information. Black *Urjanis* usually breed true; when they fail to do so, the progeny is generally a sport of a particular kind called *dijji*, uniformly red when young, more or less mottled with white when adult. These *dijjis* are apt to "throw back," and in turn produce good *Urjanis*.

One of my own mottled birds (*dijji*) remains in my possession, and is now mated to an *Urjani*—an own brother. The pair has produced this spring four young: three *dijjis*, just like the mother, and one partial reversion to the *Urjani* form, being dark-chequered blue, with red bars on the wings. The original parent pair of *Urjanis* have also raised four squabs this season—three normal and one *dijji*; sexes not yet determined. I state these facts without comment; but would be glad to know whether fanciers in England or elsewhere have observed anything quite as striking in the way of colour-variation.

Beyrout, Syria. W. T. VAN DYCK.

Dependence of the Colour of Solutions on the Nature of the Solvent.

IT is a well-known fact that the colour exhibited by one and the same body in solution depends more or less on the nature of the solvent. In some cases this phenomenon can be satisfactorily accounted for by electrolytic dissociation, but in the majority of cases hitherto examined this explanation is not admissible. Perhaps the most striking of these is that of iodine, the solutions of which are coloured variously violet, blue, brown, and yellow. The hypothesis has been put forward that the variation in absorption might be due to the formation of molecular aggregates of variable complexity; but this, at least in the case of iodine, has been rendered very improbable by the recent researches of Beckmann and others. Nor does the hypothesis that the variation may be due to a varying degree of combination with the solvent seem much more promising.

If, now, absorption be a case of electrical resonance, should one not expect a relation between the absorption of the dissolved body and the physical properties of the solvent, sufficient to account for the observed variations? That such a relation should exist, seems possible from the following rough considerations.

The period of vibration of an electric oscillator is, in the usual notation,

$$T = 2\pi\sqrt{LC},$$

where L = self-induction, and C = capacity. But now:—

$$LC = gK\mu,$$

where g is a geometrical factor and K and μ are the dielectric constant and permeability of the surrounding medium. Also $n^2 = K\mu$, where n is the index of refraction of the medium for very long waves, whence it follows that

$$T = 2\pi n\sqrt{g},$$

which means that the principal absorption-band should travel towards the red end of the spectrum as the index of refraction of the solvent increases. This result is identical with the general qualitative law enunciated many years ago by Kundt, on the basis of experimental data. There are, it is true, various breaks in the parallelism; still this mode of viewing the question seems to offer more possibilities than the others.

Holywood, Belfast. F. G. DONNAN.

Hatching Lizards' Eggs.

CAN any of your readers suggest a way to hatch lizards' eggs? I have had a pair of bright-green lizards (I think they came from Italy) in a glass vivarium in a very sunny window for two years and a half. Last year, on May 19, the female laid eleven eggs. I left them exactly as the mother laid them, and after about three weeks I opened one and found the rudiments of a young lizard; but the other eggs never came to anything. I should like to rear them this year if it is possible. H. A. ROSS.

Trevean, Penzance.

THE DIFFUSION OF METALS.

IT is now quite usual to think of alloys as being solid solutions and to recognise that the atoms of solid metals are in active movement. That this must be the case, is revealed by the passage of metals to allotropic modifications in which the physical properties differ widely from those of the same metals in their normal state. It is well, therefore, that we should remember how much was done for us thirty years ago by Matthiessen in framing such views, and by Graham in showing that solid metals are true solvents for gases which move and diffuse freely in them, sometimes to reappear with gaseous elasticity.

The experimental portion of the latter work, Graham entrusted to me, and my hope that I should be able to extend his work on the diffusion of salts, to liquid and solid metals, has been somewhat tardily realised by the delivery in the present year of the "Bakerian Lecture" of the Royal Society, of which the following is a brief abstract.

PART I.—*Diffusion of Molten Metals.*

In the first part of it allusion is made to some earlier experiments of my own conducted in 1883 on the diffusion of gold, silver, and platinum in molten lead. It is strange that although the action of osmotic pressure in lowering the freezing point of metals has been carefully examined, very little attention has been devoted to the measurement, or even to the consideration, of the molecular movements which enable two or more metals to form a truly homogeneous fluid mass. The absence of direct experiments on the diffusion of molten metals is probably explained by the want of a sufficiently accurate method. Ostwald has stated, moreover, with reference to the diffusion of salts, that "to make accurate experiments in diffusion is one of the most difficult problems in practical physics," and the difficulties are obviously increased when molten metals diffusing into each other take the place of salts diffusing into water.

The continuation of the research was mainly due to the interest Lord Kelvin had always taken in the experiments. The want of a ready method for the measurement of comparatively high temperatures, which led to the abandonment of the earlier work, was overcome when the recording pyrometer was devised, and the use of thermo-junctions in connection with this instrument rendered it possible to measure and record the temperature at which diffusion occurred. Thermo-junctions were placed in three or more positions in either a bath of fluid metal or an oven carefully kept hotter at the top than at the bottom. In the bath or oven, tubes filled with lead were placed, and in this lead, gold, or a rich alloy of gold, or of the metal under examination, was allowed to diffuse upwards against gravity. The amount of metal diffusing in a given time was ascertained by allowing the lead in the tubes to solidify; the solid metal was then cut into sections, and the amount of metal in the respective sections determined by analysis.

The movement in linear diffusion is expressed, in accordance with Fick's law, by the differential equation

$$\frac{dv}{dt} = k\frac{d^2v}{dx^2}.$$

In this equation x represents distance in the direction in which diffusion takes place, v is the degree of concentration of the diffusing metal, and t is the time; k is the diffusion constant, that is, the number which expresses the quantity of the metal in grams diffusing through unit area (1 sq. cm.) in unit time (one day) when unit difference of concentration (in grams per c.c.) is maintained between the two sides of a layer 1 cm. thick. The experiments described in the Bakerian Lecture showed that metals diffuse in one another just as salts do in water, and the results were ultimately calculated by the aid of tables prepared by Stefan for the calculation of Graham's experiments on the diffusion of salts, special tables being calculated by one of my students, Mr. A. Stansfield, in connection with this research.

The necessary precautions to be observed and the corrections to be made were described at length and the values for k—the diffusivity of certain metals in lead, tin, bismuth and mercury, given in sq. cm. per day, are as follows :—

	k
Gold in lead	3·19 at 550°
,, bismuth	4·52 ,,
,, tin...	4·65 ,,
Silver in tin	4·14 ,,
Lead in tin	3·18 ,,
Rhodium in lead	3·04 ,,
Platinum in lead	1·69 at 490°
Gold in lead	3·03 ,,
Gold in mercury	0·72 at 11°

In order to afford a term of comparison, it may be stated that the diffusivity of chloride of sodium in water at 18° is 1·04.

It is at present too soon to draw any conclusion as to the evidence which the results afford respecting the molecular constitution of metals, but it is evident that they will be of value in this connection, because, with the exception of the gases, they present the simplest possible case which can occur—the diffusion of one element into another. Thus the relatively slow rate of diffusion of platinum as compared with gold, points to its having a more complex molecule than the latter.

It is very difficult within the limits of this brief abstract to show that molten metals actually pass into each other by diffusion. The following method will, however, serve to give a rough qualitative demonstration that such is the case. A white sheet of card, B, is, as Fig. 1 shows, mounted on a frame, and by means of the gearing C C′ can be raised or lowered at a definite rate, which can be maintained by the aid of a metronome. The diffusion cell is shown at A. It consists of a clay tube about 30 mm. long, heated from its upper part so that the top portion of the tube is hotter than the lower portion. This tube is filled with molten lead, and at the bottom of the lead, is a layer of a lead-gold alloy rich in gold. A sample of lead may be withdrawn from the tube at the beginning of a lecture and set aside, while a second sample of lead may be removed at the end of an hour, by which time gold will have diffused into the upper layers of lead, and consequently this second sample will be auriferous. Other experiments have shown that in this case convection currents do not complicate the result.

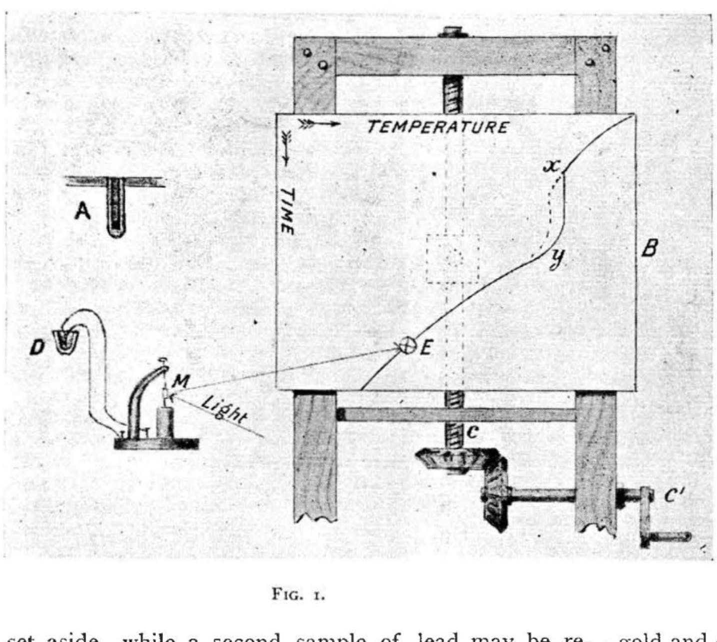

Fig. 1.

The proof that gold had diffused into lead can then be afforded by the fact that the point of solidification of the second portion of lead is, owing to the presence of gold in it, lower than that of the first portion, and this is shown to be the case in the following way. The first sample of lead is placed in a small crucible, D, and a protected thermo-junction is immersed in the lead when it is fluid. The spot of light E from the mirror M, of the galvanometer connected with the thermo-junction is allowed to fall on the movable screen, and as the lead cools down the spot of light traverses the screen from right to left. The consecutive positions occupied by the centre of this spot of light are marked by hand with a stroke of charcoal. During the solidification of the metal the spot of light remains in one position, and consequently the portion of the curve which represents the solidification of the metal is the vertical line x, y. If the second sample of lead be treated in exactly the same way, and its "cooling curve" traced, it will be seen that the freezing point is lowered, and a demonstration is thus afforded that diffusion of gold has occurred in the lead contained in the tube A.

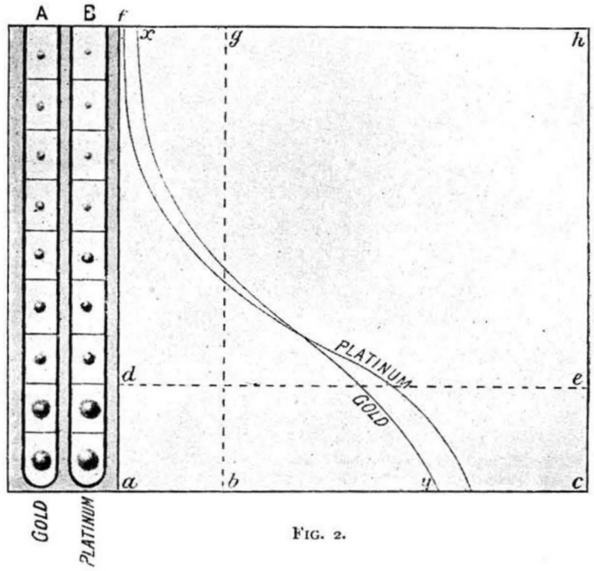

Fig. 2.

The results of the diffusion of platinum and gold in fluid lead during twenty-four hours is shown diagrammatically in Fig. 2. The lead was placed in tubes which were arranged side by side in the oven, to which reference has been made. The columns A B represent the actual length and diameter of the columns of fluid lead. The spheres, which are drawn to the left of the diagram, are slightly smaller than the buttons of gold and of platinum extracted from the several sections, shown by horizontal lines, into which the columns of lead were divided after the metal had been allowed to solidify. The curves represent the respective diffusivity of gold and of platinum. The vertical ordinate represents the *distance* in the direction in which diffusion takes place, and the horizontal ordinates *concentration* of the diffusing metal. Each of the metals gold and platinum which diffused into the fluid column of lead occupied in the form of an alloy rich in lead, the length $a\ d$, of the tube, and in both cases, the initial concentration of the alloy, denoted by *a c*, from which diffusion proceeded, was the same, so that the area, *a c e d*, represents the total amount of gold or platinum employed in the experiment, the whole quantity of either metal being initially below the line *d e*. The final state of complete diffusion would be represented by the area *a b g f*, which is the same as *a c e d*, since the quantity of gold or of platinum remains unaltered. In the same manner the area *a y x f*, would represent the distributions of the gold at the end of the experiment, and consequently in experiments which have lasted for equal times, the nearer the curve approximates to the line *b*, *g*, the more rapid is the diffusion of the metal it represents. It will be evident from the distribution of the spheres of gold and platinum that diffusion can be accurately measured in molten metals.

PART II.—*Diffusion of Solid Metals.*

The second part of the investigation was devoted to the consideration of the diffusion of solid metals. Much of the evidence is historical, for there has long been a prevalent belief that diffusion can take place in solids, and the practice in conducting important industrial operations supports this view. In this connection two truly venerable "cementation" processes may be cited. The object in the first of these is the removal of silver from a solid gold-silver alloy, while the second is employed in steel making by the carburization of solid iron. In both of these processes, however, a gas may intervene, though the carburization of iron by the diamond, which, in 1889, I effected *in vacuo*, suggests that if a gas does intervene in the latter case, its quantity must be very minute. In connection with the mobility of various elements in iron the work of Colson, of Osmond, and of Moissan must be carefully kept in view.

The electro-deposition of metals also affords evidence of the interpenetration of metals. I observed in 1887 that an electro-deposit of iron on a clean copper plate will adhere so firmly to it that when the metals are severed by force, a copper film is actually stripped from the copper plate and remains on the iron, thus affording clear evidence of the interpenetration of metals at the ordinary temperature, and this interpenetration of copper and iron will take place through an intervening film of nickel.

My friend Dr. George Gore has given me the following interesting reference to the penetration of gold and platinum at a temperature below redness, which is recorded in "Weldon's Register" for July 1863 by Edward Sonstadt, who states that he gilded a platinum crucible "inside and out . . . but no sooner was the platinum warmed than it began to change colour, and before the crucible attained visible redness not a vestige of the gilding remained."

This is interesting in connection with the earlier observation of Faraday and Stodart, who in 1820 showed that platinum will alloy with steel at a temperature at which even the steel is not melted, and they expressed their interest in the formation of alloys by cementation, that is by the union of solid metals.

The remarkable view expressed by Graham, in 1863, that the "three conditions of matter (liquid, solid, and gaseous) probably always exist in every liquid or solid substance, but that one predominates over the other," affords ground for the anticipation that metals will diffuse into each other at temperatures far below their melting points. The important work by Spring, in 1886, on the lead-tin alloys, showed that they retain a certain amount of molecular activity after they become solid, and special importance will always be connected with the proof afforded by him (1882), that alloys may be formed either by the strong compression of the finely divided constituent metals at the ordinary temperature, or (1894) by the union of solid masses of metal compressed together at temperatures which varied from 180° in the case of lead and tin, to 400° in the case of copper and zinc; tin melting at 227° and zinc at 415°.

Early evidence as to the volatilisation of solid metals may be traced to the expression of Robert Boyle's belief, that even such solid bodies as glass and gold might respectively "have their little atmospheres, and might in time lose their weight," and Merget's experiment on the evaporation of frozen mercury is specially interesting in relation to Gay-Lussac's well-known discovery that the vapours emitted by ice and water both at 0° C., are of exactly equal tension. Demarçay's experiment on the volatilisation of metals *in vacuo* at comparatively low temperatures is, moreover, connected with the evidence afforded by Spring (1894), that the interpenetration of two metals at a temperature below the melting point of the more fusible of the two is preceded by volatilisation.

It is well to remember, however, that interesting as the results of the earlier experiments are, as affording evidence of molecular interpenetration, they do not, for the purpose of measuring diffusivity, come within the prevailing conditions in the ordinary diffusion of liquids, in which the diffusing substance is usually in the presence of a large excess of the solvent, a condition which was fully maintained in the experiments on the diffusion of liquid metals described in the first part of the Bakerian Lecture. Van 't Hoff has made it highly probable that the osmotic pressure of substances existing in a *solid solution* is analogous to that in liquid solutions, and obeys the same laws; and it is probable that the behaviour of a solid mixture, like that of a liquid mixture, would be greatly simplified if the solid solution were very dilute.

The experiments on the diffusion of solid metals are of the same nature as in the case of fluid metals, except that the gold, which was the metal chosen for examination, was placed at the bottom of a solid cylinder of lead instead of a fluid one.

In the first series of experiments, cylinders of lead, 70 mm. long, with either gold, or a rich alloy of gold and lead at their base, were maintained at a temperature of 251° (which is 75° below the melting point of lead) for thirty-one days. At the end of this period the solid lead was cut into sections, and the amount of gold which had diffused into each of them was determined in the usual way. Other experiments were made, in which the lead was maintained at 200°, and at various lower temperatures down to that of the laboratory. The following are the results in sq. cm. per day:—

				k
Diffusivity of gold in fluid lead at		550	...	3·19
,,	solid	,, 251	...	0·03
,,	,,	,, 200	...	0·007
,,	,,	,, 165	...	0·004
,,	,,	,, 100	...	0·00002

The experiments at the ordinary temperature are still in progress, but there is evidence that slow diffusion of gold in lead occurs at the ordinary temperature. If clean surfaces of lead and gold are held together *in vacuo* at a temperature of only 40° for four days, they will unite firmly, and can only be separated by the application of a load equal to one-third of the breaking strain of lead itself. The nature of welding, however, remains to be investigated, as there is probably interlocking of molecules and atoms, which precedes true diffusion. It may be considered remarkable that gold placed at the bottom of a cylinder of lead, 70 mm. long (which is to all appearance solid), will diffuse to the top in notable quantities at the end of three days. At 100° the diffusivity of gold in solid lead can readily be measured, though its diffusivity is only 1/100,000 of that in fluid lead at a temperature of 500°, and experiments which are still in progress show that the diffusivity of solid gold in solid silver, or copper, at 800° is of the same order as that of gold in solid lead at 100°.

I trust, therefore, that the experiments described in the Bakerian Lecture will show that the diffusion can readily be measured in solid metals, and that they will carry one step further the work of Graham.

W. C. ROBERTS-AUSTEN.

BOOKS ON BIRDS.[1]

THE issue of works on ornithology continues in an unbroken stream. There can be little doubt that since the arrangement of the birds in the National Museum in South Kensington, in their natural attitudes and surroundings, was adopted—a system largely followed in many of our provincial museums—there has been a distinct increase in the interest taken in natural history, and, as might be expected from the amount of knowledge as to their life and habits which these groups convey, the study of birds has largely increased. The constant demand for work after work on the limited subject of British birds is very remarkable, and is to some extent a measure of the growing interest in this branch of science.

With the second volume, which has lately appeared, Dr. R. Bowdler Sharpe has completed his "Handbook to the Birds of Great Britain" in Allen's Naturalist's Library, of which he is the editor. His knowledge of the subject of which he treats is admittedly unrivalled, while the thorough manner in which he performs all his work—though vast in amount—is so well known, that his name, as editor and author, is sufficient guarantee for the value and excellence of these two volumes. All that is essential to be known in the life-history of British birds is related shortly yet fully, in clear, popular language. This work forms a concise monograph of our native birds; indeed, no better or more authoritative work on the subject has yet been published. It is illustrated by numerous coloured full-page plates, the bulk of them the resuscitated drawings of Lizars from Jardine's Library. As has been often already pointed out, and pressed upon the attention of the publishers in regard to other volumes of this series, those plates are quite unworthy of the text. In the preface to the second volume the author replies to the critics who have attacked his method of nomenclature adopted in this and other volumes of the Library, the result of which is that certain species come to be designated by a duplication of their generic and specific names. Dr. Sharpe appears to us to have adopted the only logical course open to him, and his reply would seem to be unanswerable. "Thus if Linnæus," he says, "called the Partridge *Tetrao perdix*, the name *perdix* ought to be retained at all costs for the species. When *Perdix* was taken in a generic sense and the species was called *Perdix cinerea*, I contend that it ought never to have been allowed, and if in restoring the Linnæan specific name of *perdix*, it results that the oldest generic name is also *Perdix*, and the species has to be called *Perdix perdix* (L.), I can only say I am sorry, but it cannot be helped."

In Mr. Hudson's "British Birds" a brief account is given of the appearance, language and life-habits of all the birds that reside permanently or for a portion of each year within the limits of the British islands. The descriptive accounts of the various species are shorter, less technical and precise, but not less accurate than those in Dr. Sharpe's "Handbook." On the other hand, our author trusts that his work has the merit of simplicity, as it is intended for the general reader and, more especially, for the young. The species alone are described, the family and generic characters being omitted, as there was not space to make the book, "at the same time, a technical and a popular one." Like all that comes from Mr. Hudson's pen on this subject, the present volume is sympathetically and attractively written. It is illustrated by eight chromolithograph plates from original drawings by A. Thorburn, in addition to eight full-page plates and one hundred figures in black-and-white, from drawings by G. E. Lodge, prepared for this work, the whole of which are exquisitely reproduced. Altogether the book is to be very highly recommended. It is prefaced by a chapter on structure and classification by so competent an anatomist as Mr. F. E. Beddard, F.R.S. His contribution, however, though very clear and condensed, is, we fear, somewhat above the heads of the bulk of the young readers for whom Mr. Hudson's pages have been written. On p. 17, he remarks, with reference to the fore-limb in *Dinornis* that no trace of a wing has been so far discovered. In 1892 a scapulo-coracoid, with a distinct glenoid cavity, was figured in NATURE (vol. xlv. p. 257), indicating the presence of a humerus, which is surely at least a "trace" of a wing.

In the "Wild Fowl and Sea-Fowl of Great Britain," a "Son of the Marshes" depicts the haunts rather than the habits of the birds of our estuaries and fen-lands. His volume is more a collection of shooting sketches than a serious contribution to ornithology, notwithstanding the short technical descriptions, at the conclusion of each chapter, of the several species of the group to which the chapter is devoted. The author has given us during many years numerous delightful sketches of marsh-land life at every season, and under all conditions of sky and temperature; but we have had his message so often now that it has begun to lose much of its freshness and flavour. In this latest delivery we cannot resist the impression that we have heard all he tells us before, and said even better than here. Many of his pages leave with the reader the irritating suspicion of having been elaborated with toil, and the matter beaten out to cover an allotted space. The numerous quotations from all sorts and conditions of marsh-folk, "coy" men, net-setters, and wild-fowlers, in which we fail, through obtuseness probably, to perceive anything humorous, quaint or original, might have been largely curtailed with advantage to the narrative. J. A. Owen, who edits the volume, has allowed to escape detection such unorthodox expressions as "to flight" and "flighting birds," as also the use of that most objectionable term "scientist," to indicate the professed man of science. The volume has numerous excellent full-page black-and-white illustrations by Bryan Hook.

[1] "A Handbook to the Birds of Great Britain." By R. Bowdler Sharpe, LL.D. Vol. i. 1894. Pp. xxii + 342. Vol. ii. 1895. Pp. xi + 308. (London: W. H. Allen and Co., Ltd.).

"British Birds." By W. H. Hudson, C.M.Z.S. With a Chapter on Structure and Classification, by Frank E. Beddard, F.R.S. Pp. xviii + 363. (London and New York: Longmans, Green, and Co., 1895.)

"The Wild-Fowl and Sea-Fowl of Great Britain." By a "Son of the Marshes." Edited by J. A. Owen. With Illustrations by Bryan Hook. Pp. 326. (London: Chapman and Hall, Ltd., 1895.)

"Birds from Moidart and Elsewhere; drawn from Nature." By Mrs. Hugh Blackburn. Pp. viii + 191. (Edinburgh: David Douglas, 1895.)

"The Birds of Berwickshire, with Remarks on their Local Distribution, Migration, and Habits, and also on the Folk-lore Proverbs, Popular Rhymes and Sayings connected with them. By George Muirhead, F.R.S.E. In two volumes. Vol. i. 1889. Pp. xxvi + 334. Vol. ii. 1895. Pp. xii + 390. (Edinburgh: David Douglas.)

"North American Shore Birds: a History of the Snipes, Sandpipers, Plovers, and their Allies." By Daniel Giraud Elliot, F.R.S.E. With seventy-four plates. Pp. viii + 268. (London: Suckling and Galloway. New York: Francis P. Harper, 1895.)

"The Birds of Ontario, being a Concise Account of every Species of Bird known to have been found in Ontario, with a description of their Nests and Eggs, and Instructions for Collecting Birds and Preparing and Preserving Skins, and Directions how to form a Collection of Eggs." By Thomas McIlwraith. 2nd edition. Pp. ix + 426. (London: T. Fisher Unwin; Toronto: William Briggs, 1894.)

"Birdcraft; a Field-book of Two Hundred Song, Game, and Water Birds." By Mabel Osgood Wright. With full-page plates. Pp. xvi + 317. (New York and London: Macmillan and Co., 1895.)

"Photographs of the Life-History Groups of Birds in the Grosvenor Museum, Chester." Prepared by Mr. R. Newstead, Curator; photographed by G. W. Webster. 1895.

"The Royal Natural History." Edited by Richard Lydekker, B.A., F.R.S. Vol. iv. Birds (chaps. viii.-xxi.). Pp. xv + 583. (London: Frederick Warne and Co., 1895.)

"The Fauna of British India, including Ceylon and Burma." Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. Birds. Vol. iii. By W. T. Blanford, F.R.S. Pp. xiv + 450. (London: Taylor and Francis; Calcutta and Bombay: Thacker and Co.; Berlin: Friedländer, 1895.)