would be of the first importance. In orbit computation the judges will regard with special attention care exercised in revision of published observation, ingenuity displayed in searching out and evaluating systematic errors, completeness and soundness of discussion, ability shown in indicating probable limits of uncertainty in adopted elements, &c. With regard to variable stars, enough has already been said, but the judges remark that definite reductions cannot of course be expected, as from the nature of the case many years must elapse.

GEOGRAPHICAL NOTES.

THE Hon. G. N. Curzon, M.P., read a paper on his recent journey in Indo-China at the meeting of the Royal Geographical Society on Monday. The whole region, he pointed out, is dominated by its great rivers, and may be divided into the mountain district of the north cleft by vast gorges, and the low plains of the south mainly composed of alluvial deposits, where the coast lands are steadily encroaching on the sea. In the seventh century Tongking, now 60 miles inland, was on the coast. A very remarkable feature which gives to parts of the coast a beauty comparable with that of the Inland Sea of Japan is a broken belt of limestone cut into curious flat-topped sections of all sizes, and perforated by the sea or rivers with many fantastic caverns and tunnels. The masses of caverned rock rise to a height of from 50 to 500 feet, and are best seen in the Bay of Along in Tongking. In Annam Mr. Curzon travelled to Hué by the "Mandarin's Road," a track which is carried over several cols by some skilful engineering in the form of rock staircases. Throughout Annam the traveller is much confused by the number of names applied indiscriminately to each village, and the maps hitherto constructed by the French officials are far from satisfactory. The people of Annam have the submissiveness without the nerveless apathy of the Hindu, and as craftsmen they are industrious and artistic. Coal is abundant, some seams being more than 180 feet thick at Haton, on the Bay of Along. Hué is a city of great interest, being beautifully situated and near a number of magnificent ancient tombs. Cambodia or Cambogia, as Mr. Curzon prefers to spell the name, is of interest, mainly on account of its ruins, the number and character of which make a long stay desirable, if the traveller would do justice to his opportunities.

THE newly published report of the Bengal census reveals the interesting fact that there is a steady transference of population from the most densely to the more thinly peopled parts of the province, the former prejudice against leaving the native village having apparently vanished. Mohammedanism is increasing rapidly in Bengal, and the custom of widow marriage amongst Hindus has become common. These facts are significant of progress.

THE supremacy of the great ports of Europe as entrepôts for the trade of the world is rapidly becoming a thing of the past. Two recent instances of independent action on the part of the colonies are of more than local importance. One is the establishment of a line of steamers trading direct from New York to Cape Town, another the commencement of a regular service of fast steamers from Vancouver to Sydney, N.S.W.

A COMMUNICATION was lately made to the Paris Geographical Society on the strength of a statement in a Russian newspaper, describing a curious mountain group in Podolia. This is said to rise abruptly from the plain with a grandly rugged crest composed of a broken circular rim surrounding a crater-like depression. The whole mass is composed of limestone, in which fossil corals abound, and the inference drawn is that this is, in fact, a full-sized fossil tertiary atoll. The name of the mountain is given as Miodoborski, but it is called Toltra by the natives.

AT a general meeting of the Royal Geographical Society called by the requisition of a few Fellows who objected to the action of the Council in the manner of admitting women to the Fellowship of the Society, it was proposed to frame a bye-law restricting the privileges of lady Fellows, and rendering them incapable of serving on the Council or in any office in the Society. The question whether ladies should be admitted at all was voted upon after a somewhat heated discussion, and it was decided by 147 to 105 that women should not be admitted as Fellows of the Society. This decision was entirely unforeseen; it is a retrograde step which, we feel sure, will be disapproved and regretted by the majority of the Society.

THE Royal Medals of the Royal Geographical Society have been awarded to Mr. F. C. Selous for his travels in Africa, and to Mr. W. W. Rockhill for his journeys in Tibet. The Gill Memorial was awarded to Mr. H. C. Forbes, and the Cuthbert Peek Grant to Mr. Charles Hose for his travels in Sarawak. Major Powell, Washington, Prof. Ratzel, Leipzig, and M. Vivien de St. Martin, Paris, were elected honorary corresponding members of the society.

INSTITUTION OF MECHANICAL ENGINEERS.

ON the evenings of Thursday and Friday last week, April 20 and 21, an ordinary general meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, by permission of the Council of the latter body. There were three papers on the Agenda, but only two were read, namely, Mr. Dean's paper on copper plates for locomotives, and the second report of the Alloys Research Committee, the author of which was Prof. W. C. Roberts-Austen, C.B., F.R.S. Our readers will remember that the first report of the Alloys Research Committee was read, and discussed at the October meeting of 1891, and an abstract of it appeared on page 22 of our 45th volume. A large part of the first report was taken up by the consideration of the effect of various alloys on gold, and it will be remembered that the author was somewhat sharply criticised for the course he had taken in framing his report, gold being a metal not used by engineers, at least for constructive purposes. This second report carries the matter further, and it is possible now to appreciate Prof. Roberts-Austen's reasons for taking the course he did. In opening the subject he referred again to the "periodic law" of Newland and Mendeleeff, and upon it he based a large part of his reasoning in the first report. The researches of Raoult Van't Hoff, and Arrhenius, led to the view that the molecules of small quantities of elements, distributed through a mass of a solvent, retain their individuality. The work of Heycock and Neville (and also the experiments described in the author's previous report) point to the conclusion that the added elements may retain their freedom when they are present in much larger quantities than 0·2 per cent., which is the amount of added matter the Committee usually dealt with in their researches. The point raised was whether the added element does, or does not, remain free in the mass of the solvent, and as the author pointed out, it is a vital one in limiting the scope of the inquiry.

If the added element enters into combination with the solvent its individuality will be changed, and it might be that the mechanical properties of the metallic mass would mainly depend on the degree of fusibility of the compound formed. If the concentration of the solution is such that a fraction of the dissolved body alone remains isolated, the influence of the volume of the added elements, will evidently be disturbed, as this influence is supposed to be exerted only by a single constituent of the mixture, whilst the mechanical properties of a solidified mixture are functions of both constituents, in the favourable circumstances where the solvent is not started by the added element, and where the law of atomic volumes is applicable. A metal is seldom homogeneous and is more often formed of rounded polyhedral grains, and the cohesion in the interior of a grain differs from the adherence between the neighbouring grains. The law of atomic volumes cannot apply, the report pointed out, to the adherence of the grains, that being regulated by other causes, such as the rate of cooling and pressure, and whether a compound be formed, which solders the grains together. Arguing from these facts, the author pointed out that an attempt to prove the nature of the influence of atomic volumes by mechanical tests only led to anomalies, and more or less grave irregularities being encountered. The investigation was not, however, limited to mechanical tests, independently of which it had been shown that the influence of impurity on the molecular transformation in iron, studied by Osmond, may be shown in several ways. Transformation may be assisted by the presence of impurity, the temperature at which they occur may be altered, or the molecular changes may even be entirely prevented by the presence of elements which behave in strict accordance with the law of atomic volumes. The author referred to the remarkable series of experiments recently made by E. Warburg and F. Tegetmeier, which would seem to demonstrate the possibility of producing eventually a degree of porosity in vitreous bodies, which will admit the passage of elements having comparatively small atomic volumes, while other elements, having larger atomic volumes, are strained off, thus occasioning

a mechanical sifting of the elements. In making these experiments, a cup-like receptacle was used, which had a vertical partition of sheet glass placed in it, so that the cup was divided into two parts by the glass. Sodium amalgam was placed on one side and pure mercury on the other; the whole was then heated to a temperature of 200° C., at which the glass became slightly conducting. By the aid of a battery, the sodium atoms of the sodium silicate were set in motion, and after 30 hours it was found that a considerable quantity of sodium, amounting to 0·05 gramme, had passed into the mercury which was originally pure. A corresponding amount of sodium had been lost by the amalgam, but the glass had exactly preserved its original weight and clearness. The glass was partly composed of neutral molecules of sodium silicate, together with free molecules both of sodium (base) and of the acid, and of the free sodium capable of being transported under the influence of the electric current. When Tegetmeier replaced the sodium amalgam by lithium amalgam and repeated the experiment, the sodium of the glass passed as before into the originally pure mercury, and the glass became opaque on the side touching the lithium amalgam; but after a time the opacity extended right through the thickness of the glass, and the metallic lithium began to accumulate in the previously pure mercury. It is not possible thus to chase out all the sodium present in the glass; but the free sodium atoms are replaced by those of lithium. Analysis showed that the glass originally contained 2·4 per cent. of potassium and 13·1 per cent. of sodium; but after the experiment, while retaining the same percentage of potassium, it had only 4·3 per cent. of lithium, and only 5·3 per cent. of sodium. The glass in which lithium had thus replaced part of the sodium was very tender, opaque, and friable. The conclusion to be drawn is that the atoms of lithium, having an atomic weight of 7, and an atomic volume of 15·98, can pass along the tracks, or molecular galleries left in the glass by the sodium atoms, the atomic weight and volume of which are 23 and 16·04 respectively. When a metal of superior atomic weight and volume to sodium was substituted for the lithium—such as potassium, with atomic weight 39 and atomic volume 24—it was found not possible to chase out the sodium, the new atoms being too big to pass along through the spaces where the sodium had been. We are thus confronted with a molecular porosity which can in a sense be gauged; and the mechanical influence of the volume of the atom is made evident. Proceeding to the details of the experiments made by the committee, the influence of impurities on copper was next referred to. The question was raised whether normal copper can be made to assume an allotropic state, analogous to that in which there is reason to believe iron can exist, and if so are the properties of normal and of allotropic copper as widely different from each other as those of the distinct varieties of certain well-known non-metallic elements. The point is one of considerable interest, and Prof. Roberts-Austen seems to have little doubt that copper can be prepared by electrolytic deposition, in an allotropic state, in which the density of the metal is from 80 to 82 as compared with 8·92, which is that of normal copper. The effect of mechanical and thermal treatment upon copper was then referred to, and some interesting figures were given, showing how different may be the properties of a metal chemically pure; for instance, rods of very pure electrolytic copper, all the same sample, but variously treated, broke under stresses varying between 8·219 tons and 18,750 tons to the square inch; the former being the tensile strength of cast rods, and the latter of cast rods worked and not annealed; whilst cast rods carefully worked, and annealed gave a tensile strength of 18·259 per square inch. The experiments show a difficulty in determining a standard tenacity for copper.

The effects of arsenic, bismuth, and nickel upon copper afforded one of the most interesting parts of the investigation, and from the engineer's point of view an extremely important section of the series of experiments. It has been too often accepted as a matter of fact that pure copper is the best that can be used for engineering purposes, and specifications are generally framed to this effect. The Research Committee, however, show that the metal may be, and frequently is, as a matter of practical fact, too pure for the purpose; thus, it has been found that a very fair percentage of arsenic improves the copper used in fire boxes of locomotives. It is well known that of old these parts of the boiler lasted for a much longer period of time than they do in the present day. In fact, as Mr. Tomlinson, an old railway engineer, said in the discussion, they used to expect to get half a million miles of running out of a copper fire box, whereas about half that distance is all that is obtained in the present day. This he attributes to the effect of electrical matters upon engineering practice. The electricians insist on their copper being absolutely pure, and that has raised the standard, so that now the copper smelters get all the impurities out of the metal, whereas in old times a considerable percentage of alloy, especially arsenic, was present. Antimony appears to behave like arsenic, and when present in proper proportion greatly strengthens the copper. Bismuth, on the other hand, renders copper singularly weak. With 0·1 per cent. of bismuth a sample of copper was too brittle to work, and had at the ordinary temperature a tenacity of 18,000 tons to the square inch; but at a higher temperature the fall in tenacity was very rapid, and there was practically no elongation. The prejudicial effects of bismuth did not seem to disappear, even though but a trace were present. In one test of a singularly pure copper, containing only 0·002 per cent. of bismuth, although the metal was strong and worked well, the elongation was very small. The variation in the effect of arsenic and antimony on the one hand, and of bismuth on the other, is of considerable interest, for according to the classification of Mendeleeff, arsenic, antimony, and bismuth all belong to the same family, of which nitrogen is a type. The atomic volume of bismuth—20·9—is, however, higher than that of arsenic—13·2, or of antimony—17·9, and therefore, according to the principle laid down by Prof. Roberts-Austen, bismuth ought to diminish the tenacity of copper, of which the atomic volume is only 7·1. But in accordance with this reasoning the influence of arsenic and antimony should be exerted in the same direction, even though in a less degree. The author has turned his attention to this matter, and has already been conducting a series of experiments which have extended over nearly twelve months. The investigations are, we believe, not yet complete, but the results will be given subsequently. A diagram was, however, exhibited at the meeting, in which curves were shown, illustrating the behaviour of various alloys of copper and bismuth during cooling, and the wholly unexpected fact was revealed that the copper passed below the freezing point before it actually became solid. On each curve there was a second or lower point of solidification, which occurred at a constant temperature in all the alloys, and was very close to the melting-point of bismuth itself. The existence of this second point was very evident, even when the copper contained only one per cent. of bismuth, and this fact goes far to explain the peculiar action of bismuth on copper. It would appear that whether very poor or very rich in bismuth, the alloy of copper may be a portion of bismuth, containing perhaps a little copper, always remains fluid until the temperature of the mass has fallen to 260° C., which is the point at which bismuth itself solidifies. The presence, Prof. Roberts-Austen stated, of a fluid constituent in an alloy long after the mass itself had become solid, is doubtless the determining cause which enables the metal to assume a highly crystalline, and consequently an intensely brittle structure. So far as he was aware the cause of the peculiar behaviour of bismuth could not have been revealed by any other method of investigation than the one adopted. In connection with this point, a fact brought forward during the discussion by Mr. Gowland, is of interest. In the course of his metallurgical work at the Japan mint, he had brought before him a large number of bars of silver for the purpose of coining, but they were so brittle that it was impossible to work them at all. On investigation he found that there was an appreciable quantity of bismuth in the silver. The structure was coarsely crystalline, and though the whole mass was so hard and brittle, the crystals themselves were very ductile. The conclusion he came to at the time was that the crystals of silver had become separated, as it were, by a film of bismuth. The fact bears out the correctness of Prof. Roberts-Austen's mode of reasoning. Judging from their polished surfaces, the alloys of copper rich in bismuth are to all appearances as coherent as the alloys of copper and tin, which have great strength. The report gives some interesting particulars of the effect of pressure. The passage of iron from one allotropic modification to another is accompanied not only by a change of heat capacity, but also by a change of volume. This matter was referred to in the previous report, but the author gave some further interesting particulars of experiments carried out by compressing a piece of steel in a hydraulic press, in order to obtain recalescence at a lower temperature than would be the case if the

pressure were not applied. In one case a cylindrical piece of steel, 1″ long and ¾″ in diameter, was bored through two-thirds of its length by a hole $\frac{1}{10}$″ in diameter, in which a thermal junction was placed. The mass was heated to 1000° C., and it was found that without the application of pressure recalescence occurred at 650° C., but when a load of 9 tons per square inch was applied, recalescence occurred at 620° C., and was comparatively feeble. The experiment, it need hardly be said, is one very difficult to make, and could only be done by those having command of special apparatus. Other experiments were carried out, the result showing that the recalescence point is lowered by pressure, but it was found that the lowering was not affected, unless the load was applied at a temperature well above that at which recalescence takes place. Experiments were made with Newton's alloy of bismuth, lead, and tin, the full results of which will be published at some future time. In considering the whole scope of the report, the author said that it might be asked what evidence had been gathered as to the mode of action of added elements, and whether it appeared that the atomic volume of the added element had a dominating influence on the mechanical properties of the mass in which it is hidden? The true action of an added element, the author pointed out, may readily be masked by its action as a deoxidiser. Notwithstanding these difficulties, it is undoubtedly proved that bismuth, potassium, and tellurium, all of which have atomic volumes, greatly lower the tenacity of copper. Arsenic, which has a larger atomic value (13·2) than copper (7·1) confers strength on copper, but it is very certain that the limit of elasticity, and the ductility of a metal are greatly influenced by the presence of an element with large atomic volumes. This fact may be of more molecular significance than the diminution of tenacity, to which, for the sake of simplicity, attention was mainly directed, when the early experiments on gold were made.

In the discussion which followed the reading of the paper a number of speakers took part. The most important contribution was that of Dr. Watson, of the Broughton Copper Company, who brought forward some practical experience to reinforce the deductions of the author. Mr. Arnold, of the Technical Schools, Cambridge, read a very long manuscript, which it would be rash on our part to attempt to abstract, and which we cannot afford the space to give in full. Mr. Hadfield, of Sheffield, questioned the accuracy of the beta form of iron theory promulgated by Osmond and adopted by the author. The point is one of considerable importance, but requires a wide field for its discussion.

On the whole it cannot be doubted that the report is a most valuable contribution to the scientific knowledge at the command of the engineer, and were the attention called to the action of bismuth on copper its sole result, the labours of the committee would not be without warrant.

The summer meeting of the institution will be held this year at Middlesborough on August 1 and three following days.

CONIFERS.[1]

THIS is a bulky volume of nearly 600 pages, and contains a vast amount of information. If the Royal Horticultural Society had published nothing but this since 1891 they would have amply satisfied those who are interested in conifers, and have keenly felt the want of such a book of reference as the one now under notice. Some of the papers published in the report could have been omitted without loss, but on the whole the editors have done their work well. In the preface they say, in sending out this memorial of the Conifer Conference, 1891, "we would draw attention to the fact that it contains far more than a mere verbal report of the conference, Dr. Maxwell T. Masters, F.R.S., and Prof. Carl Hansen, of Copenhagen, having promised at the time to recast their notes more fully. This they have done most kindly, and with infinite labour and research, but not without some little expenditure of time, the final sheets of MS. having only come into our hands in July, and the corrections extending up to September 29.

"The names adopted by Dr. Masters and Prof. Hansen may, of course, be relied upon as representing the latest decisions of botanical science in England and on the continent of Europe respectively, though future research may necessitate some still further slight alterations. However, the hitherto inextricably confused nomenclature of conifers may safely be described as settling down upon the lines adopted in this volume by these two eminent authorities, who, although not yet in absolute agreement, will be found to approach very nearly."

The list of conifers and texads, by Dr. Masters, is by far the most important contribution to the nomenclature and synonymy of conifers which has appeared since the publication of Parlatore's monograph in De Candolle's "Prodromus" in 1868; it is much more complete than Beissner's "Handbuch der Coniferen-Benennung," and the more recent "Handbuch der Nadelholzkunde," of the same author. There seems no reason to doubt that Dr. Masters's list will be used and followed by English systematists generally. Dr. Masters, in drawing up the list of genera, follows Bentham and Hooker's "Genera Plantarum" as the standard authority. A few deviations from it have, however, been made in accordance with more recently obtained knowledge. Pseudolarix is accorded generic rank (and not united with Larix, as in the "Genera Plantarum," whose authors had not seen male flowers); Keteleeria too, after a careful study of living material, has been separated from Abies and reinstated as a genus—Dr. Masters's studies having on these points proved the justice and accuracy of Carrière's views. The Chilian Prumnopitys is restored to generic rank, and separated from Podocarpus, with which it was united by Bentham and Hooker.

The Pinetum Danicum of Prof. Carl Hansen is unsatisfactory, and its omission from the report would have been desirable. It is a somewhat ambitious performance, but in bulk is very largely made up of extracts from books and periodicals. Many of the records are certainly useless; for instance, under *Pinus longifolia*, it is stated: "one plant, however, exposed out of doors does not appear to have suffered"; this Indian species is tropical in its requirements, and as it will not grow out of doors even in the south of England, it is in the highest degree improbable that it would, even under the most favourable conditions, exist in the open air in Denmark. A curious mistake occurs on p. 372, where the Viennese botanist, Prof. Günther Beck, Ritter von Mannagetta, figures as Prof. Günther, Knight of Beek von Managetta. On p. 330 Prof. Hansen remarks under Prumnopitys that its wood is much valued by "ebonists." He probably means cabinetmakers (ébénistes). *Tsuga hookeriana* and *T. pattoniana* are kept up as distinct species by Hansen; but Prof. C. S. Sargent, who is familiar with the two forms in their native habitats, has no hesitation in regarding them as specifically identical. Hansen accords generic rank to Biota, Thuyopsis, and Chamæcyparis, the first and second being merged into Thuya, and the third into Cupressus by Dr. Masters. It is rather annoying to find the obsolete geographical expression "New Holland" constantly used by Hansen. New Holland and South-east Victoria are given as the native countries of one species.

The coniferæ of Japan, by H. J. Veitch, is a valuable paper. From it we learn the somewhat startling fact that, in proportion to the area of the country, the flora of Japan contains more coniferous species than that of any other country in the world. Japan boasts of forty-one species and thirteen genera, whereas in the whole of Europe there are but eighteen species and seven genera.

A. D. Webster, "Conifers for Economic Planting." Mr. Webster is a practical forester of wide experience, and he considers that out of all the conifers cultivated in Britain only sixteen can be utilised in an economic sense, or for truly profitable planting. These are the larch, silver fir, Corsican pine, Douglas fir, *Pinus Strobus*, Scotch fir, *Thuya gigantea*, Spruce fir, Austrian pine, *Pinus Pinaster*, *Abies nordmanniana*, *Sequoia sempervirens*, *Cupressus macrocarpa* (or, as Mr. Webster calls it, *C. lambertiana*), *Cedrus atlantica*, *Pinus rigida*, and *Cupressus lawsoniana*. The order in which these names are given represent the relative value of the trees as timber producers. Under each heading Mr. Webster gives valuable data as to rates of growth under different conditions as regards soil, elevation, &c.

In a compact paper of thirteen pages Mr. W. Somerville gives a very good *résumé* of the present state of our knowledge of the quality of coniferous timber as affected by sylvicultural treatment. Mr. Somerville's remarks are sure to be perused with profit by landowners and foresters.

Mr. D. F. Mackenzie, on the timber of exotic conifers: uses and comparative value, contributes much valuable information. Taking the value of Scotch fir timber at 100, the author calculates that of *Cupressus macrocarpa* at 190 and that of *C. lambertiana* at 283; as these two names represent one and

[1] Report of the Conifer Conference, 1891 (issued November, 1892).