STATE AND PROPERTIES OF METALLIC SURFACES

PARIS CONFERENCE

IN August 1942 the French Ministry of Industrial Production established an organisation for the study of metallic surfaces with the title "Commission technique des états et propriétés de surface des métaux". This commission, under the presidency of Prof. A. Portevin, was able to produce several valuable reports even during the enemy occupation, the most notable being a finely illustrated memoir on the structure and properties of anodically oxidized surfaces of aluminium and its light alloys. During October 23–26, 1945, a conference on the subject was held in Paris, partly in the chemical theatre of the Sorbonne and partly in the lecture hall of the Palais de la Découverte. The conference was well attended throughout, the membership including a number of foreign delegates, and more than thirty papers were presented. M. Louis de Broglie, M. Joliot-Curie, M. A. de Gramont and M. J. Pérès were among those who presided over sessions. It should be said that the organisation was very efficient and that good discussions followed many of the papers. The poor acoustic qualities of the temporary hall in the Palais de la Découverte made it difficult for those at the back to hear, but that building was chosen on account of an exhibition of apparatus and results concerned with surfaces which was held in the Palais during the conference.

The communications covered the examination of metallic surfaces by means of the electron microscope, X-ray and electron diffraction, and the optical microscope; the estimation of the degree of surface finish by mechanical and optical means; the capillary and electrical properties of surfaces; corrosion; and the effect of surface conditions on friction and fatigue. Much use was made by the French workers of the method of electrolytic polishing introduced by M. P. Jacquet, who gave an account of recent developments of this technique and showed how it may be used to reveal structural details in age-hardening light alloys, not brought out by other methods of preparation. A communication sent by Dr. M. L. V. Gayler, of the National Physical Laboratory, also dealt with this point. Reference was made to the use of electrolytic polishing in industry, one of the objects being to produce a surface favourable to a high resistance to fatigue. M. Mondon showed that when this method of finishing is employed for piston rods, the resistance to fatigue increases progressively with the tensile strength, without the falling-off usually observed with the harder steels.

Developments in the technique of the electron microscope were described by Prof. Dupouy. Films of collodion were used to study the etch-figures produced by the action of different reagents on metallic crystals. Thus hydrochloric acid develops cubic facets on aluminium, whereas dry hydrogen chloride gives octahedra and electrolytic etching gives rounded forms. On aluminium of the highest purity the cubic facets bear pyramidal markings which are not seen on slightly less pure material. Photographs taken at glancing incidence and others obtained by a scanning method were exhibited, and these devices may be capable of further development.

The properties of the Beilby layer formed on the surface during the process of mechanical polishing have been studied by M. Grumbach and by M. Taboury, both of whom made use of the electrostatic properties of the surface. The thickness of the layer was found to increase with the time of polishing. M. Bénard exhibited detailed studies of the orientated layer of minute crystals immediately underlying the Beilby layer.

M. P. Lacombe showed a remarkable series of photomicrographs of films formed in the anodic oxidation of aluminium and its alloys in a solution of oxalic acid, stripped from the metal by means of the electrolytic polishing solution. Such films follow exactly the contours of the surface and reveal interesting details of the intergranular boundaries.

In the course of the discussion on methods of evaluating the degree of surface finish, the diversity of the instruments used in different laboratories was noteworthy. Both mechanical and optical devices are used, the former mostly depending on a tracer point, the vertical movements of which are highly magnified relatively to the horizontal. The principles of these methods and of those which, by using some physical property, give an integrated result, were discussed by Eng. Général Nicolau. Mr. Reason, describing the methods used by Messrs. Taylor, Taylor and Hobson, pointed out that each method only measures some special property and does not give a general value for the degree of finish. Both the larger and the smaller variations of surface affect the wear of, for example, a piston. Measuring instruments using a stylus were described by M. Wessel of the S.K.F. Co., in Sweden, and by Mr. Timms of the National Physical Laboratory. Mr. Hopkins, also of the N.P.L., described the use of the correlogram. In the summing-up at the close of the conference, Prof. Chaudron concluded that micro-geometric methods are not yet adequate to predict the properties of surfaces.

M. Mauzin suggested that the measurement of the coefficient of friction was useful in evaluating surface finish, and M. Pomey described an apparatus for measurements of friction under high pressures, using the torque developed when a disk is rotated under an arrangement of three steel balls. Experiments on the capillary properties of metallic surfaces were described by M. Morlock. Paraffin spreads on a mechanically polished surface at the rate of several millimetres a day, the drop being surrounded by a monomolecular layer. When a polished platinum surface is heated, the Beilby layer re-crystallizes and paraffin no longer spreads. There is no spreading on an electrolytically polished surface, but either etching or sandblasting restores the spreading property. The fields of force of metallic crystals are much higher than those of other solids or of amorphous metal.

The determination of the hardness of a superficial layer or of an applied coating such as an electrolytic deposit presents difficulties. An indentation tool, such as the Vickers diamond, penetrates too deeply, and M. Bastien showed that an oscillation method, such as the use of the Herbert pendulum, gives the best results, which are independent of the degree of finish if the metal is not too hard. On such a material as mild steel the exact shape of a Vickers diamond impression may be used to give the profile of the scratches produced in grinding or polishing.

On the subject of corrosion, Miss Palmaer, of Stockholm, exhibited a series of potential curves and discussed their various forms. Dr. U. R. Evans sent a paper describing the Cambridge work. Other communications were received from Prof. G. I. Finch on the results of electron diffraction experiments, and

from Dr. Ros on the raising of the fatigue limit by improving the perfection of the surface of machine parts. The writer presented a note on fretting oxidation, suggesting that it was more likely that oxygen was forced into combination with iron by the very high local pressures in bearings, and that the oxide was then stripped off, than that metal was first removed and then oxidized.

After the close of the meeting, some of the foreign visitors had the opportunity of inspecting the fine new Laboratoire Central des Traitements Chimiques at Vitry-sur-Seine, established by the Centre National de la Recherche Scientifique and occupying a large new building. Much of the very fine equipment was hidden during the German occupation. There is a staff of energetic young workers under the direction of Prof. Chaudron. The high quality of the microscopical work is notable, especially in the study of the light metals. Electrolytically polished surfaces, strained to produce slip bands and then etched, show sharp etch figures indicating the orientation. Such figures can also be used to demonstrate the mosaic structure in single metallic crystals. Apparatus for estimating oxygen in steel by the method of hot extraction in a vacuum, similar to that of the National Physical Laboratory but employing radio frequencies, also attracted attention. Both from the quality of the original contributions presented and as indicating a resumption of collaboration between France and other countries, the conference must be regarded as highly successful. C. H. Desch.

AVIAN EVOLUTION IN NEW ZEALAND

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ALTHOUGH the Ratite birds of New Zealand have been the subject of intense osteological study ever since Owen received the first bone of *Dinornis*, a considerable interval has elapsed since the Carinate orders received the attention which they warrant. Some twelve years ago Lowe in an extensive memoir[1] gave reasons for believing the penguins to have arisen independently from reptilian ancestors, and to have specialized from the beginning as aquatic animals. More recently, the same writer reaffirmed this view in a paper[2] in which he discounts the belief that *Archæopteryx* and *Archæornis* were birds. In other recent papers Lowe has presented a considerable amount of anatomical data supporting the conclusion that the Ratites are of primitive stock which never possessed the power of flight, nor consequently the keeled sternum[3,4]. These papers, however, did not deal particularly with evidence from New Zealand, though the deductions are of special interest there. It is therefore certain that zoologists will welcome the two important papers by Dr. W. R. B. Oliver, director of the Dominion Museum, in which he brings to bear upon the problem of the phylogeny of New Zealand birds the evidence he has obtained from a close study of their skulls[5,6].

Dr. Oliver tackles the problem from the aspect of comparative anatomy of living and recently extinct types, for indeed, as he points out, so little is known of early precursors that no other course is at present open. The splendid series of photographs (by J. T. Salmon) and the line illustrations of cranial bones, with the accompanying descriptions, are in themselves a worthy contribution to the subject, while the phylogenetic conclusions will warrant the close attention of those interested in ornithology. In a review of this length it is, of course, impossible to do justice to the paper; but some of the more interesting conclusions may be indicated briefly, particularly where these diverge from views previously expressed by overseas writers.

Gregory and Murphy[7] have taken the view that the Ratites arose from Proto-carinate ancestors. Archey[8], while supporting this view, admits, however, the primitive nature of their palate. Oliver, on the other hand, regards the Ratites as having arisen side by side with the Proto-carinates, both being derived from neornithid stock. He regards the vomer in the moas as the most primitive type found in birds, and in connexion with the vexed problem of the evolution of the Ratite sternum, his views are worth quoting. Pointing out that there is no evolutionary sequence in which Ratite sterna can be arranged, he states: "It is more than doubtful that this (keel-less) condition could be attained by the loss, through disuse of the pectoral muscles, of a keel such as is found in Carinate birds. For in those genera in which the keel has been reduced almost to vanishing point, namely, *Aptornis*, *Notornis*, *Strigops* and *Chemiornis*, there are rudiments of the keel and, in *Aptornis* and *Notornis*, considerable narrowing of the body of the sternum. These examples show the end of a cycle of evolutionary growth and are unlike the type found in Ratites, which consequently may be regarded as representing the early stages of the cycle. It is in this way that I think the evidence for the Ratite keel-less sternum being a primitive form should be stated."

Dr. Oliver disagrees with Lowe's deductions on the primitive nature and independent evolution of the penguins. He points out that the palatine anatomy of the penguins he has examined would suggest an advanced (that is, late) stage of development, especially in the case of the vomer. He suggests that the apparently primitive features of these birds may well be due to secondary simplification. He also differs from some other zoologists in that he regards the rails and cranes as having arisen from the same stock. Thus he is able to retain *Aptornis* in the latter order, accounting for such crane-like characters as it shows through a common ancestry. On skeletal characters he concludes that *Aptornis* diverged early from the remainder of the rails, the latter giving rise in turn to *Notornis*, and as a separate branch, the gallinules.

In adopting the osteological features of the palate as a basis of classification, Oliver finds that the sixteen genera of New Zealand Passeriformes fall into five main groups. Evidence is presented for believing the native thrushes (*Turnagra*) to be less closely related to the Turdidæ than was formerly thought, being allied rather to the crow shrikes. Another interesting proposition advanced with supporting osteological evidence is that the parrots may be more closely related to the Coraciiformes than to the Accipitriformes.

[1] Lowe, P. R., *Proc. Zool. Soc. Lond.*, 2, 483 (1933).
[2] Lowe, P. R., *Ibis*, 517 (1944).
[3] Lowe, P. R., *Proc. Zool. Soc. Lond.*, B, 112, 1 (1942).
[4] Lowe, P. R., *Ibis*, 37 (1944).
[5] Oliver, W. R. B., *Emu*, 45, 55 (1945).
[6] Oliver, W. R. B., *Emu*, 45, 119 (1945).
[7] Gregory, W. K., and Murphy, R. C., *Proc. Linn. Soc. New York*, 45 (1934).
[8] Archey, G., *Bull. Auck. Inst. Mus.*, 1 (1941).