

Micraster cor-testudinarium the group-form of *Micraster* is almost wholly absent. Nor are the lithological deviations less noteworthy, for the particular characters of the Chalk vary at different stages, and the same division may be nodular or smooth, and have many or no belts of flints. The value of a detailed palæontological study of our strata is abundantly manifested in this essay, and not the least interesting part of it is in the light it throws on the geographical as well as geological distribution of the fossils.

A most excellent series of plates of cliff-sections, from photographs taken by Prof. H. E. Armstrong, accompany this work. H. B. W.

THE PHYSIOLOGY OF BREEDING.¹

IT is a remarkable fact that the system of organs in the animal body to which they are themselves indebted for their existence is very largely neglected by physiologists; that a number of secretory, vascular and nervous phenomena intimately concerned with fertility, with the power of conception and the ability to bear young are neither understood nor investigated; and that a wide field of research as to the influences of various kinds of food supplied to the mother both on her capacity for breeding and on the growth, constitution, and variation of the embryo is as yet untouched. As a contribution to the subject of "breeding," therefore, this paper is specially welcome, and the author is to be congratulated both upon the careful work he has done and the treatment he has accorded the subject.

The wide variations in the power of breeding which different breeds of sheep and different individuals of the same breed are subject to is shown, and the effect of altitude, climate and food referred to.

The histological changes which take place in the uterus of the sheep during the œstrous cycle are carefully described and figured, and the homology of these changes with those elsewhere described for the bitch and monkey clearly established. A brief *résumé* of the author's work on the same phenomena in the ferret is given, and their essential similarity with that of the bitch shown.

Suggestive information follows on the question of ovulation in sheep and other mammals, on the stimulus necessary to bring about that process under various conditions, on the artificial methods adopted by some flock masters to stimulate breeding in their ewes, and on the effect of these methods on fertility. Here a subject is touched upon which is of vital importance to breeders, and one which requires and deserves careful study. Atresia among the follicles of the sheep's ovary is then studied, and its relation to the proportion of twins and to barrenness examined.

The remainder of the paper is occupied with a description of the formation of the corpus luteum of the sheep and an examination of the views of the most recent writers on that subject. The lutein cells are stated to be the much hypertrophied epithelial cells of the undischarged follicle, while the connective tissue element is supplied by ingrowth from both theca interna and externa.

Finally, the relation between the development of the corpus luteum and the changes which take place in the uterus during pregnancy is touched upon, and the view expressed that, while the functions of ovulation and œstrus do not represent cause and effect, they are primarily connected, inasmuch as each is dependent largely upon the same cause.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE new prospectus of the department of dyeing and tinctorial chemistry of the Yorkshire College, Leeds, shows that special facilities are provided for the study of the chemistry of the colouring matters and for research work upon coal tar products. An effort is being made to combine the standard of scientific teaching of a university with the practical training of a technical school, and to encourage the prosecution of original investigation in what is certainly the most scientific, yet unfortunately, in this country, the

¹ "The Œstrous Cycle and the Formation of the Corpus luteum in the Sheep." By Francis H. A. Marshall. (*Phil. Trans.*, vol. cxcvi., 1903.)

least studied branch of applied chemistry. The dyeing department was built, equipped, and endowed by the Clothworkers' Company, and is provided with lecture-rooms, pattern and diagram rooms, museums, experimental and practical dye-houses, as well as with adequate provision for research work.

THE Great Western Railway Company now offer facilities, in conjunction with the Swindon Education Committee, to their apprentices to enable them to gain technical scientific knowledge. A limited number of selected students may attend day classes at the Technical School. They must have spent at least one year in the factory, and must have regularly attended for at least one session in the preparatory group of evening classes at the Technical School. The number of studentships will be limited to thirty at any one time. For each year's course there will be a competitive examination, successful students passing on from one year's course to the next. The course of study for each year will consist of practical mathematics, practical mechanics, geometrical and machine drawing, heat, electricity, and chemistry. Those attending the classes will have their wages paid as if at work in the factory, and the Great Western Railway Company will pay their school fees. The students attending the day classes will be expected to give some time each evening to private study. Students who distinguish themselves will be allowed to spend part of their last year in the drawing office and chemical laboratory. The whole of the arrangements will at all times be under the direction of the chief mechanical engineer.

THE report on the secondary and higher education of the City of Sheffield, prepared by Prof. Michael E. Sadler, has been published in pamphlet form by the Education Committee of Sheffield. The schools and colleges now in existence in Sheffield are described and their work passed in review. A series of recommendations is then made with a view to equip the city with a complete educational system. Prof. Sadler says that the weakest spot in the educational arrangements of Sheffield is in the secondary education provided for boys. A promising boy ought to have the best educational opportunities within his reach, but at present the equipment of such higher education in Sheffield is very much behind the standard in the progressive cities of Germany and the United States. Dr. Sadler also recommends a development of the work of the Technical College. He remarks, "the work of the Technical College, admirable as it is, would greatly gain in force and depth if it were supported by a strong department of pure science." As the report rightly insists, what is wanted is that a workman should be able to deal with new problems, and in order to do this he must have, as a foundation for his technological skill, a thorough knowledge of the pure science which it is his task to apply to practical problems. The probable additional net annual cost to Sheffield of carrying out Prof. Sadler's chief recommendations is estimated at about 8500*l.*, which would mean a rate of less than three halfpence. It now remains for the Education Committee of Sheffield to put into practice some of the excellent suggestions in the report.

THE volume of "General Reports on Higher Education for 1902," just published by the Board of Education, contains with other information of importance an account of the secondary schools, science classes, art classes, and evening schools of the southern and eastern divisions of England, the former by Mr. Buckmaster and the latter by Dr. Hoffert. Speaking of the evening schools in London, Mr. Buckmaster says "the impression formed in early visits has not been removed on more complete acquaintance, and the School Board, in its laudable anxiety to throw the educational net as wide as possible, has secured quantity at the expense of quality. As missionary agencies the schools abundantly justify their existence, they bring the opportunities for improvement near to all in all parts of the metropolis, but as centres for real solid work they are not so successful, in spite of the best efforts of the teachers, the majority of whom are most enthusiastic and devoted to their work." Several methods for the improvement of these schools are suggested, such as the alteration of the rule that, where the average attendance falls below 25 per teacher, a reduction in the number of teachers should be made; that

means should be taken to improve the attendance; and to encourage homework. The polytechnics are to some extent fed by students from these evening classes, and it is of importance that their work should be as serious as possible. Dr. Hoffert is able to report considerable progress in the organisation of higher education in the eastern division of England, especially the increased attention now being paid to the improvement of secondary education. In another place Dr. Hoffert refers to the question of higher elementary schools, and expresses the opinion that schools of this type might very profitably be distributed at suitable intervals over London. "They appear destined to fill an important place in any future organised scheme of elementary and secondary education, and to form the natural completion of the elementary system."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 18.—"Radiation in the Solar System: its Effect on Temperature and its Pressure on Small Bodies." By J. H. **Poynting**, Sc.D., F.R.S., Professor of Physics in the University of Birmingham.

PART I.—Temperature.

We can calculate an upper limit to the temperatures of fully absorbing or "black" surfaces receiving their heat from the sun, and on certain assumptions we can find the temperatures of planetary surfaces, if we accept the fourth power law of radiation, since we know approximately the solar constant, that is, the rate of reception of heat from the sun, and the radiation constant, that is, the energy radiated at 1° abs. by a fully radiating surface.¹

The effective temperature of space calculated from the very uncertain data at our command is of the order 10° abs. Bodies in interplanetary space and at a much higher temperature may, therefore, be regarded as being practically in a zero temperature enclosure except in so far as they receive heat from the sun.

The first case considered is that of an ideal earth, more or less resembling the real earth, and it is shown that the temperature of its surface is, on the average, 325°, 302°, or 290° abs. according as we take for the solar constant Angström's value 4 cal./min., Langley's value 3 cal./min., or a value deduced from Rosetti's work 2.5 cal./min. The lowest value found, 290° abs., is very near the average temperature of the earth's surface, which may be taken as 289° abs. As the earth's effective temperature must, if anything, be below this, and cannot differ much from that of the ideal planet, Rosetti's value for the solar constant, 2.5 cal./min. or 0.175×10^7 ergs./sec. is probably nearest to the true value, and is therefore used in the following calculations.

The preceding calculations may be turned the other way. It is shown that, on certain assumptions, the effective temperature of the sun is 21.5 times that of the ideal earth. If we consider that the real earth with a temperature 289° abs. sufficiently resembles the ideal, we get a solar temperature $21.5 \times 289 = 6200^\circ$ abs.

The upper limit to the temperature of the surface of the moon is determined and is shown to be 412° abs. when no heat is conducted inwards. But Langley finds that the actual temperature is not much above the freezing point on the average. This leads us to the conclusion that it is not higher than four-fifths the highest possible value, the reduction being due to inward conduction.

The temperature of a small body, dimensions of the order of 1 cm. or less, but still so large that it absorbs radiation, is shown to be nearly uniform, and at the distance of the earth from the sun about 300° abs.

Under otherwise similar conditions temperatures must vary inversely as the square root of the distance from the

¹ W. Wien ("Cong. Int. de Physique," vol. ii. p. 30) has pointed out that Stefan's law enables us to calculate the temperatures of celestial bodies which receive their light from the sun, by equating the energy which they radiate to the energy which they receive from the sun, and remarks that the temperature of Neptune should be below -200° C.

sun. Thus Mars, if an earth-like planet, has a temperature nowhere above 253° abs., and if a moon-like planet, the upper limit to the temperature of the hottest part is about 270°.

PART II.—Radiation Pressure.

The ratio of radiation pressure due to sunlight to solar gravitation increases, as is well known, as the receiving body diminishes in size. But if the radiating body also diminishes in size, this ratio increases. It is shown that if two equal and fully radiating spheres of the temperature and density of the sun are radiating to each other in a zero enclosure, at a distance large compared with their radii, then the radiation push balances the gravitation pull when the radius of each is 335 metres. If the temperature of two equal bodies is 300° abs. and their density 1, the radius for a balance between the two forces is 19.62 cm. If the density is that of the earth, 5.5, the balance occurs with a radius 3.4 cm. If the temperatures of the two are different, the radiation pressures are different, and it is possible to imagine two bodies, which will both tend to move in the same direction, one chasing the other, under the combined action of radiation and gravitation.

The effect of Döpler's principle will be to limit the velocity attained in such a chase. The Döpler effect on a moving radiator is then examined, and an expression is found for the increase in pressure on the front, and the decrease in pressure on the back of a radiating sphere of uniform temperature moving through a medium at rest. It is proportional to the velocity at a given temperature. The equation to the orbit of such a body moving round the sun is found, and it is shown that meteoric dust within the orbit of the earth will be swept into the sun in a time comparable with historical times, while bodies of the order of 1 cm. radius will be drawn in in a time comparable with geological periods.

"The Phenomena of Luminosity and their possible Correlation with Radio-Activity." By Henry E. **Armstrong**, F.R.S., and T. Martin **Lowry**, D.Sc.

The possibility of regarding *luminous manifestations* generally—including radio-activity—as the outcome of oscillatory changes in molecular structure was pointed out by one of the authors more than a year ago in a communication to the Society in which the kind of change contemplated was exemplified by reference to the case of nitrocamphor. As the phenomena of radio-activity are exciting so much interest, it is thought desirable to enter somewhat more fully into an explanation of the argument underlying this conception of the origin of luminous appearances.

In the note referred to, it was suggested that *triboluminescent* substances, *i.e.* substances which become luminous at the moment of crushing, might conceivably, at the same time, manifest radio-activity. Sir William Crookes, at Dr. Armstrong's request, has recently examined saccharin from this point of view.

His remarks are described; they seem to show that saccharin is slightly radio-active towards barium platino-cyanide when crushed. The authors have been unable hitherto to detect any effect on the electrometer.

Triboluminescence.—The authors consider the nature of the change involved in the production of the luminous flash, in order that it may be clear why, in their opinion, if radio-activity were observed in such a case, it would have been as the concomitant to chemical change.

There is distinct evidence, they think, that the phenomena of triboluminescence may be correlated with the occurrence of the form of isomeric change which attends the passage of a compound into the isodynamic form of lower potential. Tschugaeff, who has examined more than 500 inorganic and organic compounds, found that about 25 per cent. of the latter gave a more or less intense flash when crushed; of these a considerable proportion appear to be such as could exist in isodynamic forms. Only about 5 per cent. of the inorganic substances flashed.

To take the case of saccharin, the two conceivable forms are:—

