AT a meeting of the electors to the Waynflete professorship of mineralogy, held at Magdalen College on December 13th, Mr. Henry A. Miers, M.A., Trinity College, was elected professor in the place of Prof. Story-Maskelyne, resigned. The emoluments of the professorship are £500 per annum, of which £400 is from Magdalen College and £100 from the University chest.

DISCUSSION AND CORRESPONDENCE.

AN EASY METHOD OF MAKING LINE DRAWINGS.

IT is often difficult to get satisfactory cuts of apparatus or of natural objects to illustrate scientific articles. A half-tone, although the easiest to get, is somewhat expensive and liable to be poorly printed, and, on account of its vagueness of outline, is in many cases not as good for scientific purposes as a half diagrammatic line drawing. To get a cheap cut that can be printed on a newspaper press the original photograph must be redrawn in lines and dots. But not everyone has the time and skill to make an accurate line drawing, while if the photograph is sent off to a professional draftsman the expense is about the same as for a half-tone, and the drawing frequently fails to bring out the very point to be illustrated.

A line drawing with the accuracy of a photograph can, however, be easily made in this way: photograph the object, take from the negative a pale blueprint, on the blueprint trace the outlines with as much detail as desired using a crowquill pen and waterproof ink, put the print in water containing a few drops of ammonia, when the blueprint will fade away leaving the black lines on white ground, wash and dry, make such alternation or additions as are required, and the drawing is ready for reproduction by the zinc etching or other process. Of course if the photograph is several times larger than the cut is to be, the reproduction will be neater. E. E. SLOSSON.

UNIVERSITY OF WYOMING.

[We are glad to give space to the above, although the method has already been recommended. For an apparently new and in many cases better method cf. Prof. Hallock's note on page 761 of the present volume of SCIENCE. J. McK. C.]

THE MEASUREMENT OF COLORS.

EDITOR OF SCIENCE—*Sir:* Mr. J. W. Lovibond, of Salisbury, mentions in *Nature* that his system of Tintometer glasses is in constant use in many laboratories and manufactories for enabling one to record and to reproduce exactly at a future time any given color; and that the method is so simple that it can be carried out by any intelligent workman. Does anyone know whether these glasses are in use in this country, or whether they can be obtained here?

C. L. F.

SCIENTIFIC LITERATURE.

ON THE STRUCTURE OF PROTOPLASM.*

WHAT is the structure of the most marvelous known substance, protoplasm, 'the physical basis of life,' is a question that has long waited its final answer. Probably the best solution thus far given is that found by Prof. Bütschli in the work imperfectly represented in what follows:

That the watery, jelly-like material we find in the most actively living parts of all plants and animals has any discoverable structure is by no means self-evident, and it is only by slow, uncertain steps that the conception of a visible physical structure in this soft living matter has become generally accepted.

The idea that protoplasm is a structureless, homogeneous fluid early met opposition from many who observed here and there facts that pointed to the existence of apparently solid portions in the protoplasm of various cells.

Remak in 1837 found the axis cylinder of vertebrate nerve fibers made up of very minute fibrils. Frommann in 1867 supposed a fibrillar structure was common to all protoplasm. Striated structures were seen in ciliated cells and in gland cells, while Pflüger in 1869 found fibrillations in liver cells.

The fibrils were then seen to be connected in the form of a reticulum. Thus Küpffer in 1870 describes the living protoplasm of the follicle

*Untersuchungen über mikroskopische Schaüme und das Protoplasm. Von O. Bütschli. Leipzig. 1892. 229 pp., 6 pl.

Investigations on Microscopic Foams and on Protoplasm. O. Bütschli. London. Adam and Charles Black. 1894.

cells of Ascidia as having a beautiful reticular structure. In 1873 Heitzmann described a reticulum in living Amœbæ, and in the same year Frommann saw networks in the living white corpuscles of the crayfish. In 1876 Schwalbe referred the fibrillar appearances of ganglion cells and of nerve fibers to the presence of a reticulum, and a year later Eimer brought the longitudinal striation of ciliated cells into the same group by observing the cross meshes connecting the fibrils.

In 1880, Schmitz supported the universal occurence of reticular structures amongst plants while Frommann, four years later, found reticular structures in all the protoplasmic objects he examined. He regarded the network, however, not as constantly persisting, but as forming and disappearing. Leydig also found a reticulum everywhere; even the surface of cells was porous. He thought the reticulum was only a supporting part and that the true living substance was in the meshes of this frame-work. Van Beneden referred the reticular appearances to a trellis-work of fibrils in three dimensions of space. Carnoy made many contributions to the evidence for the existence of a network structure in protoplasm while Flemming and Schneider could perceive only the existence of fibrils.

While there was thus growing up a conception that protoplasm was not homogeneous, but that it contained fibrils which might be united to form a net, there were other views as to the structure of protoplasm. One of the strangest was that of Fayod, who, in 1890, from results obtained by injecting vegetable cells with mercury, concluded that protoplasm consists of long, hollow, spirally twisted fibers that are usually twisted to form the walls of hollow strings, which are also twisted. Previously Künstler maintained that spherules built up the cell as the cell did the tissue; each spherule had a dense wall and fluid contents, that is, was a vesicle. Much more general, however, was the recognition of granules within the protoplasm. Called microsomes by Hanstein in 1883, these minute specks were sometimes regarded as nodal points in a network, and again as being arranged in rows to make the apparent fibrils and reticulum. Bechamp in 1867 and Martin in 1882 thought the granules might be living units, but Altmann becomes, from 1886–90, the chief exponent of the view that granules are the chief active, living constituents of protoplasm. In fact, he even supposes that protoplasm may have arisen as a sort of zoöglea mass made by granules that at one time led a separate existence, much as bacteria exist to-day!

Although it cannot be denied that in some places protoplasmic bodies appear quite homogeneous in spite of all attempts to analyze them optically yet it is generally conceded at the present day that protoplasm has a structure, that it has fibrillar portions that may be made up of granules or associated with granules, and that in many cases these fibrils are connected so as to present the appearance of a framework or network.

There is, however, another view of the structure of living matter which demands serious consideration as advanced by a most able worker in various fields of protozoan and metazoan morphology. Professor O. Bütschli, of Heidelberg, the well-known author of the comprehensive monograph on the Protozoa in Bronn's Klassen und Ordnungen.

As early as 1878 he advanced the opinion that the observed reticular appearance of protoplasm might be but the expression of an alveolar structure, that protoplasm has a froth-like structure. This idea he now supports by an extensive treatise and by several minor papers. In his view, living protoplasm is composed of fluid, or nearly fluid, vesicles filled with a fluid; more like an emulsion than like soapsuds. The walls of the vesicles form a framework or series of partitions that surround closed chambers. It is the optical section of these walls that gives the appearance of a network. The contents of the chambers, or alveoli, are spherules of liquid isolated from one another by the vesicle walls or enveloping layers, as are the air bubbles in a mass of froth by the pellicles of the bubbles.

This conception of the structure of protoplasm may justly claim the dignity of a theory of the structure of protoplasm, since it plausibly explains many of the observed optical appearances and also some of the activities of living matter. If an artificial mass is made having this froth-like structure it may present some of the optical appearances of protoplasm and also in its peculiar movements simulate some of the movements of living matter, while the same physical explanation that applies to the movements of the artificial froth will, it is claimed, apply to the like movements in protoplasm.

The evidence advanced by Prof. Bütschli in support of this foam theory may be conveniently considered under the following four heads: The structure of artificial foams; the observed structure in many forms of living matter; the movements of artificial foams; the movements of protoplasm.

His artificial foam is made by thoroughly mixing in a mortar potassium carbonate with olive oil that has been heated some time. A drop of the oil lather so made is put on a glass slip, covered with a glass cover and then soaked in water; when cleared up with glycerine it is ready to observe under the microscope.

Such an artificial foam is seen under the microscope to be made up of vesicles of oil 1–5 microns in diameter and upwards. They are full of water, alkali, soap and glycerine. The whole mass of foam is fluid and flows under pressure as oil does. Drops of this foam may be kept for four to six weeks before the oil vesicles burst. Some of the characters of these foams most to be emphasized are: That drops may enlarge or diminish by the osmotic action of surrounding liquid; on the surface of a drop, as well as in the interior on surfaces of large intervesicular spaces, the minute vesicles or alveoli are arranged in a layer of small chambers quite regular in size, with their contiguous faces at right angles to the free surface (this is Bütschli's 'alveolar border'); alveoli may be arranged in radiating lines apparently by the action of diffusion currents within the drops; fibrous appearances may arise when currents elongate the alvoli so as to extend lines of them in one direction more than in others. Other properties of these remarkable compounds will be considered later in comparing them with protoplasm.

A considerable portion of the work is taken up with a well-illustrated account of the structural appearances seen in the protoplasm of a large number of different organisms. In both living and in preserved protoplasm Prof. Bütschli demonstrates the almost universal occurrence of a network appearance similar to that caused by the oil vesicles in the artificial foams.

The methods employed consisted in: the use of Zeiss apochromatic objectives 2 mm. Ap. 1.30 and 1.40 with eye pieces 12 and 18; an iron-hæmatoxylin stain made with ferrous acetate and a ½ % aqueous solution of hæmatoxylin; an acid hæmatoxylin made by adding acetic acid to dilute Delafield's hæmatoxylin; cutting sections one micron thick and studying them, often, in water instead of in balsam.

Though no adequate idea of this net appearance can be given without illustrations, a review of the organisms in which the author has found it may at least show the universal nature of its occurrence. Among the Protozoa the group Suctoria was examined in the representative form Podophyra and a meshwork found in the nucleus and in the body of the cell while alive. An alveolar layer was also seen. The group of Ciliata show the network—living Vorticella, Paramœcium, Stylonychia, and in the dead stalks of Zoothamnium. In the Flagellata living Chilomonas, in the Radiolaria preserved Thalassicolla, and in the Heliozoa living Actinosphæria and *Actinophrys sol* all show the reticular appearances. Amœbæ, both living and prepared, show the characteristic network appearances, while amongst the marine Rhizopods with calcareous shells, drops of viscid protoplasm crushed out from living Miliolidæ show an alveolar border; in living Gromia the transition from reticular to apparently homogeneous protoplasm can be well seen in the remarkable pseudopodia.

Leaving the Protozoa, we note that in those problematical forms the Myxomycetes, a reticulum, as well as the important alveolar layer, are seen in small masses of *Aethalium septicum* fixed by a picrosulphuric-osmic mixture. Preserved *Pelomyxa palustris* also adds to the evidence for the reticular appearances that may be interpreted as foam structure. Among the lower plants bacteria and some Cyanophyceæ are claimed as presenting a nucleus-like portion with an alveolar border surrounded, in some cases, with protoplasm that presents the same net appearance.

Among the higher plants it is a noteworthy fact that, in the cells of the stamens of Tradescantia, the hairs of the nettle and of Malva, where streaming movements of the protoplasm are known in the protoplasmic strands traversing the interior of the cells fine fibril-like structures are seen to be connected into a mesh or net even in the living cells. Does not the foam hypothesis account for these apparent networks in actively streaming protoplasm better than any other? The eggs of different animal groups show also a reticulum. In sections of the eggs of the sea urchin, Sphærechinus, the well known radiated appearances about the centrosomes are seen connected by transverse lines to form a network, or, as it is interpreted, a radial series of alveoli or vesicles extending in all directions from some central vesicles that form the so-called centrosome.

The red blood corpuscles of the frog show a reticulum with marked alveolar border. Networks are seen in the living cells in the branchial epithelium of Gammarus and in living epithelia of rotifers; also in the cells of the gizzard and foot glands of rotifers and in the epidermis of the earthworm when preserved. Sections of Branchiobdella show reticular appearances in the cells of the peritoneum and epidermis as well as in the cuticle itself. In the same way the cuticles of Phascolosoma and of Distomum are found to have a reticular structure like that of living protoplasm. Various tissues in the vertebrates show a reticular character; sections of the liver cells of the frog and rabbit, the epithelium of the small intestine of the rabbit, macerations of the capillaries in the spinal cord of the calf and of connective tissue in nerves of the frog. Pigment cells in the parenchyma of Aulostomum and ganglion cells in the earthworm and in the crayfish again show the same froth-like reticulum. Nerve fibres present special arrangements worthy of consideration; in the teased nerve of the frog there are longitudinal fibrils 6–7 microns apart connected by transverse meshes; similar appearances of elongated meshes in rows are seen in the nerves of the crayfish, rabbit and calf.

In all these cases what is actually seen is but a network appearance and not a foam structure, yet as the artificial mass that seems undoubtedly to have a foam structure presents under the microscope the same network appearance as that seen in the protoplasm, there is a strong inference that this also is due to an actual foam. The resemblance between the appearances of the artificial foam and protoplasm is well seen in the so-called 'false networks' common to both. When fine granules of india ink are seen in water, or when fine oil drops are shaken in soda and compressed, there is formed a network of triangular meshes by the combination of diffraction rings about the separate spherules. Prof. Bütschli claims that the same 'false network' is seen in sections of liver and in other protoplasmic structures in addition to and on a higher level than the true network caused by the alveoli.

The foam theory assumes that protoplasm is in the fluid or viscid fluid state, but this requires demonstration, since many have held since the time of Brücke that protoplasm contains solid elements as part of its structure. The network is often regarded as a solid portion of the mass. The following considerations, however, tend to establish the fluid nature of protoplasm.

The vacuoles in protozoa are spherical and must hence be surrounded by fluid protoplasm. The flowing together of such vacuoles and their membrane-like envelopes are readily intelligible on the foam theory, but not if we assume that the network is a firm structure. The idea of a firm network involves that of a porous surface and the reformation of a new surface with solid supports when the mass is burst; on the foam theory the alveolar layer of closed vesicles makes the boundary of all surfaces and the laws of fluids reform this surface, however often the mass may be ruptured. The alveolar layer has no explanation on any but the fluid foam theory. This remarkable layer of chambers or vesicles is not a membrane, but a fluid layer, as may be seen in the cell division and conjugation of infusoria; yet it may in some cases be so modified as to become a membrane, or even a cuticle or chitinous shell, as in Arcella. The assumption of a fluid foam structure explains the radiated arrangement which the meshes of the network present around the nucleus and vacuoles. The fluid nature of protoplasm is also supported by the fact that granules occur as a rule only at the nodal points of the net, since when lamp-black is added to foam drops it collects at the nodes between the vesicles. The striated appearances of gland cells seem to indicate a fluid state and the occurrence of diffusion currents. Likewise the radiating appearances seen in dividing cells and caused by rows of meshes (alveoli) are like the lines seen in artificial foams and caused, apparently, by diffusion currents. So much do some of these striations resemble those of the artificial foam that Prof. Bütschli is led to assign diffusion currents as their cause in the case of the striations about the contractile vacuole of an amœba during diastole, and of the suns at the poles of the spindle in caryokinesis. The striated appearances in pseudopodia and in strands of streaming protoplasm in plant cells are due to rows of elongated meshes (alveoli), and may be taken as evidence of the fluid nature of the protoplasm since they appear to be rows of vesicles stretched by tension. Similar appearances in nerve fibers offer an obstacle to the idea of the fluid state of protoplasm, for we here have permanently elongated meshes without apparent tension; if their elongation were caused by stretching in growth we would yet have to grant considerable rigidity in the lamellæ or material of the net.

Before considering the movements of foams and of protoplasm we may point out the relationship of the foam theory to those cases of apparently structureless protoplasm that remain for any theory to resolve after the actual observations have reached their limit. In the pseudopodia of Gromia and in the ectosarc of Rhizopods there are clear areas of protoplasm without granules, network or other discovered structure. Such apparently structureless protoplasm has been variously interpreted: By Heitzmann as regions where the meshwork is so stretched and attenuated as to be invisible; by Frommann as regions in which the network has become dissolved in the matrix; by Flemming as due to crowding of filaments to the point of indistinguishability, and by Leydig as masses of the hyaloplasm crept out from the framework of spongioplasm. On Bütschli's theory such areas appear structureless because the alveoli are widened with walls so stretched as to be invisible. The thinness of the walls would make the mass physically more like a solid, and, as a matter of fact, we find such homogeneous protoplasm more rigid or viscid than the distinctly reticular internal parts in rhizopods.

Coming now to the movements of artificial foams as bearing upon the probable structure of protoplasm we find that such foam drops may, under favorable conditions, exhibit movements from place to place, changes in outline and certain internal currents.

The change of place may be in an extreme case as much as .45 mm. in a minute. The change of form consist in outpushings here and there that give the drop a decidedly amœboid outline that changes considerably in a few minutes' time. Of the internal currents the most interesting are the so-called 'extension currents' that pass out from the interior towards the surface, spread out over the surface and tend to return towards the point of origin. In a small drop there may be thus an axial current moving towards one end, which will be the anterior in progression, while at the other end there is a dead region where particles of india ink, if added to the foam, tend to collect in a stationary state. Such an extension current may die out and be succeeded by another with a different axis. Two drops may run together and acquire a new center of extension currents. In large drops there may be several centers of extension currents and each runs out into a pseudopodium-like outpushing of the mass. As one center of streaming dies down and another appears the outline of the large drop changes as above mentioned.

Such streaming currents may continue to exhibit themselves for a day, in one case for as many as six days. The currents are more active when the drop is heated, and electric shocks may cause change in the direction of movement, wrinkling of the surface and bursting of vesicles in the interior.

The probable explanation of these movements of the artificial foam is to be sought in the phenomena of 'superficial extension currents' that are generated whenever the surface tension of a liquid in air or in another liquid is locally diminished by bringing a spot on its surface into contact with a third liquid which has a lower surface tension than the second liquid. Thus, if a drop of oil in water be brought into contact with weak alkali active currents are set up in the water and in the oil. Now, as the foam is a framework of very minute lamellæ of oil, the meshes of which are filled with a watery liquid containing potassium carbonate and potash soap, we have the conditions necessary for the formation of extension currents and streamings if alveoli burst at the surface and readjustments are made throughout the mass by the aid of diffusion currents and the bursting of internal alveoli.

Whatever the true cause of these movements in the foams their appearance is such as to suggest some of the movements of an amœba and it becomes pertinent to inquire if certain protoplasmic movements may not be the direct physical result of their assumed alveolar or foam structure. The movements of protoplasm are commonly spoken of as due to its contractility, and in an Amœba this contractility has been thought to be located either in the ectosare or in an internal framework. Many, however, have called attention to the fact that the movements of an Amœba and the streamings in a plant cell could not be explained upon any assumed contractility in an internal framework. Hofmeister referred movements of protoplasm to changes in power of imbibition and Sachs elaborated a similar idea. Englemann in 1879 assumed that his minute theoretical particles of protoplasm, inotagmas, changing their state of turgidity passed from an elongated to a spherical form and thus brought about contraction of protoplasm. As late as 1879 older views as to the participation of electrical forces in protoplasmic contraction reappeared in the papers of Felton and of Fol. Leydig, 1885, and others since then have regarded the hyaloplasma, and not the framework, as the essential motile substance.

Surface tension as an element in protoplasmic movements was brought in by Berthold, in 1886, in explaining the streamings in plant cells; while Quincke, in 1888, explained such movements on the basis of extension currents caused by surface tension. Though Quincke's conception of the structure of the plant cell was quite unlike what has been observed his application of surface tension and of extension currents served as an introduction for Bütschli's explanation of protoplasmic movements.

Professor Bütschli attempts to explain some of the more simple forms of amœboid movement as results of the foam-like structure of protoplasm, and thinks surface tension and extension currents are the essential factors. The axial stream which is found in many Amœbæ passing towards the progressing anterior end to bend and flow back near the surface of the animal is, he thinks, an extension current. The chief differences that he sees between such axial streams and the extension currents in artificial foam is that they endure but a short time and flow back but a short distance in the Amœba. The conditions present in protoplasm may be such as to form extension currents, for, as we assume it to be a framework of liquid not soluble in water enclosing water containing substances in solution, we may suppose changes in surface tension would set up such currents as they do in the manufactured foam drops. There is some evidence that the watery parts of protoplasm are alkaline and it is also probable that fatty compounds may be present in the framework. The bursting of some alveoli at the surface would pour out on to the surface some of the watery contents which will cause a local diminution in surface tension and thus give rise to an extension current. In this way, also, pseudopodia may be formed, here and there, by local extension currents.

This explanation, however, cannot be applied to the formation of the remarkable anastomosing pseudopodia of many Rhizopods, and even where it seems to apply it meets with a severe rebuff in the results of experiments upon Pelomyxa. It was found that india ink in the water about a crawling Pelomyxa shows currents the reverse of what they are about a drop of liquid exhibiting extension currents, so that the assumption of this simple physical explanation for the movements in an Amœba seems on a very weak footing.

The author, however, thinks that in some way the extension current may perhaps be applied to the explanation of rotation movements in the protoplasm of plants cells, and that even muscular contraction may be explained along similar lines. On the foam theory the muscle is made up of a mass of polygonal vesicles; if there be chemical changes in the watery contents of many of these in one plane the corresponding changes in surface tension of the walls or lamellæ will produce changes in shape of these polygons, and in the mass a shortening and thickening or muscular contraction!

But all motions are not of this nature, since the movements of certain granules seem to be automatic and not, as is often assumed, merely passive. Yet even these granules may in turn serve to change the surface tension of the lamellæ, and so ultimately contribute to readjustment throughout the mass.

In conclusion we may venture to affirm that the foam theory at present falls short of a physical explanation of any of the activities of protoplasm, yet as an approximation to what may well prove to be the actual structure of protoplasm it cannot be too highly praised.

E. A. ANDREWS.

The Structure of Man. An Index to His Past History. By DR. R. WIEDERSHEIM, Professor in the University of Freiburg in Baden. Translated by H. and M. Bernard. The Translation edited and annotated and a Preface written by G. B. Howes, F. L. S., Professor of Zoölogy, Royal College of Science, London. With 105 Figures in the Text. Macmillan & Co., London and New York. Price $2.60.

This is an excellent book and should be in the hands of all students of anatomy. We have had in the writings of Huxley, Vogt, Darwin and Haekel dissertations on the position of man in relation to the lower animals, but no book has appeared so comprehensive in scope, yet so minute in details, as the one before us. It originally appeared in German in 1887, as an academic treatise under the title, '*Der Bau der Menschen.*' The present volume is a translation of the revised and enlarged second edition. The author states that he has prepared it especially for the lay reader, and the editor suggests in the preface that it may be of use to the medical student while engaged in the study of anatomy. The distinguished professor of Freiburg has many admirers in this country, and his book with the notable additions by the English editor will be made welcome. The following comments are made in no spirit of unkindly criticism. In the 228 pages there occur 235 citations of authors. Many of the statements are without reference, and even when journal or volume is given no uniform plan is pursued, and, often, the year of publication is omitted. The value of this display of learning when the objects of the book are recalled, does not always appear. Prof. Howes has given his numerous citations in bracketed paragraphs. Most of them are from English sources. One would suppose from statements in the preface that *Pithecanthropus* had been discussed by none but British anatomists. Throughout the book French and Italian writers receive little consideration. There is scant allusion to Albrecht, and, so far as we have seen, none to Sutton. No reference is made to the admirable essay of Dr. Frank Baker on the 'Ascent of Man.' Certainly these three writers have contributed in a notable manner to the subject embraced in the general thesis. The value of the writings of other Americans could never be determined by this book. On the homologies of the cusps of the mammalian teeth Röse is followed by Wiedersheim, Forsyth Major by the editor, while Cope, Osborn and Scott shift vaguely across the scene. We note that while the book is designed for medical students and lay readers the relations of vestigial structures to the initiation of morbid processes is not emphasized. The connection between the morphology of the vermiform appendix and the frequency with which this structure becomes a factor in disease is not mentioned. The relation existing between the apex of the lung in the region of the neck and the restriction of rib-protection at this place is dwelt on, but the next and, to our minds, the inevitable step, namely, to account for tubercular deposits in the lung apex by the same statement of facts is not even alluded to. The structure of man cannot be logically separated from the manner in which diseased action is manifested in that structure.

It is curious that from the great wealth of material illustrating atavism in the skull that the author should make nine references to the work by the cousins Sarasin on the Ceylon Veddahs. This is liberal, when it is recalled that these writers confine their observations to thirty-three skulls and a few skeletons.

HARRISON ALLEN.

Evolution in Art, as Illustrated by the Life Histories of Designs. By ALFRED C. HADDON, Professor of Zoölogy in the Royal College of Sciences, Dublin, etc. With 8 plates and 130 figures. 1 vol. 8vo. pp. 364. Price 6 sh. (London, Walter Scott, Ltd. 1895.)

Prof. Haddon is already well and favorably known to students both of art and ethnology by his admirable monograph on 'The Decorative Art of British New Guinea,' published in 1894 by the Royal Irish Academy. The present work may be looked upon as a development of that monograph, extending the principles it embodied to a much wider range of art concepts. He takes, indeed, in his opening chapter the decorative art of New Guinea as an example of the method of study of art in general.

The main body of the book is devoted to the discussion of two questions: 1, the material of which patterns are made, and, 2, the reasons for which objects are decorated. Under the first of these, he points out that the originals of decorative art designs are mainly either natural or artificial objects. For the latter, he adopts the term suggested by Dr. H. C. March, 'skeuomorphs,' from a Greek word signifying utensils, etc.; the former he divides into 'physicomorphs, biomorphs and heteromorphs.' He portrays with a large range of illustration how these objective originals became transferred into æsthetic conceptions, and at times conventionalized quite out of recognition, were we ignorant of the intervening steps.

The reasons for which objects are decorated the author considers to be mainly for the sake of information (scenes, picture writing, etc.) for the love of art itself, for the desire to display wealth and for magic and religion. He gives, among these, but a small field to 'art for art's sake'—if, indeed, any, among primitive people. Yet he does not fail to recognize, what some writers have overlooked, that the æsthetic sentiments are the real and only source of all art products, no matter what else they subserve.

The work closes with a suggestive chapter on the 'scientific method of studying decorative art,' which deserves the attentive study of all interested either in the history of art or in ethnology. It would be difficult to point to a more satisfactory statement of the subject.

D. G. BRINTON.

The Hill Caves of Yucatan. By HENRY C. MERCER. Philadelphia, J. B. Lippincott Co. 1896. 1 vol., 8vo. Illustrated. Pp. 184. Price, $2.00.

The sub-title to this book explains its aim with sufficient fullness—'A search for evidence of man's antiquity in the caverns of Central America: being an account of the Corwith expedition of the department of archæology and paleontology of the University of Pennsylvania.' Through the generosity of Mr. Corwith this expedition was fitted out and its results were destined to enrich the institution named. A competent corps of explorers under the direction of Mr. Mercer proceeded to Yucatan last February and examined a large number of caves in the low range of mountains which trends from northwest to southeast, about thirty miles south of Merida. In this immediate vicinity are situated the famous ruined cities of Uxmal, Mani, Mayapan and others. There, if anywhere, we might reasonably expect to find traces of the early art of the natives and the record of the evolution of their culture, if it was developed in the peninsula.

This would be the more certain to be the case on account of a peculiarity of the caves of Yucatan. In many portions, during the dry season, the only sources of the water supply are the springs and basins in these caves; therefore, under present conditions, from the first arrival of man he must have resorted to them daily for months at certain periods. He could not fail to have taken with him and to have left some traces of his visits, stone implements, broken pottery, bones, ashes and charcoal from his fires and the like.

Taking these facts as his guides, Mr. Mercer examined, with the most scrupulous care, layer after layer in several of the most notable caverns which were also sources of water supply. The excavations were conducted under his personal superintendence and every sign of man's presence and every bone were noted as soon as taken from their sites. In this manner he examined twenty-nine caves, six of which yielded valuable results.

His conclusion from this arduous and extended investigation is that there is no trace of any older or more primitive human visitors to the peninsula than the Mayas in about the stage of culture in which they first became known to the Spaniards.

The animal bones and shells which the expedition brought back were examined by specialists and all proved to belong to existing species. Like the remains of man, there was nothing in them to hint at a great antiquity. This fact, however, suggests that the caves themselves must be of quite modern formation; so, perhaps, the expedition was after all looking in places where it is not possible to find the relics of 'palæolithic' man if they actually are in the peninsula. We cannot, therefore, unreservedly accept the author's dictum (p. 177), 'no earlier inhabitant had preceded the builders of the ruined cities in Yucatan.'

The narrative portion of the volume are pleasantly composed, enlivened not only by an ever-present enthusiasm for the main object, but touched in frequent passages with a quick appreciation of the strange and the beautiful in nature and the odd and humorous in life. Whether archæologist or not, the reader will pass agreeable hours over Mr. Mercer's pages.

Some little criticism must be added on the author's capricious orthography of Maya words. The recognized authority is the dictionary of Pio Perez. That work admits no *s* in the Maya alphabet; but Mr. Mercer employes it freely, as *sitz* for *tzitz*, *spukil* for *xpukil*, *sac* for *zac*, thus confounding three different sounds in one. At other times his forms are incorrect, as *tzat-un-tzat* for *zataan zat*, *coyok* for *cooch*, etc. This occurs also in the Spanish, where he gives *volan* for *volante*, the name of a vehicle. The translations of some of the Maya terms are dubious, but for these he does not assume responsibility.

These, however, are slight blemishes, and the book, with its handsome illustrations, excellent paper and attractive account of travel and exploration, is sure to entertain and instruct every reader.

D. G. BRINTON.

Chemical Experiments Prepared to Accompany Remsen's 'Introduction to the Study of Chemistry. By IRA REMSEN and WYATT W. RANDALL. New York, Henry Holt & Co. 1895. Price 50 cents.

In this edition of Prof. Remsen's laboratory manual a number of new experiments have been introduced, and the course of study as now arranged covers pretty fully the ground outlined by the Committee on Secondary School Studies of the National Educational Association. Like all of Prof. Remsen's text-books this one is characterized by clearness and precision of statement. The directions for each of the laboratory experiments are carefully worded, and it is difficult to see how students in following them could possibly fail in getting good results.

The course begins with experiments which show the difference between chemical and physical phenomena, then the characteristic properties of chemical compounds as distinguished from mechanical mixtures are studied, and this leads on to a systematic study of the preparation and properties of the more important non-metallic and metallic elements. At the end of the book there is a brief introduction to the methods of qualitative analysis. Two quantitative experiments requiring the student to work with accurate weighing and measuring instruments are given; one of these is the determination of the percentage of oxygen in potassium chlorate, the other the determination of the equivalent of zinc. Nothing serves so well as a few experiments of this kind to impress upon students the significance of the fundamental laws of chemistry. Nearly every one of the laboratory directions is followed by a series of questions, the object of which is to make students think about their work, and to lead them on to draw conclusions from the results that they have obtained. There are no blank pages in the book, and it is expected that a full record of each experiment and the conclusions that have been drawn from it be kept by the student in a separate note-book, and that this note-book be submitted to the teacher from time to time for revision. Another excellent feature is that at the beginning of the directions for each experiment there is a list of all the apparatus and chemicals required for the work.

Students who follow the course of study given in this manual will have a most excellent introduction to chemistry, and teachers in arranging the work for their classes cannot go far astray if they are guided by the experience of one who has been preëminently successful in this line of work. E. H. KEISER.

SOCIETIES AND ACADEMIES.

BOSTON SOCIETY OF NATURAL HISTORY.

THE Society met November 20; eighty-four persons present. Dr. J. Walter Fewkes, in his paper, 'Some newly discovered Cliff ruins in Arizona,' described, and illustrated with stereopticon views, the early home of the Moquis. The ruins studied were of three types: First, the cave dwellings situated on high bluffs and consisting of series of chambers hewn out with stone implements—these chambers have paved floors but the walls show no trace of masonry; secondly, stone houses built surrounding large crater-like depressions; and, thirdly, two large cliff ruins situated many miles north of Montezuma's Well.

The larger of these two ruins, affording room for 500 people, was four stories in height, with floors supported by beams of pine or cedar. Excavations revealed remnants of cotton cloth, blankets made of feathers, pottery, baskets and ropes made of fibers of century plant. Skeletons found beneath the floors showed the burial customs, and the abundance of stone implements with the absence of metal seemed to prove that the workers belonged to the stone age. The walls covered with symbols, practically identical with those now found in the Moqui houses, gave evidence of formal worship. The second ruin, smaller but better preserved than the first, showed the impressions of the hands of the workmen made at the time of plastering the walls of the rooms; a quantity of corn in the ear was found beneath the floor of this ruin. The cliff houses were probably abandoned before the discovery of the country by the Spaniard, and there is no evidence that the cliff dwellers were a distinct people.

The Society held a regular meeting December 4; eighty-one persons present.

Mr. L. S. Griswold discussed some geographical and geological features of the San Francisco Mountains and the Grand Canyon of the Colorado, describing in some detail the petrified forests. The paper was illustrated by a series of lantern slides.

SAMUEL HENSHAW,
Secretary.

NEW YORK ACADEMY OF SCIENCES.

THE regular business meeting was called to order December 2, 1895.

Prof. N. L. Britton presented the report of the Committee on the Audubon Monument and asked that the committee be discharged. He reported the satisfactory completion of the monument and the placing of the new die, which is guaranteed for at least two years. He announced that after all the expenses of the monument had been paid a balance of $1,797.25 remained on hand, which the committee therewith turned over to the treasurer of the Academy, together with the following resolution:

Resolved, That after all bills incurred by the committee shall have been paid, the Secretary and Treasurer shall pay over the balance to the Treasurer of the Academy, under the title, 'Audubon Publication Fund,' the interest of which shall be annually devoted to the publication of a memoir on some zoölogical or botanical topic, if a paper suitable for such memoir shall be presented. If no such paper shall be presented during any one year, the interest shall be allowed to accumulate until one is presented. Memoirs published by this fund shall be so designated."

A committee was appointed to audit the accounts of the report.

The Section in Astronomy and Physics then organized, with Prof. Woodward in the chair.

The first paper was by Prof. Harold Jacoby, on 'The Determination of Division Errors in Straight Scales.' The author only read the introduction to the paper and outlined the method. Thereupon, with the permission of the chairman, he read an historical description of the observatory at the Cape of Good Hope.

The second paper was by C. A. Post, on 'Photographs of the Lunar Eclipse of September 3, 1895.' The photographs exhibited were