THE EARLIEST CHANGES IN ANIMAL EGGS.—The patient researches of van Beneden, Grieff, and Oscar Hertwig have discovered many interesting facts in the structure of simple ova when laid, the mode of fertilisation, and the first segmentation. Oscar Hertwig's last observations are on the starfish Asteracanthion (*Morphologisches Jahrbuch*, vol. iv. Part I.), and he describes the changes as follows :—The germinal spot of the unfertilised ovum first shows a separation into two portions, while part of the germinal vesicle contributes material out of which first one and then a second "directive corpuscle" is formed. By this time the germinal vesicle is undistinguishable, having left a small portion as the ovinucleus (*eikern*). When fertilisation takes place, the spermatozoon gives rise to a small body, the sperm-nucleus (*spermakern*); this body approaches the ovinucleus, and they fuse to form the segmental nucleus (*furchungskern*); this precedes the division of the whole egg into two cells. If such observations are extended to many species and confirmed by other observers, we shall have an important gain in our knowledge of the results of fertilisation.

GLACIAL AND POST-GLACIAL FISHES OF NORWAY.—We learn from the Danish *Naturen* the appearance in the third part of the *Nyt Magazin for Naturvidenskaberne*, of a paper, by M. Robert Collett, on the glacial and post-glacial fishes of Norway. These fishes, which are most perfectly preserved in chalk-lumps, the outer shapes of which more or less perfectly exhibit the outer shapes of the included fishes, are found in clay deposits some 360 feet above the sea; the fishes belong all to the existing fauna, displaying at the same time their Arctic and North Atlantic origin. Out of twelve species, described by the authors, the most common is the *Mallotus villosus*, which is found everywhere; one species, the *Clupea sprattus*, is worthy of notice, because it is now a native of more southern waters.

POACHING BIRDS.—Mr. N. B. Moore has made observations at the Bahamas on the *Certhiola flaveola*, which obtains nectar from the flower of *Verea crenata* by thrusting its bill at once through the petals into the nectary. It is only after the bird has made an opening that small black ants and other small insects are found in the nectary. But these birds also poach on the woodpecker's preserves. One day Mr. Moore observed a *Picus varius* extracting sap from a logwood sapling, and as the woodpecker flew away, two Certhiolæ appeared, perched near the sap-pits from which the juice was oozing, and by cunningly thrusting in their penicillate or bristle-tipped tongues, commenced to lap or suck the fluid into their mouths. This practice was constantly observed afterwards. Mr. Moore fixed the bowl of a teaspoon in a fork of the same tree, and placed some strained honey in it. In three days the Certhiolæ found this, and commenced to feed on it. They were followed by another bristle-tongued bird, *Dendrœca tigrina*, and other species, who also attacked the woodpecker's sap-pits. These are interesting instances of apparent intelligence on the part of birds (*Proc.* Boston Soc. Nat. Hist., January, 1878).

GEOLOGICAL TIME[1]

IF a rigid body be in rotation about an axis of symmetry it will continue to rotate about that axis, but if it be set spinning about an axis inclined to that of symmetry the axis about which it spins will be continuously displaced relatively to the body; in other words, it will wabble.[2] This wabbling is well illustrated by the motion of a top whilst it is "going to sleep."

As the rotating body approaches more and more nearly the spherical shape, so does the wabbling become slower and slower. If the earth, which is nearly spherical, were to wabble in its diurnal rotation it would do so in about 305 or 306 days.

Dr. Haughton has lately published[1] an ingenious speculation, founded on the possibility of the wabbling of the earth, in which he seeks to determine limits to the duration of geological time from the observed absence of any motion of this kind.

The object of the short paper, of which I am here giving an account, was to combat the applicability to the case of the earth of Dr. Haughton's results.

The method pursued by him may be shortly described as follows :—If a continent were to be suddenly upheaved the earth's axis of figure (or strictly speaking, the principal axis of greatest moment of inertia) would be displaced from its previous position; immediately after the earthquake, the axis of rotation being where it was just before the earthquake, is no longer coincident with the axis of figure, and therefore a wabble is set up in the earth's motion. If it were not for frictional resistances that wabble would continue for ever after. But it is easy to see that, as the ocean is not rigidly connected with the earth, a tide of 306 days period would be set up. This tide would then rub on the sea-bottom, and would gradually reduce the wabble and bring the earth "to sleep" again like a top.

By reference to the estimate of Adams and Delaunay of the effects of tidal friction in retarding the earth's rotation, Dr. Haughton endeavours to find a numerical value for the frictional effect of such a 306-day tide as above explained. He then finds how long it would take to reduce a wabble of given amount to one of any smaller amount.

In a previous paper he had already shown that the elevation of the continents of Europe and Asia must have shifted the earth's axis of figure by 69 miles at the earth's surface. If, therefore, such an elevation took place suddenly, it must have started a wabble, in which the axis of rotation described a circle of 69 miles radius round the axis of figure.

But Dr. Haughton is of opinion that astronomical instruments are now so perfect, that a wabble of 5 feet in radius would be detected, and that it is not, therefore, permissible to suppose that the present actual wabble has a radius of even 5 feet. His numerical calculations, then, show that it would take 641,000 years to reduce the radius from 69 miles to 5 feet by means of the tidal friction, and he, therefore, concludes that, if Europe-Asia were manufactured *per saltum*, that event cannot have taken place less than 641,000 years ago, and that it may have been at a much more remote epoch.

The improbability of this supposition induces him to consider the case of elevation by 69 geological convulsions, each of which displaced the axis through one mile, and where the radius of the wabble is reduced to five feet between two successive convulsions. He here finds that the elevation of Europe-Asia must have occupied 27½ million years, and that no geological change altering the position of the earth's axis through one mile can have taken place within the past 400,000 years.

He lastly supposes that the wabble has a radius of 5 feet, and that the geological changes take place at such a rate that the increase of the radius is exactly destroyed by friction during each wabble, so that the radius of 5 feet remains constant. On this supposition he finds that the time required was 4,170 million years.

Now it appears to me, from this method of treatment, that Dr. Haughton is of opinion that a second earthquake of elevation following a first would necessarily increase the radius of the wabble. For if not, why does he postulate a lapse of time between successive earthquakes, and in the last case make the supposition of the increase of radius be exactly destroyed? It is on this point

[1] Abstract of a paper read before the Royal Society on March 14.

[2] I follow Dr. Haughton in the use of this very expressive word.

[1] Notes on Physical Geology, No. III., *Proc. Roy. Soc.*, vol. xxvi. p. 534.

that I venture to differ from him, for it seems to me, from dynamical considerations, that a second equal impulse following a first, at some time within 306 days, might either double the wabble, alter its amount, or annihilate it, according to how it was timed to take place.

If I am correct in this view, I cannot but think that the estimate of geological time falls to the ground. For even if the elevation of continents took place impulsively, we can have no possible data for judging of how the earthquakes were timed with reference to the position of the axis of rotation, and unless they were properly timed the radius of the wabble could not increase; and the increase of the radius is, I imagine, essential to Dr. Haughton's method.

But if we set aside the impulsive theory of elevation, the work contained in my paper, "On the Influence of Geological Changes on the Earth's Axis of Rotation,"[1] will be applicable; for I there considered the effects of a slow continuous elevation of continents. In that paper I show that such a mode of elevation would set up a wabble of 306 days' period in the earth's motion. But this wabble is of quite a different character from that contemplated by Dr. Haughton, for it is unsymmetrical, so that the axis of rotation coincides with the axis of figure every 306th day.

By a very simple application of a formula given in that paper, it will be found that, supposing the continuous elevation to take place at such a rate that the axis of rotation is 5 feet distant from that of figure when at its greatest distance, then the axis of figure must be travelling with reference to the solid earth at the rate of $\frac{3}{10}$ of a second of arc per annum. Thus, in 19,200 years it will have travelled over 1° or 69 miles. That is to say, Europe-Asia might have been elevated in 19,200 years without the axis of rotation ever having described a circle of more than 5 feet in *diameter*. If the elevation were then to stop suddenly a symmetrical wabble would be set up (such as that considered by Dr. Haughton), and the *radius* of this wabble could not be greater than 5 feet, and might be zero, according to the exact time of the stoppage.

This investigation makes no reference whatever to the effects of tidal friction, and there are certain considerations which lead me to believe that even the above estimate of time might be largely reduced.

The conclusion at which I arrive therefore is that the elevation of Europe and Asia might have taken place in very much less than 20,000 years without leaving behind any wabbling in the earth's motion traceable by astronomical observations. Dr. Haughton's views, if generally accepted, are of the very greatest interest to geologists, and they therefore merit the strictest examination; as I have devoted a good deal of time to this subject I thought it might perhaps be useful to write this note. Should my present criticism be incorrect, there is little doubt but that it will meet its just fate of refutation.[2]

G. H. DARWIN

EARLY ELECTRIC TELEPHONY

IN 1861 the first successful attempt at the construction of an electric telephone was made by Philip Reis, a teacher in a school at Friedrichsdorf, near Homburg. On October 26, 1861, Reis showed his instrument, which he termed a "telephone," to the Physical Society of Frankfort-on-the-Main; and on that occasion he succeeded in electrically transmitting various melodies, which were distinctly heard throughout the room. In the paper he read before this Physical Society, published in the annual report of the Society for 1861, Reis states:—"Melodies were sung, not loudly, into the transmitting apparatus placed in a hospital some 300 feet away from the audience, care being taken that no sound could be heard, by direct transmission, or by conduction along the wires. The sounds of various musical instruments were clearly reproduced, as the clarionet, horn, organ-pipe, and even harmonium and pianoforte

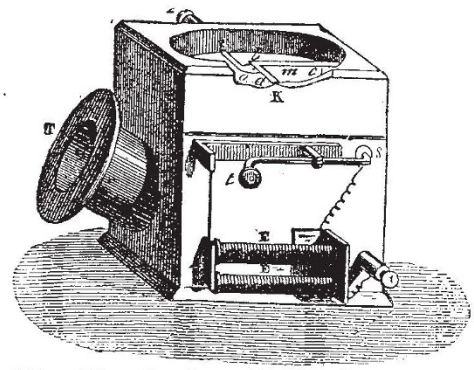

FIG. 1.—This and Fig. 2 show the usual but imperfect form of Reis's telephone. Fig. 1 is the transmitting apparatus. T represents the mouthpiece, *m* the membrane closing the upper portion of the box K, a portion of which is cut away to show the movable lever, *a b c*, resting by a projecting point *b*, on the platinum disc *a*, fixed to the centre of the membrane and connected with the binding screw 2. The arm *a b c* is metallicly connected with the binding screw 2. The key *t* closes the circuit when the instrument is in use, and the electro-magnet R E is for the purpose of receiving communications.

when the transmitter was placed on their sound-boards, provided the tones were within the compass of *f* to f''. Articulation was not reproduced equally well. Consonants, however, were in general pretty clearly heard, but not the vowels." In this report, which is entitled "Telephony by Means of Electric Currents," Reis shows how he was led to the construction of his instrument by a study of the mechanism of the organ of hearing, and of the manner whereby sounds are perceived by the human ear, and he gives a series of diagrams representing the resultant curves that would be produced by the combination of various concords and discords. Thus, he was led to perceive that "if it were possible to create, in any manner, a mode of vibration whose curve resembles that of any tone or chord, then a sensation would be produced similar to that given by the tone or chord itself." This principle, he affirms, guided him onwards.

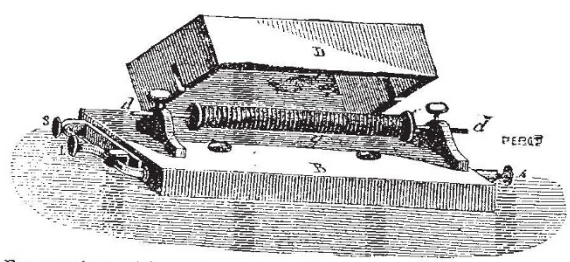

FIG. 2 is the receiving apparatus. B and D are resonant boxes, *g* is the coil through which the current passes magnetising the iron wire *d*, 3 and 4 are binding screws to which the line and return wire are attached, the circuit being closed by the key 1.

The first instrument he made was constructed of very homely materials. The bung of a beer-barrel was pierced through with a conical hole, the smaller end was then covered by a membrane, the skin of a German sausage being used for this purpose; to this was fixed, with a drop of sealing-wax, a little strip of platinum joined up to one

[1] *Phil. Trans.*, vol. 167, Pt. 1.

[2] Since this has been in type Dr. Haughton has read another paper before the Royal Society, in which he concludes, from purely geological evidence, that "the hypothesis of a shifting pole (even if permitted by mechanical considerations) is inadmissible to account for changes in geological climates." Therefore whether he agrees or not in the justice of my mechanical criticism, he seems to be of opinion that the wabbling of the earth will not give geologists much light as to the duration of geological time.