unfortunate Allies in the attempt to revive their astronomical journal. It will be issued once a month unless circumstances should enable it to appear more frequently. Subscriptions and correspondence should be sent to Felix de Roy, Hon. Sec., 29 Stamford Street, London, S.E.

THE HARDENING OF METALS.

A VISITOR at the recent meeting of the Faraday Society could scarcely have failed to be struck by the fact that although the society was supposed to be discussing the hardening of metals, in reality the discussion centred almost entirely round the various theories of the hardening of steels. The reason for this was probably twofold. First, in spite of, or perhaps on account of, the considerable amount of research work that has been published on this problem it still remains the most keenly debated topic in metallurgical circles, and one on which widely different opinions have been held. Secondly, from a practical point of view it may be broadly stated that, in regard to hardening, steels are the only alloys that really matter.

Yet there can be no doubt that the council of the Faraday Society made a wise choice in the title of the topic for discussion. Even the simplest pure iron carbon steel is a complex material. Its complexity is due to the facts that (1) iron exists in at least two well-defined allotropic forms; (2) above 780° C. it is non-magnetic; below it, magnetic; and (3) carbon has a remarkable tendency to form compounds of a high degree of molecular complexity. While considerable attention has been directed to the first two aspects of the matter, the third has not yet received the attention that it deserves, and will require before a complete solution of the problem can be reached. The position, therefore, is that while steels may be the most interesting alloys to investigate it does not follow that they are most suitable. What is first of all required is a fundamental investigation of the theory of the hardening of metals from which the foregoing disturbing causes are absent. When the foundations of this have been securely laid the precise effect of the above "variables" will no doubt be elucidated by suitably chosen experiments.

This aspect of the matter was clearly seen many years ago by Dr. G. T. Beilby, who has investigated the physical mechanism of the hardening of metals such as gold, silver, and copper, which can be obtained in a high state of purity, and from which magnetic and chemical complications are absent. Until quite recently it would have been possible to say that allotropic complications were also absent, and so far as present knowledge goes they were absent in the case of gold and silver. Recent investigations by Prof. Ernst Cohen (Utrecht), however, have led him to conclude that the metals cadmium, lead, bismuth, copper, zinc, and antimony ordinarily occur as metastable systems consisting of two or more allotropic forms, so that this consideration must be kept in view. Prof. Cohen was unfortunately unable to be present at the meeting, but an important summary of his results was available and is worthy of very close study. Ordinarily the transformations from one allotropic form to another are subject to strongly marked retardations, and it is only by employing certain devices such as the addition of an electrolyte and the use of the metal in a finely divided state that the transformation velocity can be increased to such an extent that the change from the metastable to the stable form occurs within a short time. These transformations are frequently accompanied by marked volume changes leading to complete disintegration of the metal.

These recent developments do not, however, alter the fact that Dr. Beilby chose for his investigations metals of the most suitable kind from the point of view of arriving at a physical conception of the mechanism of hardening by mechanical deformation, and they enabled him to prove the existence of a thermally stable crystalline and a mechanically stable amorphous vitreous phase in each metal investigated. How far-reaching and fundamental these conclusions have proved to be is evidenced by the fact that all the papers dealing with the hardening of steels presented at the meeting incorporated and made more or less use of them. According to Mr. Humfrey, "The hard structure which can be produced in carbon steels by quenching and in certain alloy steels by normal cooling is due to the presence of a hard, amorphous solution of α iron and iron carbide." Mr. McCance's view is that the hardening is due to "interstrained" α iron, and the suppression of the carbide change. The theory of Profs. Edwards and Carpenter is that the hardness is caused by the complete suppression of the carbide change, together with the presence of amorphous layers existing at the surfaces of slip upon which copious twinning occurs when carbon steels are quenched. On this view the *final* cause of hardening by quenching is exactly the same as that of hardening by cold working, viz., the internal deformation of the crystals.

When these theories are carefully examined it is significant to note how much they have in common. All of them agree that the carbide (Ar 1) change is suppressed, a fact of very fundamental importance. The differences centre round the precise condition of the iron, and arise chiefly from differences in conclusions drawn from the magnetic condition of the alloy. They will not be adjusted until it has been settled whether iron can be magnetic in other than the α condition. Mr. McCance apparently denies that the iron in hardened steels is amorphous. It is not yet clear precisely what he means by the term "interstrain," and how it differs, if at all, from the term "internal tension," suggested many years ago by Metcalf and Langley.

Most significant of all is the fact that none of the above theories make use of β iron. This means that the controversy has essentially changed. It is no longer between the allotropists who laid chief stress on the postulated existence of a hard, stable, crystalline β iron, which was held to be primarily responsible for the hardness of quenched steel, and the carbonists, who denied this altogether, and ascribed the hardness to the action of carbon without, however, being able to explain it. The complete solution of the problem now appears to be bound up with the acquisition of a more intimate knowledge of the molecular combinations between iron and carbon in hardened steels and their variations in the hardening range of temperature. Stimulus to investigations of this character will no doubt be given by the substantial prize offered by Sir Robert Hadfield, the president of the Faraday Society, for the best research dealing with the combinations between iron and carbon. He has rendered an important service in directing attention to this difficult but neglected side of the subject.

H. C. H. CARPENTER.

AIR, CLIMATE, AND TUBERCULOSIS.[1]

IN October, 1891, Thomas George Hodgkins, of Setauket, New York, made a donation to the Smithsonian Institution the income from a part of which was to be devoted to "the increase and diffusion of more exact knowledge in regard to the nature and

[1] Smithsonian Miscellaneous Collections. Vol. lxiii., No. 1. Hodgkins Fund. "Atmospheric Air in Relation to Tuberculosis." By Dr. G. Hinsdale. Pp. x+136. (Washington: Smithsonian Institution, 1914.)

properties of atmospheric air in connection with the welfare of man." From this fund a prize of 300*l.* was offered in 1908 for the best treatise on the relation of atmospheric air to tuberculosis. Numerous essays were submitted to the adjudicators, and Dr. Guy Hinsdale, of Hot Springs, Virginia, was one of the successful competitors. His essay, enlarged and more fully illustrated, has now been printed in vol. lxiii. of the Smithsonian Miscellaneous Collections, Publication No. 2254. It is necessary to recite these details; otherwise it would be difficult to understand the *raison d'être* of such a work as that now before us, which is that of an enthusiastic specialist. It has its faults —many of them—it also has the virtues of its kind. It is an expanded essay. It contains an enormous amount of information; facts and figures abound, and anyone studying questions of climate, the effect of elevation, the condition under which moisture is precipitated, the action of sunlight and the like, will here find ample data for consideration. One cannot but feel, however, that to it might be applied with propriety the Scotsman's description of a "haggis" as "fine confused feeding." This is to be regretted, as one is constantly coming across evidence that if the author could only leave his authorities severely alone now and again and let us have the result of his own cogitations, a far more stimulating and quite as informative a book would have been the result.

Starting out from the Adirondack Forest, whither Dr. A. L. Loomis, of New York, sent patients in order that they might have the benefit of the purest and most invigorating air obtainable, and where Dr. E. L. Trudeau, who himself had benefited from the treatment, founded a cottage sanatorium in 1884, Dr. Hinsdale, after indicating the success of Dr. Trudeau's experiment, takes his institution as an example. He maintains that the condition of the atmospheric air may be of great importance in the successful treatment of tuberculosis, and that such pure air is to be obtained in the midst of an evergreen forest of more than 10,000 square miles. It was "common knowledge" in the days of Pliny that forests, especially those which abound in pitch and balsam, are beneficial to consumptives, or to those who do not gather strength after long illness, and that they are of more value than the voyage to Egypt (C. Plinii, Hist. Nat., lib. xxiv., cap. 6). Such forests are to be found in the Hartz Mountains and the Black Forest of Germany, in the Ardennes, the large American and Canadian forests, and in our own New Forest areas. Here the air is pure and moderately moist—an important feature, though one to which too little attention is paid—and the rainfall averages not too high, in order that patients may get out of doors during a considerable part of the year.

It appears that there is a slight excess of ozone in the air of forests, and this, of course, may be a factor in the treatment of consumptive patients, though it is maintained by some that ozone which, even in great dilution, irritates the lungs, the throat, and the frontal sinuses cannot be of much value in the treatment of such cases. The author ventures no opinion on this point, but quotes Lorrain Smith to the effect that oxygen which at the tension of the atmosphere stimulates the lung cells to active absorption, at a higher tension acts as an irritant and sets up inflammatory processes.

Perhaps the most important points brought out by Dr. Hinsdale in connection with forests and afforestation are that the work of raising, transplanting, and caring for trees is specially adapted to the strength of convalescent consumptives and that various forms of woodcraft, such as basket-making and the manufacture of small rustic articles, may easily be carried on under healthful conditions in the forest.

The site of a model sanatorium for consumption may, with advantage, be above the snow-line for some part, if not for the whole, of the year. Here there is less organic matter in the atmosphere, and, as demonstrated by Boycott and Haldane, it is the organic matter in the air and not an excess of carbon dioxide that gives rise to the discomfort, headache, etc., suffered in badly ventilated rooms; moreover, the anaphylactic phenomena corresponding to those noted in "horse asthma" or "stable asthma," may be avoided by changing the air even when considerable quantities of carbon dioxide are allowed to persist. It is interesting to learn that the consumptive daughter of the discoverer of oxygen, Dr. Joseph Priestley, was condemned to pass a considerable time in a cow-house in order that the diminished oxygen and increased carbon dioxide "might lower the inflammatory action associated with the disease." Dr. Beddoes, who had charge of the patient, thought that this treatment would not be acceptable to all his patients, "as it seemed to me hopeless to propose residence in a cow-house, I advised that the patient should live during the winter in a room fitted up so as to ensure the command of a steady temperature. This advice was followed. Double doors and double windows were added to the bedroom, the fireplace was bricked up round the flue of a cast-iron stove for giving out pure air." Dr. Hinsdale's comment on this note is that the doctor persisted in his plan of treatment until the patient died. Dr. Hinsdale, from his own experience, makes a further point on which sufficient attention had not been concentrated. It is not the expired air of tuberculous patients that carries infection, but the sputum and the tiny drops of moisture coughed by the patient that carry the bacilli and communicate the disease to others, but, be it remembered, that many of the bacilli carried into the nose, mouth, and upper air passages soon lose their activity or are extruded.

In his chapter on the influence of sea air the author mentions that Aretaeus, about 250 B.C., recommended sea voyages to the patient strong enough to endure them, for the cure of consumption, and that about three hundred years later Celsus prescribed a voyage from Italy to Egypt, or, failing this, that the patient should pass a large portion of his time sailing on the Tiber. Such treatment has fallen out of vogue, probably because long distances are now covered in such short periods that changes in temperature and atmospheric conditions occur far too rapidly, and the patient is unable to accommodate himself to them sufficiently rapidly. Patients who are fond of the sea and who have the opportunity of travelling in a sailing ship in roomy, well-ventilated cabins, and under medical supervision, even now receive great benefit from this treatment which, however, should not be used indiscriminately.

It would be difficult to follow the author through his disquisitions on warmth, moisture, fog, and the like, but it may be accepted that he favours quiet, bracing atmospheres, through which the sun's actinic rays can pass but little obstructed. These, he thinks, are to be found on high ground, where also expansion of the thorax almost invariably occurs, though, following our own surgeons who send their cases of surgical tuberculosis to Margate, he recommends sea air for such cases. High grounds, he maintains, are natural gymnasia where patients living out in the open air can *graduate* their exercise and form and absorb their own tuberculin. Dr. Hinsdale insists that rest is essential to the well-being of the patient during the febrile phases of phthisis, and that a patient must never *over-exercise,* as he is greatly tempted to do in clear, bracing climates. Finally, he comes to the very common-sense conclusion that when all is said and done it is the man behind the climate who is able to

treat a tuberculous patient with greatest advantage, and that even he can do little without the hearty co-operation of his patient.

Many interesting questions are raised by Dr. Hinsdale; he gives numerous excellent and interesting illustrations of shelters, of institutions, of methods of treatment, of the results of heliotherapy and immobilisation in plaster; he delineates patients before treatment, patients during treatment, in plaster jackets and in sun baths, and patients after treatment, and altogether makes us feel that the publication is what it pretends to be, a collection of data that will interest those engaged in the treatment of tubercular patients. With all this it is a constant matter for regret that the author has not put a little more of himself into his work. For what it is, however, we are grateful, and it may be anticipated that it will be very widely consulted.

THE BRITISH ASSOCIATION IN TASMANIA.

THE Tasmanian contingent of the British Association left Melbourne by the s.s. *Loongana* on Saturday, September 5, at 10.30 p.m., and arrived at Launceston about 5 p.m. on the following day. The party numbered twenty-one. Owing to an unfortunate dislocation in the boat service it was impossible to carry out the Launceston portion of the original programme, although time was found to visit the Launceston Museum on Sunday evening, under the guidance of the curator, Mr. H. H. Scott, to whose zeal and energy this excellent little museum owes so much. On the following day there was just time for a brief visit to the beautiful Cataract Gorge before leaving by rail for Hobart. Tuesday, September 8, was occupied by receptions at the Hobart Town Hall, the museum, and the university, and a luncheon at Government House, and in the evening Dr. G. T. Moody gave a lecture on some commercial aspects of education. Wednesday, September 9, was devoted to a motor excursion to Mount Wellington, the party being entertained at lunch at the Springs Hotel by the Hon. Henry Dobson, who has done so much to open up Mount Wellington as a tourist resort. Some of the party proceeded on foot from the Springs to the summit, while others devoted themselves to the collection of natural history specimens, including the remarkable "mountain shrimp," *Anaspides tasmaniae*, so characteristic of the mountain streams of the island.

On Thursday, September 10, the party divided for several excursions in the neighbourhood of Hobart, including a dredging trip to the D'Entrecasteaux Channel, which resulted in the collection of much interesting material. On the following day they left for Maria Island, on the east coast, proceeding by motor as far as Spring Bay, whence the crossing to the island was made by motor boat. Maria Island is celebrated as the scene of a former convict settlement, and afterwards of various industrial experiments of the "wild-cat" type, in which much capital appears to have been sunk. The limestone rocks, of Permo-Carboniferous age, are crowded with fossils, which may be collected in unlimited quantity both in the "Fossil Cliff" on the shore and in an extensive quarry excavated to supply the now defunct cement works. Perhaps the most conspicuous of the fossils in the cliff is the large bivalve Eurydesma, but numerous others occur in profusion. A dredging trip in the neighbourhood of the island, in about 20 to 25 fathoms of water, yielded an enormous profusion of sponges in great variety, including some very remarkable and novel Calcarea. On the island itself numerous land planarians were collected, and the botanists were delighted to find the curious Tmesipteris growing upon tree-ferns.

The party left Maria Island early on Sunday, September 13, and after crossing to Spring Bay visited the kitchen middens at Little Swan Port. These were found to consist almost entirely of immense quantities of oyster-shells, forming a deposit several feet in thickness, and extending over a good many acres. The curiously rough chipped "flints," so characteristic of the Tasmanian aborigines, were found here in abundance. After lunch at Spring Bay the party motored back to Hobart through very beautiful scenery. This concluded the main part of the programme, but the zoological visitors remained by special invitation to take part in a collecting expedition to the Great Lake. Before leaving Hobart on this trip Prof. Dendy gave an address to the Royal Society of Tasmania on progressive evolution, and Dr. W. M. Tattersall delivered a public lecture on the depths of the sea. A visit was also paid to Mrs. Roberts in Hobart, whose collection of living Tasmanian and other animals excited much interest, two "native devils" (Sarcophilus) with young ones being particularly admired.

The party for the Great Lake started from Hobart on the morning of September 16 in three motor cars, and reached their destination the same evening. It had been hoped that they would be able to obtain a good deal of marsupial and monotreme material for the committee appointed by the council of the British Association for that purpose, but these hopes were only very scantily fulfilled. No monotremes were seen, though tracks and burrows of Ornithorhynchus were found on the shore of the lake, and only a very few wallabies and rat kangaroos were obtained to represent the marsupials. The invertebrate fauna of the neighbourhood, however, yielded a large number of extremely interesting specimens. The shrimp-like Paranaspides was obtained in quantities by dredging in the lake, and under the stones along the shore were found Phreatoicus, numerous freshwater planarians (one of remarkably large size), etc.

The forest around the lake has unfortunately been ravaged by fire, but laborious turning over of the fallen timber yielded many most interesting cryptozoic animals, including the land nemertine (*Geonemertes australiensis*), which was fairly common, a number of species of land planarians, and several specimens of the rare Tasmanian Peripatus (*Ooperipatus insignis*). The visitors returned to Hobart on September 22, and some of them left Launceston for Melbourne by the s.s. *Rotomahana* on the following day.

In every respect the Tasmanian visit must be regarded as a very great success. The thanks of the visiting members are due to all who contributed so generously to this result, and especially to his Excellency the Governor of Tasmania (Sir W. Ellison-Macartney) and Lady Ellison-Macartney, to the Premier and other members of the Government, to local scientific men, such as Mr. R. M. Johnston, Mr. Rodway and Mr. May, and, above all, to Prof. T. Thomson Flynn, the able and energetic organiser of the visit. A. D.

AUSTRALIA AND THE BRITISH ASSOCIATION.[1]

IT is just one hundred and forty-four years since the first scientific expedition from Great Britain to Australia visited Moreton Bay. The expedition consisted of his Majesty's barque *Endeavour*, a vessel which had been built for the coal trade and was chosen because she was an excellent sea-

[1] Concluding discourse delivered before the British Association at Brisbane on August 31 by Sir Edward Schäfer, F.R.S.