

Bournemouth a small bed of dark clay was found full of leaves of feather palm, crossing each other in every direction; the tip of a frond in my collection measures four feet in length, by three feet broad. Amongst other interesting specimens is a Smilax leaf of larger dimensions than any now living, and a twig of Dryandra, with many leaves attached, from Alum Bay, which unites in itself several of M. Watelet's species from the Grès du Soissonnais. The discovery of a finely preserved neuropterous wing, and of two apparently hemipterous abdomens, are of interest in connection with the large series of insect remains from Gurnet Bay, Isle of Wight, lately deposited in the British Museum.

The history remains to be written] of the subsidence of the great continent, whose further limits Edward Forbes surmised are yet traceable in the banks of Gulf Weed, ranging between the 15th and 45th parallels. Many, however, have written on Atlantis, but lacking the direct proof of its former existence in comparatively recent times, which has since come to light. The disappearance of almost an entire continent, is not a more startling proposition than the elevation of the Alps, Pyrenees, Apennines, and Carpathians, over whose highest summits the sea rolled at this period. Of the history of this disappearance Bournemouth presents us with but a page, still a page full of meaning. The incoming and disappearance in succession of oaks and beeches, figs and laurels, palms and delicate ferns, the swamp-loving aroids and Eucalyptus, Chrysodeum and Osmunda, on the same spot; the appearance in masses of the fruit of Nipa, which is stated by travellers to be found in brackish estuaries; the incoming of shore crabs and mud-boring crustacea, sea-shells and Flustra, shingle beeches and deeper sea deposits, are each well-marked stages in the history of the disappearance of this continent, whose existence at this and a later period may be gathered from the writings, made from different standpoints, of Prestwich, Godwin-Austen, Sorby, and many others. The Bournemouth and Sheppey vegetable remains were brought down by one of the rivers draining this continent, which at a later period silted over the reptiles of Hordwell and the estuarine shells of the fluvio-marine series. That the oscillations which gradually led to the disappearance of the land, vestiges of which remain in Cornwall, the Channel Isles, Brittany, Madeira, &c., have not ceased, even in historic times, there is ample local evidence to show. This branch of the subject, however, is scarcely yet ripe for discussion, nor would space here allow it to be fully entered into.

Baron Ettingshausen and myself are preparing a monograph upon the ferns of this flora which I hope very shortly to place in the hands of the Palæontographical Society.

J. S. GARDNER

### THE TELEPHONE

AT the Society of Telegraph Engineers on the evening of October 31 a lecture of great interest was given by Prof. Graham Bell on the Telephone, with the invention and improvement of which his name is so intimately connected. The lecture was largely illustrated by diagrams, to which Prof. Bell made constant reference, and with these illustrations will be published at length in the forthcoming part of the *Journal* of the Society. We have already given a full account of the telephone and its principles, and will only now refer to some of the interesting episodes which occurred in the course of Prof. Bell's experiments.

Prof. Bell's account of his experiments for devising methods of exhibiting the vibrations of sound, specially for use in teaching the deaf and dumb, is very interesting. For some time he carried on experiments with the manometric capsule of Koenig, and with the phonautograph of Léon Scott. He was led to the idea of constructing a

phonautograph modelled closely on the mechanism of the human ear, and at the suggestion of Dr. C. J. Blake, he made use of the human ear itself, a specimen of which was prepared by Dr. Blake, for conducting these experiments.

It occurred to him that if a membrane as thin as tissue paper could control the vibration of bones that were, compared to it, of immense size and weight, why should not a larger and thicker membrane be able to vibrate a piece of iron in front of an electro-magnet, in which case the complication of steel rods in his first form of telephone could be done away with, and a simple piece of iron attached to a membrane be placed at either end of the telegraphic circuit.

The form of apparatus he was then employing for producing undulatory currents of electricity for the purposes of multiple telegraphy he describes thus: a steel reed was clamped firmly by one extremity to the uncovered leg of an electro-magnet, and the free end of the reed projected above the covered leg. When the reed was vibrated in any mechanical way, the battery current was thrown into waves, and electrical undulations traversed the circuit, throwing into vibration the corresponding reed at the other end of circuit. He immediately proceeded to put his new idea to the test of practical experiment, and for this purpose he attached the reed loosely by one extremity to the uncovered pole of the magnet, and fastened the other extremity to the centre of a stretched membrane of goldbeater's skin. He presumed that upon speaking in the neighbourhood of the membrane it would be thrown into vibration and cause the steel reed to move in a similar manner, occasioning undulations in the electrical current that would correspond to the changes in the density of the air during production of the sound; and he further thought that the change of the intensity of the current at the receiving end would cause the magnet there to attract the reed at that end in such a manner that it should copy the motion of the reed at the transmitting end, in which case its movements would occasion a sound from the membrane there similar in *timbre* to that which had occasioned the original vibration.

The results, however, were unsatisfactory and discouraging. With a reduction, however, in the size and weight of the spring employed, distinctly audible effects were obtained. "I remember," Prof. Bell said, "an experiment made with this telephone, which at the time gave me great satisfaction and delight. One of the telephones was placed in my lecture-room in the Boston University, and the other in the basement of the adjoining building. One of my students repaired to the distant telephone to observe the effects of articulate speech, while I uttered the sentence, 'Do you understand what I say?' into the telephone placed in the lecture-hall. To my delight an answer was returned through the instrument itself, articulate sounds proceeded from the steel spring attached to the steel membrane, and I heard the sentence, 'Yes, I understand you perfectly.' It is a mistake, however, to suppose that the articulation was by any means perfect, and expectancy no doubt had a great deal to do with my recognition of the sentence; still, the articulation was there, and I recognised the fact that the indistinctness was entirely due to the imperfection of the instrument." After a time he produced a form of instrument which served very well as a receiving telephone; and it was in this condition his invention was exhibited at the Centennial Exhibition in Philadelphia. It was in this condition also that Sir William Thomson exhibited the instrument to the British Association in Glasgow.

In pursuing his investigations Prof. Bell has come across many interesting facts which we regret we cannot refer to in detail. It has long been known that when an intermittent current of electricity is passed through the coils of an electro-magnet a musical tone proceeds from the magnet. "I have discovered," he said, "that these sounds



are not due wholly to sudden changes in the magnetic condition of the iron core, as heretofore supposed, but that a portion of the effect results from vibrations in the insulated copper wires composing the coils. An electro-magnet was arranged upon circuit unto an instrument for interrupting the current, the rheotome being placed in a distant room so as to avoid interference with the experiment. Upon applying the ear to the magnet a musical note was clearly perceived, and the sound continued after the iron core had been removed from the coils. The effect may probably be explained by the attraction of the coils for one another during the passage of the galvanic current and the sudden cessation of such attraction when the current ceased. It is probable, too, that a molecular vibration is occasioned in the conducting wire by the passage of an intermittent current. I have found that very distinct sounds proceed from straight pieces of iron, steel retort-carbon, and plumbago, when an intermittent current is passed through them."

When a powerful current is passed through the body a musical note can be perceived when the ear is closely applied to the arm of the person experimented upon. The sound seems to proceed from the muscles of the forearm and from the biceps muscle. Mr. Elisha Gray has also produced audible effects by the passage of electricity through the human body. An extremely loud musical note is occasioned by the spark of a Ruhmkorff's coil when the primary circuit is made and broken with sufficient rapidity; when two rheotomes of different pitch are caused simultaneously to open and close the primary circuit a double tone proceeds from the spark.

A curious discovery has been made by Prof. Blake. He constructed a telephone in which a rod of soft iron, about six feet in length, was used instead of a permanent magnet. A friend sang a continuous musical tone into the mouth-piece of a telephone, which was connected with the soft iron instrument alluded to above. It was found that the loudness of the sound produced in this telephone varied with the direction in which the iron rod was held, and that the maximum effect was produced when the rod was in the position of the dipping needle.

This curious discovery of Prof. Blake has been verified by Prof. Bell.

"Prof. Peirce has observed the most curious sounds produced from a telephone in connection with a telegraph-wire during the aurora borealis; and I have just heard of a curious phenomenon lately observed by Dr. Channing. In the City of Providence, Rhode Island, there is an over-house wire about one mile in extent with a telephone at either end. On one occasion the sound of music and singing was faintly audible upon one of the telephones. It seemed as if some one were practising vocal music with a pianoforte accompaniment. The natural supposition was that experiments were being made with the telephone at the other end of the circuit, but upon inquiry this proved not to have been the case. Attention having thus been directed to the phenomenon, a watch was kept upon the instruments, and upon several subsequent occasions the same fact was observed at both ends of the line by Dr. Channing and his friends. It was proved that the sounds continued for about two hours, and usually commenced about the same time. A searching examination of the line disclosed nothing abnormal in its condition, and I am unable to give you any explanation of this curious phenomenon. Dr. Channing has, however, addressed a letter upon the subject to the editor of one of the Providence papers, giving the names of such songs as were recognised, with full details of the observations, in the hope that publicity may lead to the discovery of the performer, and thus afford a solution of the mystery."

Prof. Bell referred to some experiments made by Mr. F. A. Gower and himself to show the slight earth connection required to establish a circuit for the telephone.

"One experiment which we made is so very interesting that I must speak of it in detail. Mr. Gower made earth connection at his end of the line by standing upon a grass plot, whilst at the other end of the line I stood upon a wooden board. I requested Mr. Gower to sing a continuous musical note, and to my surprise the sound was very distinctly audible from the telephone in my hand. Upon examining my feet I discovered that a single blade of grass was bent over the edge of the board, and that my foot touched it. The removal of this blade of grass was followed by the cessation of the sound from the telephone, and I found that the moment I touched with the toe of my boot a blade of grass or the petal of a daisy, the sound was again audible."

Prof. Bell concluded as follows:—"The question will naturally arise, through what length of wire can the telephone be used? In reply to this I may say that the maximum amount of resistance through which the undulatory current will pass, and yet retain sufficient force to produce an audible sound at the disturbed end, has yet to be determined; no difficulty has, however, been experienced in laboratory experiments in conversing through a resistance of 60,000 ohms, which has been the maximum at my disposal. On one occasion, not having a rheostat at hand, I may mention having passed the current through the bodies of sixteen persons, who stood hand in hand. The longest length of real telegraph line through which I have attempted to converse has been about 250 miles. On this occasion no difficulty was experienced so long as parallel lines were not in operation. Sunday was chosen as the day on which it was probable other circuits would be at rest. Conversation was carried on between myself, in New York, and Mr. Thomas A. Watson, in Boston, until the opening of business upon the other wires. When this happened the vocal sounds were very much diminished, but still audible. It seemed, indeed, like talking through a storm. Conversation, though possible, could be carried on with difficulty, owing to the distracting nature of the interposing currents.

"I have had the opportunity of testing the telephone upon the artificial cable owned by Sir William Thomson. No difficulty was experienced in conversing through the equivalent of 120 miles of submarine cable. Vocal sounds were audible when the equivalent of the whole Atlantic cable was interposed between the two telephones, but the sounds were so faint that conversation could not be carried on. Songs that were sung into one telephone were readily recognised at the other end of the circuit, and the articulation of pre-arranged sentences was readily recognised. That the sounds were electrically produced was evident from the fact that they ceased when the circuit was broken and when the coils of the telephone were short circuited. No difference was observed between the pitch of the note which was transmitted through the artificial cable and the same note when transmitted directly through the air. The artificial cable experimented upon had four times the resistance of the Atlantic cable, and one-fourth its electrostatic capacity. I am informed by my friend, Mr. Preece, that conversation has been successfully carried on through a submarine cable, sixty miles in length, extending from Dartmouth to the Island of Guernsey, by means of hand telephones."

In a lecture on the 8th inst. at Glasgow, Prof. Bell, referring to the use of the telephone in mines, pointed out how the instrument might be of the greatest service in determining whether the ventilation of a mine was perfect or not; for by listening to the telephone, if the mine was in good order, a little sound could be heard every moment.

#### AFRICAN EXPLORATION

MR. STANLEY'S letter and the map in the *Telegraph* of Monday enable us to realise somewhat more fully the nature and extent of the discoveries made by the