longest two migrations, 615 miles or 990 km. (to the River Tweed) and 450 miles or 724 km. (to the Conon River), were accomplished in 47 and 31 days, respectively, or at the rate of 13.1 miles (21.1 km.) and 14.5 miles (23.3 km.) per day, respectively.

These experiments have clearly indicated a substantial movement of salmon north-westwards along the coasts of County Antrim, a result which was somewhat unexpected.

¹ See Menzies, W. J. M., "The Stock of Salmon" (London: Edward Arnold and Co., 1949).

TAXODIACEOUS CONIFERS*

IT is seven years since the discovery was announced of living *Metasequoia* in China, and already the elegant saplings are familiar. It is but ten years since Miki first distinguished the fossil genus from the Japanese Tertiary.

We now learn that *Metasequoia* was the chief Taxodiaceous conifer, and no doubt a forest dominant, over a great part of the northern hemisphere, especially North America and not merely in eastern Asia. It is surprising that it awaited discovery so long, for its fossil shoots were figured more than eighty years ago, and hundreds have been studied in more recent times. Its most obvious distinguishing character, its opposite leaves, are easily recognized in a fossil; but for some reason this character was either missed or ruled out as unimportant. The first to recognize it properly was Endo in Japan in 1928 (who based a species on this character), and Miki later found additional differences in shoot, in cone and in structure, and rightly distinguished it generically.

There are three fossil Taxodiaceous genera with rather similar foliage: true *Sequoias* resembling *S. sempervirens*, *Metasequoias* resembling *M. glyptostroboides* and true *Taxodiums* resembling *T. distichum*. Chaney shows that the three genera are easily distinguishable by several macroscopic characters. Before the recognition of *Metasequoia* the confusion was grievous since the numerous fossil *Metasequoia* specimens were forced into the two remaining genera, spoiling both. The confusion does not exist in Europe because, apparently, *Metasequoia* never grew here (unless a few pollen grains represent it). However, Chaney leaves us nothing to be complacent about; he makes it clear that the old descriptions of our Tertiary *Sequoias* are too bad for anyone to use nowadays, and he does, in fact, neglect them in his comparisons.

According to Chaney, *Metasequoia* has two American species, one less abundant in the Cretaceous, the other, *M. occidentalis*, being abundant in the older Tertiaries but disappearing in the Miocene. He cites fifty references to the Tertiary species, half under the names of five species of *Taxodium*, the other half under six species of *Sequoia*. The most abundant true Tertiary *Sequoia* has only twenty-five records under five specific names, but *Taxodium dubium* does better with forty records under seven species of *Taxodium*, five of *Sequoia* and a few others. A paper which reduces names like this is a joy. Even these remaining names are of doubtful status since some of the fossils may be identical with the living species or with the European fossils.

* A Revision of Fossil *Sequoia* and *Taxodium* in Western North America based on the Recent Discovery of *Metasequoia*. By Ralph W. Chaney. *Trans. Amer. Phil. Soc.*, N.S., 40, Pt. 3 (1951).

Many respected palaeobotanists are exposed in Chaney's gallery of those who made the mistake of confusing *Metasequoia* specimens with the other two genera. He singles himself out for obloquy; but this seems unfair—palaeobotanists are no worse than other people at missing what ought to be obvious.

Chaney spares no trouble in his work; it is therefore the more interesting that he makes no use of microscopic characters. Most Tertiary palaeobotanists shun the microscope, and I gather from other sources that they secretly believe that the Mesozoic palaeobotanists have gone mad in pursuit of the very minute. It may well be so, for I at least, while admitting that Chaney's macroscopic characters for the discrimination between these species are convincing, would have been happier had he included their epidermal cells.

This paper deals with a noble subject, the history of the world's greatest trees, and it rises to the grand manner. The treatment is both interesting and charming, and I would recommend anybody who has to revise a confused group to see how Chaney has done his work.

TOM M. HARRIS

BRITISH IRON AND STEEL RESEARCH ASSOCIATION, 1946-50

ESTABLISHED in 1945, the British Iron and Steel Research Association got off to a more-or-less flying start, as a result of its connexions with the research committees of the Iron and Steel Institute, with which the late Dr. W. H. Hatfield was so intimately concerned. An impressive account has now been published by the Association of the results of the first five years of its activities*.

The Association is divided into six sections, dealing respectively with the manufacture of iron, the production of steel, mechanical working, steel castings, plant engineering and metallurgy.

Starting off at the very beginning of the industry's work, an operational study has been made of the transport of the raw materials to, and within, the works. The output of the furnaces has received similar attention, and it has been shown that the time to melt the charge in an open-hearth furnace is the shorter when the furnace is charged steadily than when a considerable weight is put in at one time. The preparation of the materials for the blast furnace is now recognized as one of the most important factors in its efficient performance, and work has been carried out on the crushing and screening of the ores, etc. Increasing supplies of fine-grained concentrates present a problem, as conventional sinter plants can only deal with them at the expense of a reduction in output. Work, therefore, is in progress on other techniques of agglomeration, particularly 'pelletizing', which consists in passing fine ore of suitable size, distribution and moisture content through a rotating drum, in which balls or pellets are formed and grow by a snowball effect; the pellets are then fired, to give adequate strength for use in the blast furnace. The experience already gained has justified the erection of a pilot plant.

In connexion with the manufacture of iron, the knowledge of the actual and relative velocities of the gas is important, for example, in assessing the advantages of the development in the United States

* Five Years of Co-operative Research, 1946-1950. Pp. 24. (London: British Iron and Steel Research Association, 1951.) Free.

of high top pressure, the effect of which is to make the gas travel more slowly, thus giving more time for the reactions between the reducing gases and the burden. Radioactive gas has been used for measuring the velocity of the gaseous flow through the furnace, the radon being projected into one tuyère by a small explosive charge. As a result of these experiments it has been found that the gas takes about seven times as long to pass through the furnace as had previously been thought. The effect of injecting lime through the tuyères of the blast furnace on the control of the slag has also been examined. Normally, when lime is added at the top, the time-lag between the addition and its effect on the slag is something of the nature of six to eight hours. With tuyère injection the delay is reduced to one to two hours, and as much as three tons of lime have been introduced in two and a half hours through half the tuyères, without detriment to the hearth or any significant change in the lime content of the flue dust.

A simplified and more efficient open-hearth design, termed the 'single uptake' furnace, has been developed. The idea of a single air-uptake terminating immediately below the gas port, although not new, seems hitherto not to have received serious study. Small-scale trials have led to most promising results, and there are now eighteen such furnaces in operation in at least eleven steel-works, and more are being installed. The design leads to increased production, better control of the melting operations, and a smaller consumption of fuel and refractory materials.

As a result of the increasing use of instrumentation in open-hearth furnaces, there are already in Great Britain at least six firms which are using automatic control in open-hearth melting shops to a considerable degree, and the performance has been so satisfactory that other similar installations are being planned.

The value of oxygen enrichment in steel-making has been the subject of considerable work, particularly in the refining of stainless steel in arc furnaces, a practice which can be economic even at the present cost of liquid oxygen. This makes it possible to raise the bath to a considerably higher temperature, with a resulting reduction in the loss of chromium; and charges consisting of all stainless-steel scrap are now being regularly refined. Oxygen is also being used in the arc furnace for refining plain carbon steels, and in the production of 4 per cent silicon transformer steels, with economies in time, current and electrodes. The oxygen content of the blast of the basic Bessemer converter may be increased to 24 per cent, the time of the blow being shortened, the quantity of scrap used increased, and the nitrogen content of the steel significantly reduced.

The importance of economies in the consumption of ingot moulds will be realized from the estimate that the steel industry, even after allowing for the value of the scrap, spends £4,500,000 a year on such moulds. It has been shown that the setting of the moulds too closely together in the casting pit has an excessively detrimental effect, the life of a mould being increased by 50 per cent simply by setting two moulds on each bogey in place of three.

In steel-making, as in the production of iron, practical studies need the support of fundamental work, and reports have been published on the thermodynamic background against which existing processes may be checked or new ones developed. Theoretical and experimental studies have been made of the relationship between carbon and sulphur in iron, the mechanism of the transfer of sulphur from furnace

gases to metal, and of slag compounds in the refining of steel. Heat transfer by radiation from the flame is being examined in an open-hearth furnace made available by the Royal Dutch Steel Works, for joint trials by scientific workers from France, Holland, Sweden and Great Britain, while the size of the carbon particles responsible for the luminosity of flames and the ignition and combustion times of heavy fuels are being examined in the Association's own laboratories.

With regard to the hot fracture of castings due to cooling stresses, which has been found to occur normally round 1,400° C., it has been shown that although most normal alloying elements, when added in small quantities, increase this susceptibility to tearing, larger additions of chromium, molybdenum, titanium and vanadium reduce it. Silicosis in foundries has been studied, in collaboration with the Ministry of Labour's factory inspectorate, and pathological studies have been carried out on the effects of various materials present in foundry dust. The possibility of continuous casting or the fabrication of semi-finished steel directly from the liquid metal has attracted the steel industry for many years, and a small-scale apparatus casting bars up to 3 in. in diameter has been built and operated successfully. A detailed study of solidification-rates has been completed, and it appears probable that in the first instance the process will be rendered practical for the production of alloy steel.

Work on the rolling of steel has resulted in the development of roll force-meters for measuring loads up to 600 tons under the difficult conditions existing in the works. This instrument has made possible considerable developments in automatic control, particularly of the thickness of the strip. Considerable interest has been shown in Great Britain and the United States in methods of 'die-less' drawing, that is, the stretching of the wire between drums revolving at different speeds. Although the Association's experiments have, as yet, only reached an early stage, encouraging results have been obtained, both with steel and copper wire.

In connexion with the work on surface coatings, a method of regenerating fresh sulphuric acid from the spent liquor of the pickling bath has been developed, and a pilot-scale plant is now being built. Economic appraisal of the process on a large scale suggests that it should result in substantial savings and in conservation of sulphur.

Research on the heat-treatment of steel has resulted in the publication of "The Atlas of Iso-Thermal Transformation", in which are given the *S*-curves of many steels. The very large number of observations required meant that this publication could only have been produced by the co-operative effort of many laboratories; and it is clear that here, as in all the Association's work, such collaboration of the individual works and the assistance of their scientific personnel has made the achievements of the past five years possible.

Work on steels for high-temperature service in steam plants, on methods of analysis, corrosion, the brittle fracture of mild-steel ship plates, fundamental researches on brittleness, X-ray methods for following directly the change of structure of a steel during transformation, and a high-temperature microscope with a magnification up to 500 and working up to 1,000° C., are some of the other aspects of the Association's activities which are here summarized.

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