lobe; a report by Mr. J. E. S. Moore was presented on the fauna of the African lakes; Prof. M. M. Hartog read a paper on the Morphology of the Rotifera and the Trochophore larva; and a letter was read by Prof. A. Newton from Dr. Stirling, on *Genyornis Newtoni*, an extinct Ratite bird from Australia allied to the Emu, but with leg-bones like those of the Moa, supposed to belong to the order *Megistanes*.

Wednesday, September 23.—The first paper of the final meeting of the Section was by Mr. A. T. Masterman on "*Phoronis*, the earliest ancestor of the Vertebrates." Mr. Masterman described two diverticula of the gut in the Actinotrocha larva, which he concluded from their structure represented a double notochord. He hence proposed a new group, to be called the Diplochordata. Hence the supposed relationship of *Phoronis* to the primitive vertebrate was confirmed. Mr. E. W. McBride said that there was such a strong tendency to discover ancestors for the Vertebrata, that great caution should be exercised before needlessly adding to the list. He thought that a double notochord was too great a demand upon their credulity, although Mr. Masterman's diverticula might function as a notochord.

Prof. W. A. Herdman then read a report on the Zoology, Botany, and Geology of the Irish Sea (illustrated by the lantern). A very interesting account was given of the work done by the members of the Liverpool Marine Biology Committee and other naturalists, and slides were shown of the Laboratory at Port Erin and its surroundings. The Committee were doing a useful work, and a work which was very far from being complete. The Rev. T. R. R. Stebbing spoke of the admirable faunistic work being done by the members of the Committee, and thought that they were to be congratulated on their report. Mr. W. E. Hoyle thought the results obtained by Prof. Herdman and his colleagues had an important bearing upon questions of general oceanography, and it was to be hoped, therefore, that the work of the Committee would not cease. Prof. Johann Walther testified to the admirable work that had been done in British seas during the last fifty years. This work, which was so important to marine biologists and oceanographists, had been initiated by Edward Forbes, and continued by Prof. Herdman, whom he regarded as Forbes' natural successor. Dr. Hjort and Mr. A. O. Walker also took part in the discussion.

Mr. Masterman read a further paper on "Some Effects of Pelagic Spawning on the Life-Histories of Marine Fishes," in which he maintained that pelagic spawning was more primitive than littoral. This explained many well-known facts in the migration of fishes. Dr. W. B. Benham then read a short paper on the structure of the genital glands of *Apus*, which, he asserted, could not be described as an hermaphrodite. He had recently made some observations on the reproductive organ of a male *Apus*, and showed diagrams of the spermatogenesis. The specimen had not been well preserved, but, except in this respect, he believed he was the first to study the testis of *Apus* according to modern methods. After some remarks by Prof. Hartog, the meeting concluded with a paper on the life-history of the Haddock, by Prof. W. C. McIntosh, communicated by Mr. Masterman.

MECHANICS AT THE BRITISH ASSOCIATION.

THE meetings in Section G—that devoted to mechanical science—at the recent Liverpool meeting of the British Association were generally well attended, and, on the whole, the proceedings compared not unfavourably with those of recent years. But only qualified praise can be given, as for long "G" has fallen short of its vocation. We look back to past times, to the days of Rankine and Froude, when the Section was more constant to its true mission, and sigh over later records. Mechanical science, though only applied science, *is* science; and though the Section must be utilitarian, it need not be a penny-readings or a means of trade advertisement. We think that any one acquainted with the proceedings of later years will agree that both the latter elements have been too much in evidence. With regard to the penny-readings or popular-lecture side of the question, we had more than one example during the recent meeting. There were some most interesting lectures and discourses, illustrated by equally interesting lantern slides, but they could hardly be classed as scientific They were just admirable penny-readings—nothing more.

With regard to the second undesirable feature to which reference has been made, we feel we are on delicate ground. A man having made an invention of a useful nature, and translated it into a machine or a process, naturally wishes to bring it prominently before the world for financial reasons. A cheap and efficacious method of doing so, is by reading a paper before a technical society. That is a perfectly legitimate proceeding, and is thoroughly recognised by the various societies and institutions of this nature; for however much they may strive to pose as scientific, they know well enough they are no more than technical, and founded on commercial bases. Were it not for the hope of advertisement—it is best to call spades, spades—not one half the papers read before engineering societies would ever be written; but that is no reproach to the societies. They do most admirable and useful work, without which the country would not make the progress it does. The morality of technical societies is, as it should be—"If a man has anything new and instructive to tell us, he is entitled to his advertisement, short of introducing purely commercial details."

But the British Association for the Advancement of Science should take higher ground than this, even in Section G. It should not allow a paper to be read on a trade article at the same time that illustrated catalogues and price-lists of the article are distributed amongst the audience. Neither should it allow its officials to distribute among the audience touting circulars asking members present to subscribe to a public company which bears evidence of being a trade association.

There were, however, at the recent meeting one or two good examples of the work Section G ought to do. Mr. Beaumont's paper may be taken. It was an endeavour to account for a somewhat obscure, but well-known, engineering phenomenon by the aid of scientific or physical data. The author may have been wrong in his conclusions, even in his premises, as some speakers during the discussion suggested, but at any rate he had a proper conception of what a British Association paper should be, and some regard for the dignity of the Section. Mr. Wheeler's report on tidal influences was also a piece of good work, which will be useful to those making scientific investigation of the subject; and there were one or two other items in the programme of a character proper to the Section; but we will proceed to details.

This year Sir Douglas Fox was President of the Section, and on Thursday, September 17, the proceedings were opened by his inaugural address. This we have already printed in full. The first paper taken was by Mr. G. F. Lyster, and was on the "Physical and Engineering Features of the River Mersey, and the Port of Liverpool." This was not a contribution of the popular-lecture order, because it was not popular, and it was certainly not a "mechanical science" paper. It could hardly be called an engineering paper, excepting in respect of it being a catalogue of engineering works. It was very long, and its author read it to the bitter end. It is to be printed in the *Proceedings*.

Mr. Beaumont's paper, to which reference has already been made, came next. The following is an abstract of this contribution. The author was of opinion that the failure of any rail, however perfect, is chiefly a question of the number and weight of the trains passing over it. The result of the rolling of the heavily loaded wheels of engines and vehicles is that a gradual compression of the upper part of the rails takes place, and this produces internal stresses which are cumulative and reach great magnitude. That which takes place in the material of a rail head under the action of very heavy rolling loads at high speed, is precisely that which is purposely brought into use every day in ironworks. The effect is, however, obscured by the slowness of the growth and transmission of the forces which are ultimately destructive. It was pointed out, further, that when a piece of iron or steel is subjected to pressures exceeding the limit of elastic compression, by a rolling or hammering action, or by both these combined, the result is spreading of the material and general change of the dimensions. This is equally the case with a plate hammered or rolled on one side while resting on a flat surface. In these cases, the hammering or rolling work done upon the surfaces tends to compress the material beneath it, but being nearly incompressible and unchangeable in density, the material flows, and change of form results. Generally the material thus changed in form suffers permanently no greater stresses than those within its elastic limit of compression or extension. When, however, the material is not free to flow or to change its form in the directions in which the stresses set up would act, the effect of continued work done on the surface is the growth of compressive stress exceeding elastic resistance.

In the case of railway rails the freedom for the flow of the material is very limited. Hardening of the surface takes place, and destructive compression of the surface material is set up. If the material be cast iron, the destructive compression causes crumbling of the superficial parts, and the consequent relief of the material immediately below it from stress beyond that of elastic compression; but when the material is that of steel rails, the stress accumulates, the upper part near the surface being under intense compression, differentiating from a maximum at the surface. This compression gives rise to molecular stresses, analogous to those which, on the compression side or inner curve of a bar bent on itself, originate traverse flaws on that side. This condition of compression exists along the whole length of a rail, so that when its magnitude is sufficient to originate crumbling or minute flaws, any unusual impact stress, or a stress in the direction opposite to that brought about by the usual rolling load, the rail may break into two or into numerous pieces. Stresses originating in the same manner explain the fracture of railway tyres as described fully by the author in the "Proceedings of the Institution of Civil Engineers," 1876, vol. xlvii.

A good discussion followed the reading of this paper. It was opened by Prof. Unwin, who took a somewhat different view from that of the author. The latter, the speaker pointed out, attributed the ultimate failure of a rail to the number of trains which passed over it; but his, the speaker's, experience told him that there was most danger in new rails. Again, according to the paper, one would expect soft rails to give way more quickly than hard ones; but here again experience negatived the assumption. A defect in the paper, however, was that the author had neglected to consider the composition of the rail, and this was the governing factor. Other points to which the speaker made reference were fatigue, and the change from a homogeneous to a non-homogeneous material. It was well known that a rail might be used in one way for a considerable time, but that when turned over it would be liable to break, and the speaker further illustrated his point by the analogy of a punched hole; but in this case one part was put in tension, so that annealing removed the defect. These things, however, did not solve the problem, and in his opinion work put upon the rail in use strengthened rather than weakened it; but the initial condition had far more influence than the rolling of wheels.

Mr. Johnson, of the Midland Railway, had strips taken from various parts of broken rails, and did not find difference in composition. Fractures had undoubtedly occurred through rails being made from a "piped" ingot—that is to say, one in which the whole of the head and pipe, in which the impurities collect, had not been sufficiently removed.

Dr. Anderson, Director-General of Ordnance Factories, pointed out the similarity of the effects described by the author in the case of rails and those observed in big guns which had been much fired. In the bore of guns a large number of minute cracks were discovered, and the deterioration of the A tube of a gun was due to the powder gases breaking out the squares. Here there was ultimate compression and release of pressure, as in a rail.

The President had examined rails which had failed, by the microscope, and had noticed the minute cracks referred to. He would point out that rails often gave way at the ends, and this bore out the theory that defects were caused by insufficient cropping leaving the "pipe." He pointed out that a crack once started might easily be extended by lower strains than would be required to start it; just as a tear or rent commenced on a piece of paper would be easily continued. Prof. Hele-Shaw pointed out that if the rail were planed, the latter defect would be removed. It may be worth putting on record that the late Mr. Spooner, chief engineer to the Festiniog Mountain Railway, who used to turn his rails at times, once told us that an unplaned rail was more liable to break than one which had been planed. Of course the object of planing was not undertaken with a view to prevent breakage, but to take out the dents from the chairs; but the result stated had been observed.

In replying to the discussion Mr. Beaumont stated, in regard to Prof. Unwin's remarks, that he, the speaker, had submitted facts, and not speculations, to explain breakage of rails. The Board of Trade inquiry on the subject had proved that there was a good deal to learn, and he had mainly put forward his paper with a view to raising discussion. He could produce figures tending to show that sometimes the hardest rails lasted longest, though when they did give way they were apt to break into a greater number of pieces. Undoubtedly the rail must be of good steel—not impure—to do its work properly; that, he had concluded, was a foregone conclusion. The question of the rail forming a continuous girder affected the matter of end breakage, and in this respect the influence of the modern stiff fish-plate had to be considered.

On the following day, Friday, September 18, the proceedings opened with the report of the Sectional Committee appointed to consider the effect of wind and atmospheric pressure on the tides. The members of the Committee were Profs. L. F. Vernon-Harcourt and W. C. Unwin, Messrs. G. F. Deacon and W. H. Wheeler. The latter acted as secretary, and drew up the report. Information had been obtained from various ports in England. It was concluded, firstly, that the tides are influenced both by atmospheric pressure and by the wind to an extent which considerably affects their height; secondly, that the height of about one-fourth the tides is affected by wind; thirdly, that the atmospheric pressure affecting the tides operates over so wide an area, that the local indications given by the barometer at any particular spot do not afford any trustworthy guide as to the effect on the tide of that particular port; fourthly, that although, so far as the average results go, there can be traced a direct connection between the force and direction of the wind and the variation in the height of the tides, yet there is so much discrepancy in the average results when applied to individual tides that no satisfactory formula can be established for indicating the amount of variation in the height of the tide due to any given force of wind; fifthly, the results given in the tables attached to the report relating to atmospheric pressure indicate that the effect of this is greater than has generally been allowed, a variation of $\frac{1}{2}$ inch from the average pressure causing a variation of 15 inches in the height of the tides. As the report will be printed in full in the published *Proceedings* of the Association, we have thought it unnecessary to give more than the conclusions reached, but the whole is well worthy of the attention of those interested in the subject. Mr. Wheeler is well known as a trustworthy and diligent student of this question, and his professional status enables him to obtain information from a wide source.

A brief report on the calibration of instruments in engineering laboratories was the next item in the programme. Copies of this report, so far as we could ascertain, were not distributed.

Mr. Barry's lecture on the Tower Bridge followed, and attracted a large audience. It was interesting, and the lantern slides were well managed. Mr. J. Parry followed with a long paper of the historical-record order, dealing with the Liverpool Waterworks. The last item on this day was a contribution by Mr. A. J. Maginnis, entitled "The present position of the British North Atlantic Mail Service." It was a good paper in its way, but its way was not quite that of mechanical science; indeed, the author dwelt rather on the economics of ocean service than on its engineering aspects. Some instructive figures in regard to coal consumption were given, it being stated, among other things, that the *Campania* burns 20 tons of coal per hour. To drive an improved *Campania*, 700 feet long and 74 feet wide, 23 to 24 knots would require 46,000 indicated horse-power, supposing existing practice were followed. The cost of the vessel would be £800,000.

The next sitting of Section G was held on the Monday following, September 21, and was, according to custom, devoted to electrical engineering. The first business was the reading of a report by the Committee on small screw gauges. This report has been looked forward to with interest for some time. It will be printed in full in the *Proceedings* of the Association. Mr. Preece (the chairman of the Committee) drew up the report. After giving details of the method of work followed by the Committee, and referring to the labours of others in the same field, the report proceeded to notice a method, suggested by Colonel Watkin, for making very accurate comparison. There would be thrown, side by side on a screen, photographic images of the screw to be examined, and of the standard with which would be compared, together with the image of a scale which might be divided to one ten-thousandth of an inch. The images of these three objects being so close to one another, a comparison to a very high degree of accuracy could be made. Mr. Price, a member of the Committee, submitted a microscopical method, in which the screw to be measured is attached to the stage of the microscope, the traversing slide of which is provided with a vernier scale, while a vernier cross-hair in the eye-piece forms the index of the instrument. When the microscope has been adjusted for clear focus, the screw is traversed across the field until the cross-hair intersects the thread of the screw at the desired point. The traversing screw of the slide is then turned until the corresponding point of the next thread is intersected by the cross-hair, and the reading of the vernier on the scale gives the measurement of the pitch with great accuracy.

The Committee decided that gauges for ordinary workshop use would be best tested, as regards pitch and form of thread, by a template or "comb," the accuracy of which would be verified by the photographic method. External dimensions could be obtained by micrometer gauge, and the internal diameter, or core, by a gauge suggested by Mr. A. Stroh, a member of the Committee, the details of which have yet to be worked out. The Committee failed to discover any very trustworthy method of testing a female standard gauge. Naturally a mathematically accurate male gauge cannot be screwed into a mathematically accurate female gauge of like dimensions, but the variation should not exceed a "good fit." A table prepared by Prof. Le Neve Foster, dealing with this subject, was added as an appendix. The details given refer to works managers' gauges. Those used by the workman or foreman need not possess the mathematical accuracy of the standard gauges. For full details of this useful report, we must refer our readers to the published *Proceedings* of the Association, where it will be found printed together with the illustrations necessary for its full comprehension.

A long paper, by Mr. W. H. Preece, on "The Tests of Glow-Lamps," followed. It comprised the results of a very large number of tests, the details being given in diagrams handed round at the meeting. It would be impossible here to give even a summary of the results of tests, for the lamps tried were supplied by a number of makers, and varied according to the numerous conditions of trial. Some of the cheaper lamps gave results not at all in accordance with what would be expected from them if the statements of the makers were to be taken as guides. The experiments tended to prove that in continuous lighting for 1000 hours the candle-power fell about 30 per cent., and the watts per candle-power rose about 28 per cent. Lamps for installation work of about $3\frac{3}{4}$ watts per candle-power, burning from seven to nine hours per day, behave, as regards life and efficiency, about the same as when giving continuous illumination; but high efficiency lamps deteriorate more quickly. Good 100 to 105 volt 16-candle-power lamps, taking $3\frac{3}{4}$ volts per candle, should stand a gradual increase of pressure of direct current up to 225 or 280 volts in $3\frac{1}{2}$ minutes before the filament breaks. When the pressure is regularly raised in $2\frac{1}{2}$ minutes to 170 volts, and afterwards re-tested at ordinary voltage, the candle-power should not be less than 14·4, nor higher than 17·6, while the watts per candle should not exceed 4. The author also suggested in his paper a quick and ready way of satisfactorily judging the quality of lamps. To obtain this end the voltage of several lamps was gradually run up for each lamp singly at a uniform rate until the filaments broke. At the moment of rupture the voltage, current, and time of running up were noted. Before increasing the normal voltage the current was measured and the resistance calculated. The average breaking voltage of the filaments was found to be 230, and the time of running up was $3\frac{1}{2}$ to $4\frac{1}{2}$ minutes. Mr. Preece also gave a standard specification for glow-lamps which he had drawn up for use in the Post Office.

Prof. Ayrton, in the discussion on the paper, said that it was to be expected, as noticed by the author, that lamps which gave at first less than their nominal candle-power would last longer, as they were worked at a lower pressure. He pointed out that certain figures given by the author as to the cost of illumination by glow-lamps showed electricity to be dearer than gas burnt in an Argand burner, and very largely in excess of gas burnt by the Welsbach system. It had been noted that the illuminating power had gone up in certain glow-lamps, though the voltage remained constant. That was an interesting point, and one difficult to account for. It had been thought that the improvement was due to improved vacuum, but this was hardly to be believed, and he suggested it might arise from improvement of the filament during use. Prof. Fleming referred to the unsatisfactory nature of the standard candle, and also to the importance of personal error in photometric investigation. Mr. Swan approved of the short test suggested by the author, and pointed out that the length of life of a lamp depended upon constancy of pressure, a thing often much to be desired in central stations. Mr. Preece, in replying, said that though gas might be cheaper per hour than electricity, yet the ease with which the latter was turned on and off led to less light being wasted, and therefore an equality of cost was produced. If, however, local authorities would use electricity for tram propulsion, the cost of electric light per hour would be brought greatly below that of gas, in consequence of equalisation of the load factor.

A paper by Mr. S. B. Cotterell, on the "Liverpool Overhead Railway," was next read, in which the author described the engineering and other details of this construction. Mr. E. W. Anderson also read a paper on "Electric Cranes," the author expressing opinions favourable to the application of electric power for lifting heavy weights. Papers on "Hysteresis," by Prof. Fleming, and on "Street Lighting," by Mr. Walker, were also read.

The Section had a long sitting on the Tuesday of the meeting, but some of the papers were not of great importance. The first taken was by Captain Jaques, of New York, and was on "Armour and Ordnance." It was devoted largely to showing the great superiority of the United States over the rest of the world in the field. A spherical balanced valve was described by its inventor, Mr. J. Casey. It is an engineer's fitting involving an application of known principle. Prof. Hele-Shaw next gave an interesting description of certain instructional apparatus used in the Walker Engineering Laboratory, including Froude's dynamometer break, the speaker giving an excellent popular description of this ingenious appliance. A good discussion on the subject of technical education followed, in which, among others, Profs. Perry, Beare, Schröter (of Munich), Ritter (of Zürich), Merrivale, and Hele-Shaw took part. The opinion was expressed that the course of instruction proposed for the establishments known as Polytechnics, which have been so plentifully started in this country of late, is too ambitious, and the apparatus so complicated that evening students have not either time or ability to take advantage of it. Papers on "Colour Printing," by Mr. T. Cond, and on "Expanded Metal," a species of network made by slitting metallic sheets, were also read. The last sitting of the meeting was held on Wednesday, September 23. A paper by Mr. J. Bell described a system of wreck-raising, which the author and others had worked out. Lifting pontoons are employed in the ordinary way, but in place of the rise of tide being used to raise the wreck from the bottom, winches are adopted. The details of construction were illustrated by models. Finally a lecture on "Motor Carriages," by Mr. Sennett, was given. It was of an entirely popular character.

This brought the proceedings in Section G to a close.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

AFTER the President's Address (*cf.* NATURE, October 1, p. 527), the remainder of Monday was devoted to papers dealing with Prehistoric Archæology. Mr. Seton Karr exhibited specimens and photographs of the palæolithic implements which he had collected in Somaliland; these form an interesting link in the series of finds extending from India to Britain. It is well known that ordinary palæolithic implements of the river-gravel type are wanting in Ireland; but Mr. W. J. Knowles contends that the older flint implements he has found in the north-east of Ireland belong to this epoch, and that some bear striæ which "have been pronounced to be glacial." A discussion arose in the afternoon, in connection with some photographs of dolmens in Brittany exhibited by Prof. Herdman, as to the age of such structures. Prof. Boyd Dawkins maintained that they belonged to the Bronze Age, while Dr. Montelius, Dr. Garson, and others recognise that they are essentially Neolithic.

The proceedings on Friday commenced with speeches by the President, Sir William Turner, Prof. A. Macalister, and Mr. Brabrook, in commemoration of the centenary of the birth of Prof. A. Retzius, who was the originator of some of the modern methods of craniology, and who did a great deal to stimulate anthropological science in Scandinavia. Mr. A. W. Moore and Dr. J. Beddoe read a joint communication on the physical anthropology of the Isle of Man as analysed from the "Description Book of the Royal Manx Fencibles," in which are contained particulars of 1112 Manxmen enrolled between 1803 and 1810. Speaking roughly, there are