THE report of the Joint Select Committee of the British House of Lords and House of Commons on electrical energy (generating stations and supply) has been published in a Blue Book.

A COMMISSION has been appointed to revise the United States patent laws.

As we have already stated, the Albert Medal of the Society of Arts has this year been awarded to Professor Bunsen. At the annual meeting of the Society held recently, says *Nature*, the work of Professor Bunsen was referred to by the Council in the following words: "Amongst the numerous and important scientific discoveries which have rendered the name of Bunsen famous wherever science is valued, perhaps the most striking is the one in which he was associated with his distinguished colleague, Professor Kirchoff, viz., spectrum analysis, a discovery which has shed a new and unexpected light on the composition of terrestrial matter, and has enabled us to obtain a distinct knowledge of the chemical composition of sun and stars. The contributions which Bunsen has made in the application of chemistry and physics to the arts and manufactures are of the utmost value, and their importance may be measured by two out of many instances. The Bunsen battery was, until the introduction of the dynamo, the cheapest source of electricity; the Bunsen gas-burner, by which a non-luminous, smokeless, but highly heated flame is obtained, is now not only indispensable in all laboratory work, but is used for heating purposes in thousands of houses and manufactories, and for illumination, by the incandescent system, in millions of lamps. Beyond these Bunsen's contributions to the sciences of chemistry and physics have been of the highest importance; but, perhaps, the greatest benefit which he has conferred, through a long life devoted to the advancement of science, has been the influence which he has exerted as a teacher.

UNIVERSITY AND EDUCATIONAL NEWS.

IT was stated in a recent issue of SCIENCE that Mr. George A. Fowler had rebuilt the engineering building of the University of Kansas, which was struck by lightning and destroyed by fire last March. In addition to this gift instruments and machinery to the value of $30,000 have been given to furnish the building.

MR. JOHN D. ROCKEFELLER has subscribed $10,000 toward the special fund now being collected for Barnard College.

CARROLL COLLEGE, of Waukesha, Wis., has received from Mr. and Mrs. Ralph Voorhees, of New Jersey, a gift of $50,000 on condition that $50,000 more be subscribed by October 1st. $6,000 towards the latter sum has already been subscribed.

THE University of Paris has instituted a degree of 'Doctor' without any qualifying word. The new degree is open to foreigners and the tests are a thesis in French or Latin and a few questions on subjects selected by the candidates.

DISCUSSION AND CORRESPONDENCE.

MIOCENE EDENTATES.

IN the *American Naturalist* for December, 1886 (p. 1044), Professor Cope described a number of osseous scuta and toe bones as those of a 'giant armadillo from the Miocene of Kansas,' under the name *Caryoderma snovianum*. The type specimen is now in the University of Kansas Museum. The scuta and toe bones are identical in all respects with another series recently removed from the carapace of a large tortoise from the same formation in Kansas, the Loup Fork. The tortoise is provisionally placed in the genus *Xerobates*, and is specifically probably identical with *Testudo undata* Cope. The error was not an extraordinary one on the part of Cope, since the dermal ossicles are peculiar for a tortoise. Its rectification, however, is important, since this reference was, I believe, the only one of the edentates to the Miocene of North America.

S. W. WILLISTON.
UNIVERSITY OF KANSAS, July 16, 1898.

SCIENTIFIC LITERATURE.

La fatigue intellectuelle. Par A. BINET et V. HENRI. Paris, Schleicher Frères. 1898. Pp. 336. (Bibliothéque de Pedagogie et de Psychologie.)

It would be difficult to select a topic in the field of psychology that would enlist a wider interest than that of mental fatigue. It is one of the most characteristic of the ills that flesh, or at all events civilized flesh, is heir to. From the school boy to the professor, in all professions and in business, the cry is overwork, exhaustion and fatigue. The well known tired feeling is altogether too familiar, particularly in newer civilizations and in communities in which the push and drive of commercial ambition set the pace for an equally exhausting social and intellectual competition. As a question of practical hygiene the avoidance of undue fatigue is of the highest importance; and here, as elsewhere, the only certain path to relief is the one that leads through a systematic study of the nature of the normal and abnormal processes concerned. The physiology and psychology of fatigue must be minutely and successfully investigated before the practical applications can be made to the routine of the school room or the most economical division of labor for the intellectual worker. In a matter of such fundamental and familiar import there is, of course, a considerable accumulation of wisdom, which, however vague or ill arranged, must not be altogether despised. It is, unfortunately, true that in many emergencies of life our actions cannot be guided, even if we are ready to guide them, by scientifically established principles and logically verified inductions. Particularly in such complex matters as psychology must take into account is there the greatest necessity for discernment and caution in applying knowledge to practice. Individual differences and circumstantial details often profoundly affect deductions; for it is equally true that one man's meat is another man's poison, and that one man's work is another man's play. These considerations are presented to imply not that the management of intellectual effort and the avoidance of fatigue cannot be directed by scientific principles, but rather by mother wit, but only that the illumination of this field of inquiry is a difficult and slow process. None the less we can dispel the total darkness that hangs over the region and here and there get up a modest searchlight that may reveal the more intimate nature of a few limited areas.

The work of Messrs. Binet and Henri, though not the first work on fatigue, is the first work on mental fatigue, and the first attempt to prepare a compendium of our knowledge regarding the general topic. If the net outcome seems meagre the above considerations regarding the difficulties and newness of the inquiry may be urged in excuse. It should also be borne in mind that the removal of misconceptions and the elaboration of a method in themselves form a considerable advance.

The investigations regarding mental fatigue naturally fall into two divisions: first, the effect of intellectual effort upon physiological functions; and second, their effect upon psychological activities. The establishment of the general principle that mental processes are correlated with cerebral functions, which in turn depend upon the integrity of a wholesome blood supply, prepares us for the conclusion that all intellectual effort modifies, however slightly, the physiological status of the moment. The ingenious demonstrations of Mosso and others have revealed the marvellous delicacy of this psycho-physical interdependence, that seems to be limited only by the sensitiveness of our devices for detecting it. More directly, Hodge has shown the effects of more or less prolonged fatigue upon nerve cells, so that our conception of a tired nerve cell is no longer purely a matter of hypothesis. There is, of course, no definite point at which work passes into fatigue; the effects of fatigue are the effects of continued activity, the intensity and even the kind of effects depending upon the prolongation of the effort. There are also the accompanying subjective feelings of fatigue, but these have not been made part of experimental investigations.

The first group of problems in such investigation relates to the selection of typical forms of mental effort and the technique by which their effect upon physiological functions may best be noted. Counting the number of letters in a printed passage, writing to dictation at a maximum speed, reading aloud, numerical calculations performed mentally, committing numbers or syllables to memory, have all been employed. The main desiderata for the most

suitable experimental mental effort is one that shall involve a minimum of motor expression; that shall, too, as nearly as possible, involve the same processes when performed by different persons; that shall involve continuous but not too severe concentration, and that shall yield results by which the duration and the correctness of the task performed can be measured. No one of the above processes answers all of the requirements—and they are not the only ones—but on the whole the authors prefer the dictation and regard simple calculations as highly appropriate. One further general fact must be taken into account. In repeatedly performing the same mental task we become more proficient and do it more rapidly and better. Fatigue would tend to lengthen mental processes and introduce error. Hence the effect of practice tends to counteract and disguise the effects of fatigue; still it would remain true that the most fatiguing type of effort would show a less rapid increase of efficiency with practice than lighter occupations. Neglecting for the moment these and other difficulties, we may briefly review the established results regarding the effect of certain typical forms of intellectual effort upon physiological and psychological functions.

It appears that intellectual effort at first quickens the heart beat, but later (after 30 minutes or more) slackens it; at the same time the pressure of the blood is increased; more blood flows to the brain, and the character of the pulse curve is affected. Likewise the respiration is quickened, but the amplitude of each inhalation is diminished and the amount of carbonic acid given off and of oxygen absorbed is increased, while for any considerable mental effort the bodily temperature becomes higher. It likewise appears that the effects of prolonged effort are frequently of an opposite character to those of a brief, even if violent, effort, and that individual differences are significant. Moreover, most of these results are quantitative in character, and by far the largest portion of the first part of the volume (in itself over 200 pages) is devoted to a technical account of the equipment by which such quantitative results may be secured.

A particularly important relation is that between intellectual effort and muscular effort. A brief mental exertion (15 minutes or less) seems to increase the momentarily available muscular energy as measured by the dynamometer, but a longer mental exertion distinctly decreases it, and particularly does it decrease the total capacity of muscular work as measured by the Ergograph. Emotional excitement in connection with intellectual work may postpone the muscular enfeeblement and continue for a longer period the increase of muscular energy which appears to accompany brief mental exertions. Furthermore, the effect of longer and shorter periods of rest may be measured by their restoration of the total working energy as compared with the normal. In some of Mosso's subjects this tendency of mental work to deplete the muscular energy is most striking; and the Ergographic curves written by a professor on three successive days of holding oral examinations of candidates for a degree reveal a progressive muscular exhaustion, which in turn gives place to a gradual recuperation after one or more days of rest. Evidence of this character leads Professor Mosso to hold that physical exercise is not a proper relaxation from mental effort; absolute rest of mind and body is more desirable and effective. In this connection, as well as elsewhere, it is important to emphasize the difficulty of establishing a normal by which deviations caused by mental exertion or other influences may be measured; for there are larger and smaller fluctuations of all kinds. The morning and the evening, before and after meals, or sleep, the summer and winter, age, sex and temperament, all introduce complications which can only be eliminated by prolonged and logically conducted observations.

Before proceeding to the more strictly psychological studies attention may be drawn to two interesting fatigue curves, which the authors have found in their observations. The first relates to the consumption of bread in certain French boarding schools for the different months of the year, it being understood that bread is supplied *ad libitum*. It appears that in the months following the vacations most bread is consumed, the amount decreasing with fair regularity until the minimum is reached in

July; and this is interpreted to mean that there is a gradual decrease in vitality as the result of the continued school work. The second is the remarkably close correlation between changes in touch sensitiveness as tested by the æsthesiometer and the fatigue effects of mental occupation. After an hour or two spent in the class room the distance apart between two points which can still be felt as two when applied to the forehead, or the nose, distinctly increases, and after a rest it again decreases. This is probably to be interpreted as a modification not in skin sensibility, but in the attention, for it requires close attention directed to the part touched to distinguish whether one feels a single point or a pair of points. None the less it is somewhat noteworthy that this test should yield more positive and uniform results than several others in which the mental element is apparently more prominent.

In the psychological tests the pervading principle is the detection of changes in the rapidity, accuracy, scope and extent of mental processes due to a general intellectual fatigue or to the special waning of the particular group of processes as the result of their prolonged exercise. A good example of the latter class is the test frequently applied to school children of requiring them to perform an extended series of simple additions or multiplications. In a typical result there is first an increase in facility due to the practice or adaptation to the task, which gives place to a decrease in facility from quarter-hour to quarter-hour; and the increase in the number of errors furnishes a still more striking evidence that fatigue is setting in. Here, again, a period of rest will bring about a return to a normal facility, and a rest of two hours will be more effective than a rest of one hour. A good example of general fatigue is evidenced in the comparison of the rate and accuracy of addition or dictation or memory or reaction-times in the early morning hours and again at the close of the morning or the day's work. In a typical curve, in which time or errors are tabulated, the time needed for the calculations, as well as the proportion of mistakes, increase after school work, decreasing again after hours given to recreation. There is quite definite evidence as well that a more concentrated effort brings about a greater increase in time and errors, and that the various forms of test for mental fatigue—calculations, dictations, reactions, memorizing and the like—yield consistent although not equally definite results.

It thus appears that an appreciable advance has been made in the methods of detecting the nature and degree of fatigue of various types; that interesting and fairly precise means of measuring these have been devised; some insight into the variety and complexity of the factors involved in fatigue has been gained, and some moderately successful applications to the work of the school room have been offered. To pursue the investigations further requires a further elaboration of technique, a more complete elimination of the sources of error, a more thorough application of logical method to the arrangement and interpretation of tests. One very wholesome lesson of all this is that the path from knowledge to practice is a long and tortuous one. A suggestion arising from a slight experimental investigation is not a sufficient basis for raising a cry of overwork, or for reforming the school program; nor is an offhand acquaintance with the general results of studies in fatigue without a detailed comprehension of the experimental conditions under which such results were obtained, a proper basis for either their criticism or their application to pedagogical problems. The study of mental fatigue is certain to become, and practically has become, a technical acquisition; the popular interest must be severely regulated by scientific method and caution; its possible practical aspect and the desire to reach practical results must not be allowed to interfere with a proper theoretical discussion and analysis. Moreover, the road from theory to practice must be by way of a quantitative analysis. The determination of the facts of fatigue, however useful and indispensable, is in part subservient to the determination of the degree of fatigue; the how much rather than the how is needed for practical application, or rather it is precision of nature and degree that makes practice possible. The fact that many diseases are of germ origin is, of course, of great importance, not only negatively by discountenancing

other hypotheses, but positively by shaping men's views regarding disease in a right direction; but the great applications of this view came only when it was demonstrated that certain definitely recognizable microbes were the cause of definitely recognizable diseases. It was the precise, not mere general, knowledge that most largely influenced practice. In the same way regarding fatigue our most valuable applications can be expected to appear only when detailed and precise investigations have reached a high degree of development.

Not all fatigue is dangerous or abnormal, and because children or scholars become tired it does not follow that they are overworked. The lowest functions, notably the heart beat, seem to have an automatic or semi-automatic form of recuperation; so that, provided there is no forcing of them to work at too high a speed, recuperation keeps pace with exhaustion. The highest functions, and, most of all, the brain energies demanded by civilized life, fatigue most readily. At what point normal fatigue passes into abnormal it is not easy to determine. The best test is the capacity for recuperation. A fatigue, however severe, whether physical or mental, that is totally dissipated by a night's rest can hardly be said to be abnormal. It is only when the principal is being drawn upon that the danger of exhaustion begins. Severe effort, periods of strain and stress, are unavoidable in modern life. The capacity to undergo them is a legitimate aim of education, but still more important is the recognition of the danger line and the strength to refrain. A most important phase of intellectual hygiene is that suggested by the dangers of abnormal fatigue. This is only slightly touched upon in the present volume and still awaits a comprehensive as well as practical treatment.

'La fatigue intellectuelle' must be welcomed as a useful and ably prepared compendium; it is by no means a perfect book, possibly not even as good a book as the imperfect material at command made possible. There are some important omissions, such as the neglect of the important work of Lombard and Hodge; the perspective is frequently unfortunate, many pages being allotted to technical discussions which more properly belonged to an appendix, and the main line of argument consequently suffering in continuity; and considerable material is introduced, such as the long discussion of the report on 'le surmenage intellectuel' of the French Academy of Medecine, which is of a secondary interest and hardly germane to the rest of the work. None the less, the volume is a noteworthy one, which no student of psychology can afford to overlook.

It is further noteworthy as the first volume of a series on pedagogy and psychology. The announcement of such a series indicates that in France the problem of the relation between these two disciplines has been seriously taken up. The authors of the present volume are most forcible in their expression of the view that the pedagogy of the future must be founded upon psychology, and that most of the old pedagogy is 'verbiage.' The further progress of this movement in France will be watched with the greatest interest by those in America who are laboring with the same problem.

Joseph Jastrow.

Syllabus der Pflanzenfamilien. Eine Uebersicht über das gesammte Pflanzensystem mit Berücksichtigung der Medicinal- und Nutzpflanzen. Zweite, umgearbeitete Ausgabe. Von Dr. Adolph Engler. Berlin, Gebrüder Borntraeger. 1898. 8vo. Pp. 214.

The near completion of *Die natürlichen Pflanzenfamilien* originated by Engler and Prantl some ten years ago gives this *Syllabus* a peculiar interest, as it attempts to place in compact form the conclusions of the senior and only surviving author of the *Pflanzenfamilien* with reference to the relationships of the various groups of plants. We can but feel that if the cryptogamic projector had lived, the *Uebersicht* would have been less one-sided, for on its cryptogamic side it shows patch-work instead of a logical summary made from a broad perception of relations and perspective. We shall criticize the work mainly from the cryptogamic side, but, as it represents the highest generalization of the so-called Berlin school of botanists, it must also be criticized in those points in which it departs from their announced principles of taxonomy. For the arrangement of the spermaphytes it represents, without doubt, the work