TELEGRAPHIC PHOTOGRAPHY AND ELECTRIC VISION.

THE success achieved by Dr. A. Korn in the telegraphic transmission of photographs (NATURE, vol. lxxvi., p. 444) has been followed by a remarkable development of inventive activity in the same line. Among several new processes which have recently claimed public attention three of the most promising were described in detail at the April meeting of the Société Française de Physique. As in Dr. Korn's method, the reproduced picture is in all cases constituted by a close spiral line of varying intensity traced upon a photographic film, or other material, covering a cylinder which rotates synchronously with another cylinder in the transmitting instrument. The use of selenium for controlling the resistance of the circuit is, however, generally discarded, the requisite variations of current being effected by purely mechanical means; ordinary film negatives, therefore, cannot be used.

In M. E. Belin's process, which he calls "Téléstéréographie," the original picture is a thickly coated gelatin-bichromate print, which has the form of a relief, lights being represented by elevations of the surface, and shades by depressions. The print is wrapped around the transmitting cylinder, which rotates uniformly, and at the same time moves slowly in a direction parallel to its axis. A sapphire point attached to the short arm of a lever presses lightly upon the picture, and is caused to move in correspondence with the contour of the surface. At the end of the long arm of the lever is a contact piece which slides over the edges of a series of thin copper plates, separated by sheets of mica, and connected with resistance coils, the whole constituting a rheostat capable of interposing in the circuit a resistance ranging from 0 to 4000 ohms in 20 steps. The current, regulated in accordance with the undulations traversed by the sapphire point, passes at the receiving station through an aperiodic reflecting galvanometer, such as Blondel's oscillograph. A beam of light concentrated upon the galvanometer mirror is reflected to a convex lens so placed as to project an image of the mirror over a small hole in the side of a light-tight box, inside which rotates the receiving cylinder covered with a photographic film. Between the hole and the lens, and close to the latter, is inserted an "optical wedge," consisting of a sheet of glass tinted by gradations from perfect transparency at one end to opacity at the other. A slight deflection of the mirror displaces the reflected rays from the centre of the lens towards the edge, and causes them to pass through a different part of the optical wedge; thus the intensity of the projected image of the mirror, and therefore of the photographic action upon the film, is varied in correspondence with the strength of the current. Photographs measuring 13 cm. by 18 cm. were transmitted by this apparatus over a double-wire telephone line in 22 minutes.

For use in Carbonnelle's instrument, the "Téléautograveur," the photograph is submitted to a treatment, details of which are not published, whereby the electrical conductivity is varied locally, being greater in the shades than in the lights. The picture is mounted upon the transmitting cylinder, and a stylus bearing upon the surface is joined to one of the line-wires. The receiving cylinder is covered with a sheet of soft metal, gelatin or celluloid, or simply by several sheets of white paper separated by carbonic paper. The sheet is acted upon by a graving point attached to the diaphragm of a telephone, which is in circuit with the transmitting apparatus. This process is said to give very satisfactory results, and to be remarkably rapid, a portrait 9 cm. by 7 cm. having been reproduced over a distance of 90 kilometres in 88 seconds.

A picture adapted for transmission by M. Pascal Berjonneau's "Téléphotographe" is prepared as a cylindrical half-tone block, the surface consisting of a multitude of metallic points, the density of which varies with the lights and shades. The block rotates under a stylus in the usual way, regulating the current which passes over the line. At the receiving station a galvanometer actuates a shutter which allows more or less light to pass through a small aperture to the photographic film. It is claimed for this apparatus that it is the only one which can be operated satisfactorily on an ordinary telegraph line, all others requiring a telephone line with metallic return. The time occupied in sending a portrait from Paris to Enghien by a single wire is said to have been 247 seconds.

The problem of telegraphic photography is often associated in the popular mind with that of distant electric vision, or "seeing by electricity," as it has been called. According to a telegram from the Paris correspondent of the *Times*, dated April 28, the latter problem is now engaging the attention of M. Armengaud, president of the French Society of Aërial Navigation, who "firmly believes that within a year, as a consequence of the advance already made by his apparatus, we shall be watching one another across distances hundreds of miles apart." It may be doubted whether those who are bold enough to attempt any such feat adequately realise the difficulties which confront them. The telegram referred to seems to contemplate the transmission of optical images over an ordinary telegraph or telephone line by a method in which advantage is taken of visual persistence. A necessary condition would be that the sensitive substance—selenium or other photoelectric body—should pass at least ten times per second over every unit of the surface upon which the image to be transmitted is projected, while at the distant station electrical connection is established, also ten times per second, between the line wire and every individual element in succession of the apparatus illuminating the receiving screen; and the synchronism of the arrangement must be so perfect that at the moment when the sensitive substance occupies any given unit area on the surface of the transmitter, connection must be made with the corresponding unit in the receiver. The difficulty imposed by this condition depends chiefly upon the necessarily large number of the units of area to be dealt with. Suppose that the image is received upon a screen no greater than 2 inches square; if its definition is to be as perfect as that presented by the eye or by a good photograph, the number of elements required would amount to about 150,000, and the synchronised operations to a million and a half in every second. If we are satisfied with a definition equal to that of the coarse half-tone pictures to be found in some of the daily newspapers, the necessary number of elements might be reduced to 16,000, and that of the synchronised operations to 160,000 per second. Even this would be wildly impracticable, apart from other hardly less serious obstacles which would be encountered. The number of operations might, of course, be greatly diminished by employing an oscillating or rotating arm, carrying a row of sensitive selenium cells, as was proposed by Profs. Ayrton and Perry nearly thirty years ago. For a coarse-grained picture 2 inches square 120 of these might suffice; but such an arrangement would require 120 line wires, and would also introduce a new series of troubles.

But although the problem is apparently incapable of solution upon the lines indicated, there is no reason beyond that of expense why vision should not be electrically extended over long distances. The only method which can be regarded as feasible (unless, indeed, M. Armengaud has made a revolutionary discovery) is that suggested by the structure of the eye itself; the essential condition is that every unit area of the transmitter screen should be in permanent and independent connection with the corresponding unit of the receiving screen. This idea would naturally present itself to anyone approaching the subject for the first time, but would probably be rejected in favour of something apparently more simple. Such an apparatus could, however, be constructed without any serious complexity apart from that arising from the mere multiplication of its components. I have made a rough estimate of the cost, assuming the stations to be 100 miles apart, the received picture to be 2 inches square, and the length of a unit to be 1/150 inch. Of each of the elementary working parts—selenium cells, luminosity-controlling devices, projection lenses for the receiver, and conducting wires—there would be 90,000. The selenium cells would be fixed on a surface about 8 feet square, upon which the picture would be projected by an achromatic lens (not necessarily of high quality) of 3 feet aperture. The receiving apparatus would occupy a space of about 4000 cubic feet, and the cable connecting the stations would have a diameter of 8 or 10 inches. The thing could probably be done for 1,250,000*l*., but not for much less. By an application of the three-colour principle it would be possible to present the picture in natural colours, like that shown upon the focussing screen of a camera. The cost would in that case be multiplied by three.

SHELFORD BIDWELL.

ARISTOTLE AND NATURAL SELECTION.

A PASSAGE of Aristotle's "Physics," in which he alludes to the theory of natural selection, has been frequently quoted and almost as frequently misinterpreted. It may therefore be worth while to devote a short space to a careful consideration of its import.

The passage in question is in the "Physica Auscultatio," ii., 8, §§ 1–6. In it Aristotle begins by asserting the existence in nature of final causes (*ἕνεκά του αἰτίαι*). He next considers objections that may be brought against this view, as, for example, that rain falls simply in obedience to natural law (*ἐξ ἀνάγκης*) and not for the sake either of making the corn grow or of spoiling it when cut. So, too, the supposed objector proceeds, with the parts or organs of animals; what is to prevent us from saying that the teeth originate in their various forms of incisors and molars simply by the operation of natural law? That they are serviceable respectively for cutting and grinding is not purposeful, but coincidental (*οὐ τούτου ἕνεκα γενέσθαι, ἀλλὰ συμπεσεῖν*). The existence of these apparent adaptations, the objector adds, can be accounted for by the fact that, as Empedocles has pointed out, those organisms that are unfitted for their conditions do not survive, but perish.

It will be seen from the foregoing that Aristotle does not advance the theory of natural selection as part of his own explanation of adaptation in nature, but as a principle that might be used to reinforce an alternative view.

We may now turn to his answer. The objection, he replies, will not hold, because things that arise naturally (*φύσει*) always, or nearly always, come about thus; *i.e.*, like the teeth, already adapted and fit to survive; while beings such as the unadapted monsters imagined by Empedocles originate, if at all, by chance or spontaneously (*ἀπὸ τύχης καὶ του αὐτομάτου*), and are, Aristotle would say, outside the ordinarily observed course of nature. It cannot be alleged, he goes on to point out, that such phenomena as rain and warm weather are altogether dependent on chance or coincidence (*ἀπὸ τύχης οὐδ᾽ ἀπὸ συμπτώματος*). Warm weather is the rule in the dog-days, and rain in winter. Everyone admits that things of this kind are in accordance with the ordinary course of nature; and if they occur in this regular way neither of themselves (like monsters) nor by mere coincidence (like unseasonable rain) it remains that they must exist for some purpose (*ταῦτ᾽ ἕνεκά του ἂν εἴη*). It must then be concluded that final causes exist in reference to natural products (*ἔστιν ἄρα τὸ ἕνεκά του ἐν τοῖς φύσει γιγνομένοις καὶ οὖσιν*).

Whatever may be thought of Aristotle's argument, it is clear that his general object throughout this passage is to defend his doctrine of final causes (it is to be observed that he does not say that final causes are of universal operation). He is unable to fall in with the view of natural selection as propounded by Empedocles, because, as it appears to him, adaptations are produced ready-made; the non-adapted is not merely eliminated, but seldom comes into existence at all. He seems, however, to admit that for those who believe (as he does not) in a purely fortuitous origin of natural objects, the hypothesis of natural selection affords a feasible explanation of adapted structures.

The erroneous views that have been taken of this passage by various writers have been due, I think, to the general failure to recognise that the whole of sections 2, 3 and 4 are devoted to Aristotle's statement of a possible objection to his own opinion. Thus Gomperz ("Griechische Denker," xiv., pp. 103, 104; Leipzig, 1908), although he clearly states Aristotle's position with regard to the Empedoclean monsters, nevertheless quotes the sentence about the rain and the growing corn as if it gave Aristotle's own explanation instead of the plea of an opponent. Osborn ("From the Greeks to Darwin") falls into the same error; the author of a pamphlet (*Αἱ τῶν* Lamarck *καὶ* Darwin *Θεωρίαι παρὰ τῷ Ἀριστοτέλει*), lately published at Athens, has similarly missed the point; nor has Darwin himself escaped the like misapprehension, for which probably the translator on whom he relied was responsible ("Origin of Species," note to "Historical Sketch" in the later editions). On the other hand, the general drift of the passage was rightly appreciated by G. H. Lewes, though the confusion of ideas with which he taxes it belonged, perhaps, rather to his own mind than to that of Aristotle.

F. A. DIXEY.

NOTES.

WE notice with deep regret that Sir John Evans, K.C.B., F.R.S., died at his residence, Britwell, Berkhampsted, on Sunday, May 31, in his eighty-fifth year.

SIR GEORGE DARWIN, K.C.B., F.R.S., and Prof. E. B. Tylor, F.R.S., have been elected corresponding members of the Vienna Academy of Sciences.

THE twenty-fourth Congress of the Royal Sanitary Institute will be held at Cardiff on July 13–18, under the presidency of the Earl of Plymouth. In addition to sectional meetings, there will be a number of conferences on various aspects of sanitary science, among the subjects being spring cleaning and its sanitary significance, and the sorting and grouping of school children for educational purposes.