torrid; it only illustrates the fact that the order was a primitive type once very widely spread throughout the world, and now restricted by the competition of more specialised types. Therefore the occurrence in the Cretaceous rocks of Greenland of the tree-fern *Dicksonia*, which, although it still lives in New Zealand, is said to be most characteristic of the tropical parts of Northern Queensland, is no proof that the Arctic regions had a tropical climate. And it would not be so, even if Sir J. D. Hooker had not warned us, that ferns are the least trustworthy witnesses as to climatic conditions.

Hence an examination of the evidence of the fossil plants of the Arctic regions leads to three conclusions: (1) that, as current opinion rests on Heer's determination of fossil palms and tropical leaves which cannot now be supported, the changes of climate have been greatly exaggerated; (2) that without a complete revision of Heer's work, such as is now being carried out by Prof. Nathorst, the exact extent of the climatic changes cannot be estimated; (3) that the conclusions based on the belief that three months' darkness would be fatal to the growth of trees, cannot be maintained, while most of the fossil tree trunks in question have probably been brought as drift wood from the south.

The fossil faunas of the Arctic regions have been held to demonstrate climatic changes no less enormous than do the fossil floras. The most striking proofs quoted were the asserted occurrence of fossil coral reefs in the Silurian and Carboniferous rocks of various parts of the Arctic area, notably Bank's Land, Grinnell Land, Spitsbergen, and the New Siberian Islands. It is, perhaps, the best-known fact in the science of geographical distribution that coral polypes cannot build coral reefs in water of a lower temperature than 68° F. If, therefore, coral reefs formed by madreporarian corals do occur in the Arctic regions, this would be conclusive evidence of a great change in the temperature of the northern ocean. Let us take the case of the corals of Grinnell Land, of which specimens were brought home by Colonel Feilden, and determined by Mr. Etheridge. The collection included eleven species; of these six were simple corals, one was a simply branching, another was a cluster of simple corals, and the remaining three species, although compound, occurred in small nodules. Of corals in the condition of reef builders, there are none in the collection. Simple corals live in the Arctic ocean at the present day, while compound corals as large as the specimens from Grinnell Land are found far outside the range of existing coral reefs, and at far greater depths. The collection from Grinnell Land gives no proof that coral reefs were ever formed there. We have only to compare the few insignificant species from that region, with the massive corals that lived at the same time in English seas, to realise that there was almost as great a difference between the temperature of the sea in the two areas in Silurian times as there is to-day. Baron von Tol's list of Anthozoa from the Silurian rocks of the New Siberian Islands also includes eleven species; but of these only three are true Madreporaria. Compound Hydrozoa and Alcyonaria have a greater range than the reef-building Madreporaria, both in latitude and depth. Hence, in arguing from the distribution of the fossil corals, we must eliminate all except Madreporaria; and the moment we apply this rule to the New Siberian coral reefs, we lose all but a few small Madreporaria, which certainly cannot be described as forming reefs.

If limestones as full of corals as the Silurian rocks of Wenlock Edge, or some of the beds in the Carboniferous series at Clifton, be ever found north of 80° N. lat., they will no doubt prove that at the time of their formation the Arctic Ocean was a coral sea. But the evidence so far seems insufficient. That the northern seas had a warmer temperature at some parts of the Palæozoic era than at present is not denied. It is proved by the occurrence of coral reefs in various parts of Europe and America; and in places massive corals grew as far north as the Arctic Circle, as in the Timan Mountains, and sometimes even a few degrees beyond, as in Bank's Land. But the northern coral faunas are poorer than those of temperate Europe, and as we go nearer the pole, they become so stunted that they ceased to form reefs.

The corals alone, therefore, are insufficient to prove the universality of a tropical climate in early geological times, and it is advisable to consider the evidence of the fossil faunas as a whole. Arctic marine faunas are known from six of the geological systems—the Silurian, Devonian, Carboniferous (including Permian), Triassic, Jurassic and Cretaceous. The six faunas are characterised by the following general features:—

(1) They are often rich in individuals, but poor in species.

(2) Crustacea, trilobites, zoophytes, and other animals with chitinous exo-skeletons are proportionately common and often large in size.

(3) Compound corals are scarce, and occur in nodules instead of in reef-forming masses.

(4) Sea-urchins and sea-lilies are extremely scarce—in fact, barely represented.

(5) There is a striking poverty in new or special types.

But these are, in the main, the characteristics of the existing Arctic fauna; and it is difficult to compare the Arctic fauna of any one period with that which then lived in southern Europe, without concluding that all through geological time the northern faunas have lived under the blight of Arctic barrenness.

This reminds us of the question of the shifting of the position of the pole, which was proposed as a help to palæontologists in explaining the former Arctic faunas and floras. But the facts seem explicable without the aid of this hypothesis. Neumayr has published a map of the probable climatic zones in the Jurassic period, which appear to have been as parallel to the equator then as they are now. In Tertiary times the evidence of the fossil plants seems to show the same; for, from whatever direction we approach the pole, the fossil floras become sparser and more boreal in aspect, as we may see by a comparison of the plants of Disco Island and Grinnell Land, of the Great Slave Lake and Prince Patrick Land, of Iceland and Spitsbergen, and of Saghalien and New Siberia.

Hence the palæontological evidence, instead of demanding the shifting of the pole, seems to be opposed to this theory, and to show that, in all the periods for which palæontological evidence is available, the pole stood near its present position. Palæontological evidence, moreover, when freed from sensational exaggeration, shows that the variations in the climate of the Arctic region have not been so extreme as have been assumed, and thus it greatly simplifies the discussion of the causes of the changes that have occurred. The size of the Palæozoic sun was increased to warm the Arctic Ocean up to the temperature of a coral sea; the pole was shifted to remove the fatal spell of Arctic night, and clothe parts of the polar lands in subtropical forests. When Lyell proposed to explain the climatic variations by alterations in the position of land and water, he called upon his theory to account for the alternation of a vast polar ice-cap with tropical conditions. Such results could not be explained by the geographical theory, which accordingly fell into disrepute.

But if we call upon that theory to explain changes for which there is valid evidence, it is not improbable that it may not suffice. A different distribution of land and sea, a greater or less elevation of the mountain ranges, a deflection of the ocean currents, the reduction of the ice-covered sea, and the meteorological changes that would be thus produced may, as Lyell thought, be quite sufficient to account for all the climatic variations which the facts of Arctic geology require.

J. W. GREGORY.

THE IRON AND STEEL INSTITUTE.

THE annual summer meeting of the Iron and Steel Institute was held last week at Cardiff. The President this year is Mr. E. P. Martin, who is at the head of the executive of the great Dowlais Iron Works; and it was appropriate, therefore, that the meeting should be held in the commercial metropolis of Wales. The meeting was in every respect most successful, though certainly it fell off somewhat from a technical point of view; but that, after all, was largely due to the weather, it being too hot to sit in a lecture theatre and discuss details of iron and steel manufacture. An unusually large number of members attended, and many of them were accompanied by ladies.

On the members assembling on Tuesday morning, the 3rd inst., they were welcomed by the Mayor of Cardiff, after which Mr. Martin took the chair, and other formal business having been transacted, Mr. Thomas Wrightson's paper, "On the Application of Travelling Belts to the Shipment of Coal," was read. In this he described a new method of placing coal into a ship, expeditiously and without breaking it. The latter is a very important point, as small coal or dust is worth very little; and the old-fashioned method of shooting coal from a staith direct into the hold of a vessel, leads to the formation of a great deal of small coal. The apparatus Mr. Wrightson has designed,

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and which is in use on the Tyne, consists of a series of belts or creepers and a continuous chain, with leaves attached, working in a trunk. The coal is lowered on to the belts, and is thus conveyed any required horizontal distance until it reaches the end of the staith or pier against which the ship is moored. One end of the trunk, in which the continuous chain or belt works, is lowered into the hold of the ship, and by means of the trays the coal is lowered down and gently deposited in the required position. The action of the lowering part of the apparatus is similar to that of a grain elevating machine, or of a bucket and ladder dredger; but of course the working is reversed, the material being lowered in place of being raised. The machine in use was said to be capable of dealing with 400 tons of coal an hour, and as, presumably, a machine could be used for each hatch, a vessel of say 2400 tons dead weight, and having three hatches could, we suppose, be brought to her bearings in a couple of hours. In the discussion that followed, the arrangement was rather sharply criticised, but it must be remembered that Cardiff is the home and birthplace of a rival scheme that has been in successful operation for some years. Naturally those who have used the older method and have experienced the benefit of it as compared with the primitive shoots, are loath to change, and it is also natural that the maker of the original apparatus should not welcome a competing scheme with too great enthusiasm. It would seem, however, that the Wrightson invention ought necessarily to have an advantage in point of speed because it is continuous, whilst the work with the older method is intermittent.

Mr. George B. Hammond's contribution, "On the Manufacture of Tin-plates," was an omnibus paper dealing with the subject at large—historically, commercially, and technically. From the historical and technical point of view, there was very little new to say, and indeed the commercial side of the question is already a thrice-told tale of sadness and decay. America was our great customer for tin-plates, and under the enormous impetus given to the industry by the spread of the canning trade in provisions fortunes were made in South Wales, and enormous wages were paid. The inevitable reaction followed. The United States, pursuing their protectionist policy, put an import duty on tin-plates which was absolutely prohibitive, and that market was lost. There were, however, other outlets for the commodity, and had both employers and employed recognised the need of hard work and frugality the trade need never have fallen to the low ebb it has. Over-prosperity had, however, destroyed the moral fibre of those who had experienced it. There were large profits, high wages, antiquated methods, and artificial restrictions to output which no one wished to forego, and the consequence is that South Wales sees every prospect of American competition in neutral markets. This, however, is somewhat beside Mr. Hammond's paper; but it would be difficult for us to deal with the technical part without the illustrations of machinery which accompanied the paper.

On the following day, Wednesday, the first paper taken was that of Prof. Honoré Ponthière, "On a Thermo-chemical Study of the Refining of Iron." It was read in brief abstract by Mr. Brough in the absence of the author. From its title it will be seen how impossible it would be to abstract such a subject within anything approaching the limits of space at our disposal. It began with a discussion on the conditions under which the elements exist in iron, and treated of the various possible or probable reactions which take place during the process of steel-making by the two chief processes, and of puddling.

Mr. E. H. Saniter's paper "On Carbon and Iron" followed, being read in full by the author. This was the most important contribution to the meeting. It discussed the thermal treatment of tri-basic carbide of iron; the saturation point of iron with carbon by fusion in contact with excess of carbon; the saturation point of iron with carbon by heating without fusion in contact with excess of carbon; and the etching of pure carbon alloys at a red-heat in order to ascertain their structure by means of the microscope at that temperature. The last branch of the subject brought forward points of considerable interest, and the paper raised the old, and it would seem interminable, controversy on the alpha and beta states of iron. Mr. Saniter, we gather, is more of a carbonist than an allotropist, and his reasoning seemed to support the former party. Unfortunately there were no allotropists present, or if there were they were silent; so the discussion went all one way. The photo-micrographs attached to the paper were interesting, and in some respects this new method of treatment showed unexpected results. Mr. Saniter made a strange mistake in his paper. He attributed to so competent an authority as Edward Riley the statement that the saturation-point of iron for carbon was 4 per cent. Mr. Riley, who was present, naturally exclaimed against this, and asked Mr. Saniter for his authority, which the latter gave as the Journal of the Institute for the year 1877. What the saturation-point may be has not, we believe, been exactly determined, but at any rate it is higher than 4 per cent. Mr. Saniter's mistake, of course, was that he did not verify his authority when the statement was so questionable and the reference to the original so easy.

The last paper read at the meeting was Mr. Henning's contribution on a recorder of stretching, which was taken charge of by Mr. Wicksteed, in the absence of the author. The portable recorder referred to consists of a pair of clamps attached to the two ends of the specimen rod. To one of these clamps is attached a parallel motion with a projecting arm, at the end of which is a pencil. The motion is worked by rod from the other clamp, so that when the specimen stretches, and the clamps are thus pulled apart, the arm moves. In this way a record can be obtained on a card which is mounted on a revolving drum, which is actuated by a cord from the poise weight. It will be seen that in construction the apparatus bears a resemblance to a steam engine indicator, both in regard to the parallel motion and the paper-drum. It was objected during the discussion that the poise could not be moved fast enough to give true indications when the specimen ultimately gave way; but probably if a record can be obtained within the elastic limit, that will be sufficient for the majority of engineers, as a material strained beyond this limit is very little good for structural purposes.

Five other papers were on the agenda, but were not read at the meeting.

The excursions and entertainments during this meeting were numerous and the hospitality profuse. Several of the large iron and steel works were visited, the Cardiff and Newport docks were inspected, and also other places of industrial interest. There were lunches, dinners, soirées, a Welsh concert, garden parties, and illuminations packed in as close as time would permit; but the culminating point in all these delights was the Marchioness of Bute's ball. To this over three thousand guests, including all the members of the Iron and Steel Institute and the ladies accompanying them, were invited.

ON PRACTICALLY AVAILABLE PROCESSES FOR SOLDERING ALUMINIUM IN THE LABORATORY.

It seems that ever since the metal aluminium has been used in construction, difficulties have arisen in soldering it. Further, from contemporary literature it appears probable that some perfectly satisfactory methods of getting over the difficulty are known, but not published in sufficient detail to be available.

Hence it seems well to put on record any advance towards the solution of this somewhat troublesome problem. In the first place, my experience is that it is not easy to solder aluminium simply by using an alloy of definite composition without a flux. Also that the only other process which does not require special apparatus, that based upon the use of silver chloride, is very troublesome indeed unless the local fusion of the aluminium be immaterial. I find, however, that cadmium iodide is distinctly more satisfactory. If it be fused on an aluminium plate, decomposition of the salt occurs long before the melting point of the aluminium is reached. The result is generally the violent evolution of iodine vapour and formation of an alloy of cadmium and aluminium on the surface of the metal.

The decomposition of the cadmium iodide is, however, too rapid to be convenient, and the pulverulent white residue is in the way. It is, therefore, of advantage to add some other body which, if possible, will obviate these defects. I find that zinc chloride answers fairly well. Thus I mix concentrated zinc chloride solution with a little ammonium chloride, evaporate in a round porcelain dish, and ignite a low red heat till a part of the ammonium chloride is volatilised. The fused chlorides are now mixed with cadmium iodide. The proportions of zinc chloride and cadmium iodide are best adjusted experimentally.

The final result, when the salts are completely fused together, is a flux which readily enables tin (or other soldering alloy) to unite perfectly with aluminium. The melted flux can be taken up in a pipette with india-rubber teat, and dropped on to the surface of the metal to be soldered. Some powdered metallic

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