did not appear in the original drawing. But these slight and unavoidable lapses are in this case so few and so little noticeable that they do not detract in any appreciable degree from the beauty and accuracy of this charming series of pictures of our birds.

A characteristic of this work is that it aims at including every species of bird which has occurred in these islands. Other earlier works have done the same. But accidental wanderers, "new to the British list," occur here from time to time so frequently that a book soon gets out of date in this respect. Indeed, these additions to the British list have poured in at such an astonishing rate of late years, especially from one district in England, that Mr. Thorburn has had the opportunity of figuring, for the first time, as British, quite a large number of birds which have, many of them unexpectedly, appeared on our list. To have not merely a figure but a beautiful coloured figure of all these will be most acceptable, especially to those who attach any great importance to these recent additions or many of them. At all events, we are all glad to know what they look like without referring to books perhaps not very accessible. Among those birds now painted for the first time as British we may mention the dusky thrush, black and pied wheatears, thrush nightingale, subalpine and Sardinian warblers, masked shrike, and collared flycatcher; and there are a good many others also. A number of birds are figured on each plate, and this, giving as it does an opportunity of comparing at a glance two or more nearly allied species, will be a great advantage to the beginner in ornithology and to those not far advanced in the study of British birds. And it is to these, we suppose, that the book will chiefly appeal, although there will be many past-masters in the art who will not be able to resist the desire to possess such a beautiful memorial of their favourites.

Some appropriate plants, flowers, and branches, introduced and skilfully blended in the plates, are instructive as to birds' habits, and greatly add to their beauty and effect. We may mention, for instance, the gorse blossom about the Dartford warbler and the stonechat, the rosemary on which the rufous warbler is perched, and the gentian by the side of the Alpine accentor; while a yellow crocus near the cock blackbird matches his orange bill. Most of the birds were drawn from life, and are the result of many years of studies of birds from the life with this object in view. To this we owe the remarkable success the author has had in catching the characteristic attitudes of the birds depicted. When it was not possible to obtain living birds for the drawings, the author has filled up the gaps from the best preserved specimens he could procure. Of the letterpress in this work it is not necessary to say much, because, as the author points out, being more familiar with the brush than with the pen, it was his first intention that the book should be simply a sketch-book of British birds practically without letterpress. But as the work proceeded he was induced to write a short description of the various species. Thus we have a condensed account of the distribution, nest and eggs, food, song, and general habits of each species. This letterpress is admittedly and of necessity largely a compilation, but the author has inserted, in addition to what has already appeared in print, such notes as he has been able to add from his own and his friends' observations.

So far as we can see from the present volume, the author may be congratulated on having produced the most accurate series of coloured figures of British birds (as such), as well as quite the most beautiful book on the subject, which has yet appeared. The publishers are also to be congratulated on the form in which it is issued. It is beautifully printed on really good paper, and the plain red linen-cloth cover with a gold line is just what we should desire. O. V. A.

SIR ANDREW NOBLE, BT., K.C.B., F.R.S.

SIR ANDREW NOBLE, the chairman and managing director of Sir W. G. Armstrong, Whitworth and Co., died on October 22 at his residence in Argyllshire. He was a great man of business, but what was more important to his country, a great scientific artilleryman. The story of his scientific work is, in fact, the history of the development of artillery in all its branches from the time of the Crimean War to the present date.

When Noble entered the Royal Artillery in 1849, after passing through the Edinburgh Academy and the Royal Military Academy, Woolwich, line-of-battle ships were all sailing vessels; the heaviest gun weighed 95 cwt., and fired a projectile of 68 lb.; rifled guns did not exist, and little or nothing was known of the principles of internal ballistics. This state of affairs was the opportunity for a clever, energetic officer with distinct scientific ability, and Noble was not long in forcing his way to the front. After serving for a short time with Sir Edward Sabine on the magnetic survey at the Cape, he became, in 1857, secretary of the Royal Artillery Institution, and wrote his first important paper, "On the Application of the Theory of Probabilities to Artillery Practice." He had in the meantime been appointed secretary to the Committee on Rifled Cannon, and it became necessary to ascertain the relative precision of fire of the various guns which came before the Committee for report. This he accomplished by calculating for each gun the area within which it was an even chance that any one shot would strike. He introduced the phrase "probable rectangle," which has been one of the commonplaces of artillery science ever since. The method adopted was naturally that of "least squares," but in applying this celebrated theory he showed much scientific intuition. He calculated separately the probable errors in range and deflection, and thence deduced the dimensions of the rectangle.

In 1859 Noble became secretary of the Com-

mittee on Plates and Guns, received the appointment of Assistant Inspector of Artillery, and entered the proof department of Woolwich Arsenal. Almost immediately after this he was made an associate member of the Ordnance Select Committee and a member of the Committee on Explosives. He was thus in closest touch with the burning questions that presented themselves for solution on the introduction of rifled guns. At this time (1860) the Government might possibly have secured his services for a further considerable period if they had promptly offered him a position suited to his growing reputation as a gunner of original ideas and untiring energy; but the Government acted too late, and a good offer found that he had already bound himself by contract to enter the Elswick firm as the director of its ordnance department. He, however, was retained on several Government committees, upon which his presence was invaluable, as he had the means at Elswick of carrying out many special researches, the results of which he freely placed at the disposal of the Government.

Noble's first important work in exterior ballistics appears to have been his experiments with the electro-ballistic apparatus of Navez, which had the object of making a close determination of initial velocity. He ascertained the causes which affect the velocity both with smooth-bore and rifled guns, and in particular he showed that with reduced powder charges the air-space in the powder chamber had a notable effect. He also discussed at length the law of dependence of the resistance of the air upon velocity in connection with previous researches of Probert, St. Robert, Mayevski, and Didion. The next paper, "On the Ratio between the Forces tending to produce Translation and Rotation in the Bores of Rifled Guns," was of much importance at the time it was written. Rifled guns were getting bigger every day, and there was much difference of opinion as to the best method of rifling and. in particular, as to the relative merits of uniform and increasing twist. He showed that with the uniform twist the force required to give rotation was only a small fraction of that required to give translation, and that in all cases the increment of gaseous pressure due to rifling was insignificant. With regard to the increasing twist (parabolic system of rifling) he also made a thorough mathematical investigation, and found again that the pressure on the studs due to rifling is only about $2\frac{1}{4}$ per cent. of the pressure required to give translation; also that the substitution of parabolic for uniform rifling reduces by about one-half the maximum pressure on the studs; and that the increment of gaseous pressure due to rifling, tending to burst the gun, is exceedingly small and less than that which obtains when the rifling is uniform.

His researches in interior ballistics properly so called commenced when he first went to Elswick, but the first publication appears to have been in the Proc. Roy. Inst. for 1871, "On the Tension of Fired Gunpowder." Previous investigators, de la Hire, Robins, Count Rumford, Cavalli, Neumann, Mayevski, Rodman, had obtained results for the pressure exerted by gunpowder fired in a closed vessel varying from 1000 to 100,000 atmospheres. Bunsen and Schischkoff later found 4374 atmospheres, about 29 tons on the square inch, for the pressure which the gases may approximate to but can never reach. Commencing in the year 1861, Noble, in conjunction with Sir W. Armstrong, carried out a large number of experiments, employing a chronoscope specially invented by himself. This beautiful instrument was able to measure a millionth of a second of time with ease. It was used in conjunction with a series of crusher gauges in determining the pressures exerted by the powder gases at various places along the bore extending from the powder chamber to the muzzle. The results were of first-rate importance. It was shown that the maximum pressure of fired ordinary gunpowder of unit density is not much above 40 tons to the square inch, but that in large guns, owing to the violent oscillations produced by the ignition of a large mass of powder, the pressure is liable to be locally exalted to an extent which endangers the endurance of the gun while detracting from the useful effect. It was also found that the intensity of this wave action is directly influenced by the position of the vent or firing point, and that it is desirable to have as short a powder cartridge as possible.

Noble's remaining researches in gunnery, extending over nearly fifty years, may be for the most part summed up under the title "Researches on Explosives." In these he was for many years associated with Sir Frederick Abel and Sir James Dewar. The objects in view were to ascertain the products of combustion of powders fired in circumstances similar to those which exist in guns—to ascertain the pressure exerted by the products of combustion at the moment of explosion and the law of its variation with the gravimetric density; to find the influence of the size of grain; to find the effect upon the products of a change in the pressure under which firing takes place; to measure the volume of the permanent gases liberated; to compare the explosion in a closed chamber with that in the powder chamber of a gun; to find the heat generated; and, finally, the work which the explosive is capable of performing on a projectile in the bore of a gun. That this lengthy programme was successfully carried out was largely due to Noble's extraordinary ability and energy. The results obtained were of the utmost importance to the manufacture of guns of all calibres. When fired in a closed space the temperature of the explosion of gunpowder was found to be 2200° C. The total work of gunpowder when indefinitely expanded was found to be 332,000 grm.-metres per gramme of powder, or 486 foot-tons per lb. of powder.

It is impossible in this short notice to say more upon these results, which are fully set forth in communications printed in the Transactions of the Royal Society between the years 1875 and 1879. The experiments were repeated as gunpowder gradually altered in physical characters,

and ultimately, when the cordite explosives were under consideration, a new set of experiments pointed out the modifications in gun construction that were necessary. It may safely be said that Noble threw light upon every question of internal ballistics. No doubt at Elswick he had very great facilities, but these would have been of no avail if he had not supplied practical knowledge and scientific insight, and supported these by his vigorous mind and untiring energy. It has been said that when a problem has been correctly stated, much has been already done towards its solution. When internal ballistics was in a state of chaos, Noble was able to extract the real questions from much that was irrelevant, and to give them a scientific statement. The result of his work has been that the splendid guns which we possess in the Navy and Army are at least as good as any in the world. It is certain that no history of gunnery will be complete which does not devote much space to a description of his pioneer work. That work was recognised on two occasions by the Royal Society: in 1870, when he was elected to the Fellowship, and in 1880, when he was awarded a Royal Medal.

P. A. M.

DR. R. ASSHETON, F.R.S.

BRITISH zoology, which recently sustained a severe loss by the death of Prof. Minchin, has received a second blow by the unexpected death of Dr. R. Assheton, which occurred at his residence, Riverside, Grantchester, near Cambridge, on October 24.

Dr. Assheton was born at Downham Hall in Lancashire in 1863, and belonged to an old Lancashire family. He was educated at Eton and afterwards entered Trinity College, Cambridge, where he came under the influence of the new school of embryology founded by Foster and Balfour and ably carried on by Sedgwick. He read for the Natural Sciences Tripos, in which he took first-class honours when he graduated in 1886. Thereafter he devoted himself to research in embryology, and was not long in making a name for himself. In 1889 he was appointed lecturer in zoology under Prof. Milnes Marshall in Victoria University, Manchester, and he held this post until Prof. Marshall's death in 1893. In 1901 he was appointed lecturer in biology to the medical school in Guy's Hospital, and took up his residence in Grantchester; he resigned this office in 1914 in order to give his whole time to teaching and research in Cambridge, where he was appointed lecturer in animal embryology. In the same year he received the well-merited honour of election into the Royal Society.

Assheton's earlier work was concerned with the difficult subject of mammalian embryology, and especially with the earlier stages of development and the beginnings of the placenta. He undertook a costly series of investigations into the early development of the sheep, and arrived at a novel view of the origin of the wall of the blastoderm vesicle from which the fœtal part of the placenta is principally derived. This he considered to be endodermic, not, as had always previously been believed, ectodermic. We think that this view is not adequately supported by the evidence which he adduced, and that it will scarcely survive. But Assheton did not by any means confine himself to mammalian embryology. The early stages of development of the frog, and the development of the curious Egyptian fish, *Gymnarchus niloticus*, also became the subjects of his researches.

From the very beginning of his work there was one feature by which Assheton was distinguished from most of his contemporaries. He was not content either with the simple description of developmental processes or with the search for their phylogenetic significance. In every case he endeavoured to analyse these processes into the differential rates of growth which underlay them, and then to find reasons for the differential rates of growth in differences of nutrition. He was, in a word, the first experimental embryologist in England. He succeeded in opening the hen's egg and keeping it still alive and developing for some days, and in this way he was able to watch the development of one and the same embryo, and by suitable tests to measure its growth. At a time when many embryologists were inclined to accept the view of His, that the nervous and skeletal axes of vertebrates were built up by the gradual concrescence of two lips bordering an elongated slit, Assheton was able to show that this view was an entire misinterpretation of the events, and to propound a solution which substituted for the alleged concrescence a growth in length of the embryo which he called *deuterogenesis*. All subsequent careful work has supported Assheton's view. Finally, in a paper entitled "The Geometrical Relation of the Nuclei in an Invaginating Gastrula (Amphioxus), considered in connection with cell-rhythm and Driesch's conception of entelechy," he measured swords with the "entelechy" of Driesch, and in substituting for that mystical factor a simple force which may well be of chemical or physical nature. At the time of his death Dr. Assheton was engaged in the preparation of a text-book of the embryology of mammalia. If this work was at all near completion it is to be hoped that it may be published, as otherwise a most valuable compilation of facts and a storehouse of illuminating ideas would be lost to science.

Dr. Assheton married a daughter of Sir Thomas Bazley, Bart., and is survived by his widow, one son, and two daughters. His son is serving as an officer in the 1st Cambridgeshire Regiment. He had a most charming personality which attracted all who knew him, and his loss will be deeply regretted by a wide circle of colleagues and friends.

E. W. M.