular.—On the rime-frost of January 6 and 7, 1889, by Mr. C. B. Plowright. The author gives an account of the very heavy rime which occurred in the neighbourhood of King's Lynn on these days, when the fringe of crystals upon twigs and branches of trees was about 2 inches in length. The weight was so great that nearly all the telegraph wires were snapped and an immense number of branches of trees broken off.

Zoological Society, April 16.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—The Secretary exhibited a pair of a fine large Buprestine Beetle of the genus *Julodis* (*Julodis ffinchi*), obtained by Mr. B. T. Ffinch near Karachi; and a Mole-cricket (*Gryllotalpa vulgaris*), sent by Mrs. Talbot from Bagdad.—Mr. Sclater made some remarks on the animals he had noticed during a recent visit to the Zoological Gardens of Rotterdam, Amsterdam, and Antwerp.—A communication was read from Mr. A. H. Everett, containing remarks on the zoo-geographical relationships of the Island of Palawan and some adjacent islands. In this paper it was contended that Palawan and the other islands intervening between Borneo and Mindoro form an integral portion of the Bornean group, and do not naturally belong to the Philippine Archipelago, with which they have hitherto been treated. The writer founded his contention upon the grounds (1) that the islands in question are connected with Borneo by a shallow submarine bank, while they are separated from the Philippines by a sea of over 500 feet depth; and (2) that a comparison of the Bornean and Philippine elements in the fauna of Palawan, so far as it is known, shows a marked preponderance of the former over the latter element; while the Philippine forms are also more largely and more profoundly modified than the Bornean species. This fact indicated that they had been longer isolated, and consequently that the fauna of Palawan was originally derived from Borneo, and not from the Philippines, though a considerable subsequent invasion of species from the latter group had taken place.—A communication was read from Mr. Oldfield Thomas, containing an account of the mammals of Kina Balu, North Borneo, from the collections made on that mountain by Mr. John Whitehead in 1887 and 1888. The species represented in Mr. Whitehead's collection were 21 in number, of which six had proved to be new to science.—Mr. G. A. Boulenger read the second of his communications on the fishes obtained by Surgeon-Major A. S. G. Jayakar at Muscat, on the east coast of Arabia. The two collections recently received from Mr. Jayakar contained examples of 80 species not included in Mr. Boulenger's former list.

PARIS.

Academy of Sciences, April 8.—M. Des Cloizeaux, President, in the chair.—Fixation of nitrogen by vegetable soil with or without the aid of leguminous plants, by M. Berthelot. The paper deals with a fresh series of sixty-four methodic experiments carried out during the year 1888, and fully described in the April number of the *Annales de Chimie et de Physique*. They form a sequel to the systematic researches begun by the author in 1883, and tend fully to confirm the views already announced by him on the fixation of free nitrogen in the ground effected either with or without the co-operation of luzern, vetches, and other leguminous plants. He considers the fixation now fully established, and finds in this fact the true interpretation of a multitude of phenomena highly important to agriculture.—Experiments on putrefaction and the formation of manures, by M. J. Reiset. The more recent experiments here described fully confirm the results of those undertaken by the author so far back as 1854, and show that, in the process of organic decomposition, nitrogen is not fixed, but liberated.—On the identity of erysipelas and acute lymphangitis, by MM. Verneuil and Clado. The researches of the authors in the Hospital de la Pitié show that these are not two distinct disorders, as is often assumed, but merely two forms of the same contagious, infectious, and parasitic disease, due to a special microbe easily recognized, isolated, cultivated, and inoculated in animals. This microbe, hitherto discovered in erysipelas alone, has now also been detected in acute lymphangitis with all its characters and biological properties.—On the influence of refraction in the reduction of the observations of a meridian transit, by M. G. Rayet. The conditions already described by the author in his communication on the influence of refraction in the reduction of the observations of the circumpolar stars (*Comptes rendus*, March 11, 1889), are here shown to be equally applicable to the reduction of the observations of transits at any declination.—Direct determination of the compressibility of glass, crystal, and metals, up to 2000 atmospheres, by M. E. H. Amagat. By direct determination is here meant a determination effected without employing any formula. The results already communicated in recent notes were for slight pressures only; hence these further experiments have been undertaken for the purpose of ascertaining whether, under very high pressures, the compressibility of glass, crystal, &c., undergoes any considerable diminution. The process employed is that adopted by Mr. Buchanan, and afterwards by Prof. Tait in their researches.—On the intensity of telephonic effects, by M. E. Mercadier. During his researches on the theory of the telephone, the author has been led to study the causes to which is due the varying intensity of the effects produced by this instrument. Here he studies more particularly the influence of the thickness of the diaphragm for a telephone of well-defined form, and for a like variation of the magnetic field. Some experiments are described with iron diaphragms, and it is generally inferred that for all telephones of a given magnetic field there is a given thickness of the iron diaphragm which yields a maximum effect.—On the solubility of salts, by M. H. W. Bakhuis Roozeboom. This is a reply to M. Le Chatelier's critical remarks (*Comptes rendus*, March 18, 1889) on the work recently published by the author on the conditions of equilibrium between the solid and liquid combinations of water with salts, more particularly with calcium chloride.—On methylacetanilide, by M. H. Giraud. It is pointed out that the scientific name of ortho-methylacetanilide given to the *exalgine* recently prepared by M. Brigonnet, can only be applied to the substance described by Beilstein and Kuhlberg under the name of aceto-orthotoluide. It is further shown that M. Brigonnet's preparation is not new, that it was described by Hofmann in 1874, and that its true name is methylacetanilide.

BERLIN.

Physiological Society, March 27.—Prof. du Bois-Reymond, President, in the chair.—Dr. Klemperer spoke on the proteid needs of the animal economy in health and in certain pathological conditions. Voit's teaching, that the human body in health requires daily from 100 to 120 grammes of proteid in order to supply its nitrogenous needs, has been recently contested from many sides; and even if the experiments on which the attacks were based were not altogether free from some defects, they still sufficed to cast a good deal of doubt on Voit's theory. The speaker had endeavoured, working from the clinical point of view, to decide the question whether an increased proteid metabolism can be prevented or diminished by an increased ingestion of carbohydrates or fats. He carried out experiments on the nutrition of two healthy persons, in which the daily dose of proteids was very considerably diminished, even down to 40 grammes, while in compensation for the lessened proteids larger quantities of fats, sugar, and easily absorbed and oxidizable alcohol were administered. The nitrogen excreted in the urine was constantly less in amount than that taken in the food, thus showing that healthy, active men can be fed with largely diminished amounts of proteid without the occurrence of any destructive metabolism of their tissue-proteids. He next proceeded to investigate whether, in diseases which are characterized by an abnormally large breaking down of tissue-proteids, this increased nitrogenous metabolism could be lessened by the ingestion of an increased quantity of non-nitrogenous food. An increased nitrogenous metabolism occurs in dyspnœa, fever, anæmia, cancer, tuberculosis, diabetes, and Addison's disease. For dyspnœa, experiments were made on animals; while for anæmia, cancer, diabetes, and Addison's disease, observations were made on the human subject, and results were obtained which corresponded to the supposition under which the experiments were started. A very considerable reduction of the nitrogen excreted in the urine was observed when only moderate quantities of proteid were given, while at the same time increased amounts of carbohydrates, fats, and alcohol, were administered. It is impossible to enter here into the interesting details of these experiments, which were all carried out by very precise methods, or into a discussion of the hypotheses which were advanced in explanation of the phenomena which had been observed.—Prof. Rosenthal, of Erlangen, gave an account of calorimetric experiments with which he had been busied for the last few years. He employed in these an air-calorimeter of special construction. It consisted of a copper vessel, of easy ventilation, in which the animal was placed; this was surrounded by an air-tight envelope, filled with air and constituting the reservoir of an air-thermometer; external to this was a covering to shield the whole apparatus from any changes in the temperature of the surrounding atmosphere. When the animal gives up to the envelope of air, per unit of time, exactly the same amount of heat as the whole apparatus radiates into the surroundings, the temperature of the air in the envelope remains constant, as also its *pressure*: hence the heat produced and given off by the animal during any known time could be measured by means of a manometer. Notwithstanding that the dog used in the experiments was fed in exactly the same way at each meal, the quantities of heat produced varied very largely, and any considerable uniformity is only obtained by taking the mean of a long series of observations. Up to about the third hour after the meal the heat-production diminishes, then rises rapidly to a maximum, and from this point, at about the eighth hour, it begins to fall again slowly and with irregularities, until the next meal. Over the whole twenty-four hours the heat-production is more uniform during the second period of twelve hours than in the first; about 20 per cent. more heat is produced during the first than during the second half of the whole day. When an excess of food was given the heat produced was always less than that calculated out from the oxidation of the food itself; but with a uniformly constant diet the mean value of the heat produced corresponded to the heat calculated for the oxidation of the food. The amount of carbonic acid gas given off by the animal was found to correspond to the heat given off during the same period only in cases where prolonged intervals of time were taken into account. When the surrounding temperature varied between 5° and 25° C., all other conditions remaining the same, a minimal production of heat was observed at 15° C.: from this point it increased uniformly in both directions, not only when the temperature fell to 5° C., but also when it rose to 25° C.—Prof. Schweigger demonstrated several pieces of apparatus, which by the use of small incandescent electric lamps, could take the place of the ophthalmoscope, and even render a binocular examination possible. They also made the measurement of refraction in the eye both simple and exact.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Useful Native Plants of Australia (including Tasmania): J. H. Maiden (Trübner).—The Psychic Life of Micro-organisms: A. Binet; translated by T. MacCormack (Chicago).—The Elements of Vital Statistics: Dr. A. Newsholme (Sonnenschein).—Catalogue of the Fossil Fishes in the British Museum (Natural History). Part 1: A. Smith Woodward (London)—Richtigstellung der in bisheriger Fassung unrichtigen Mechanischen Wärmetheorie und Grundzüge einer Allg. Theorie der Aetherbewegungen: A. R. von Miller-Hauenfels (Wien).—The Land of Manfred: J. Ross (Murray).—Bulletins de la Société d'Anthropologie de Paris, tome xi., 4e fasc. (Paris).—Mémoires de la Société d'Anthropologie de Paris, tome iv., fasc. 1 (Paris).—Journal of Anatomy and Physiology, April (Williams and Norgate).—Zeitschrift für wissenschaftliche Zoologie, xlviii. Band, 1 Heft (Leipzig).

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