of germ-cells in the animal body, to which Weismann attached so much importance. The fact is that the constitution of the higher plants and of the higher animals is in this, as in many other points, radically different, and arguments from one to the other are dangerous in the extreme. Those who interest themselves in evolutionary questions do not, I think, sufficiently realise that the utmost that can be claimed is analogy between the higher terms of the two kingdoms. Their phyletic separation certainly dates from a period prior to that of which we have any knowledge from the fossil record. Let us give full weight to this fact, as important as it is indisputable. The early definition of germ-cells in the animal body will then count for nothing in the evolutionary problem of plants. Moreover, we shall realise that the plant, with its late segregation of germ-cells, will present the better field for the inquiry whether, and how far, the environment may influence or induce divergences from type. From this point of view the widespread opinion among botanists that the environment in some sense determines the origin and nature of divergences from type in plants should command a special interest and attention.

I must now draw to a close. I have passed in review some of your more notable plants, and pointed out how the Australasian flora, whether living or fossil, includes in unusual richness those evidences upon which the fabric of evolutionary history is being based. I have indicated how this history in certain groups is showing ever more and more evidence of parallel development, and that such development, or convergence, presses upon us the inquiry into the methods of evolutionary progress. The illustrations I have brought forward in this address clearly show how important is the positive knowledge derived from the fossils in checking or confirming our decisions. Palæophytology is to be prized not as a separate science, as, with an enthusiastic view restricted between blinkers, a recent writer has endeavoured to enforce. To treat it so would be to degrade it into a mere side alley of study, instead of holding it to be the most positive line that we possess in the broad avenue of botanical phylesis. An appreciation of such direct historical evidence is no new idea. Something of the same sort was felt by Shakespeare three centuries ago, and it remains the same to-day. Nay, more: it may lead us even to forecast future possibilities. In following our evolutionary quest in this spirit we shall find that we are indeed—

> "Figuring the nature of the times deceased
> The which observed, a man may prophesy
> With a near aim, of the main chance of things
> As yet not come to life."
>
> (King Henry IV., Part II, Act iii., Scene i.)

THE WIDMANSTATTEN STRUCTURE IN VARIOUS ALLOYS AND METALS.[1]

The surface of meteoric iron after polishing and etching in the way usually adopted, prior to examination under the microscope, shows characteristic figures which are for the most part triangles or parallelograms. These figures were observed for the first time in 1808 by M. Alois de Widmanstätten, the director of the Imperial Porcelain Works at Vienna on the Ilraschina meteorite, and although Widmanstätten himself had published nothing regarding his discoveries, a knowledge of them spread very quickly, and what he had seen were soon universally known under the name of "Widmanstätten figures." It was then generally considered that these figures were characteristic of meteoric iron and that they were not found in terrestrial iron. Guillet-Laumont[2] in 1813 already saw an analogy between the two varieties of iron; but the majority of investigators for a long time were of a different opinion, and the views of Guillet-Laumont were forgotten.

Fig. 1.—Widmanstätten Structure in Carbon Steel (Carbon 0·55 per cent.). Alloy No. 8. Magnified 8 diameters.

The interest in meteorites shown by Dr. Sorby, the founder of the science of metallography, and especially the brilliant researches of Osmond, led anew to attention being directed to the figures of Widmanstätten. Thus it was that in 1900 M. Osmond announced the discovery in the head of a steel ingot of equilateral triangles which recalled, he said, "the figures of Wid-

[1] Paper presented to the Institute of Metals for the September meeting by Capt. N. T. Belaiew (Michael Artillery Academy, Petrograd). Translated from the French of the original MS. of Capt. Belaiew, and, in consequence of the European War, not since revised by him.

[2] Cohen, *Meteoritenkunde*, 1894, vol. i., p. 41.

manstätten, which are known to belong to the regular octahedral system."[3]

In a previous paper[4] the author described a steel containing 0·55 per cent. of carbon, prepared in 1908 at the works of Igewsky in accordance with the directions of the author. This steel showed throughout its mass beautiful Widmanstätten figures, which were so developed that they were perfectly visible to the naked eye (Fig. 1). The analogy between the structure of the alloy and that of the meteorites was so close that the author considers that it may be regarded as a synthetic production of a meteoritic structure, and that it is fair to refer to this structure as the Widmanstätten structure (Figs. 2 and 3).

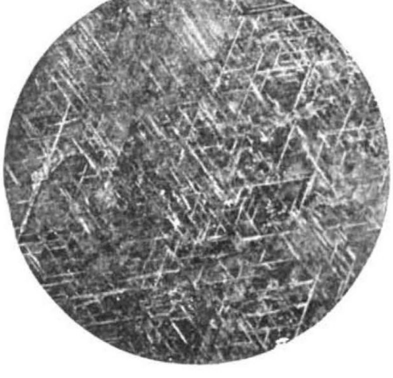

FIG. 2.—Widmanstätten Structure in Taze-well Meteorite. Section parallel to the Surface of the Octahedron. Magnified 6 diameters and slightly reduced.

FIG. 3.—Widmanstätten Structure in Carbon Steel (Carbon, 0·55 per cent.). Alloy No. 8. Magnified 9 diameters and slightly reduced.

FIG. 4.—Swedish Iron heated to the point of Incipient Fusion (Osmond, "Sur la Cristallographie du Fer"). Magnified 16 diameters.

Not only could the meteoritic structure be henceforth artificially reproduced at will, but the crystallisation of iron as well as its crystallography could be easily studied from such examples.

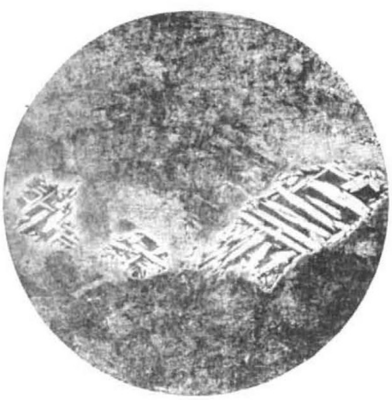

FIG. 5.—Widmanstätten Structure in Bronze, containing 55·1 per cent. Copper. Cooled in Sand and Annealed (L. Guillet, "Les Laitons au Nickel"). Magnified 30 diameters and slightly reduced.

FIG. 6.—Widmanstätten Structure in Alloy of 90 per cent. Platinum and 10 per cent. Aluminium (Chouriguine, "Sur les alliages du Platine avec l'Aluminium"). Magnified 50 diameters and slightly reduced.

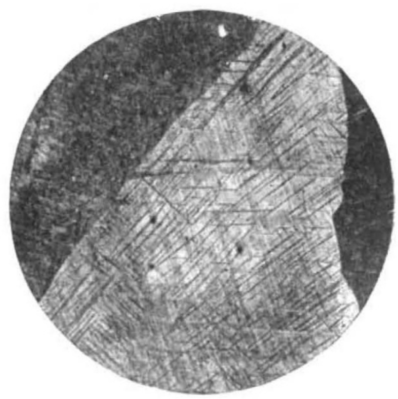

FIG. 7.—Widmanstätten Structure in Zinc, cast and cooled slowly (G. Timothéieff). Magnified (?) diameters and slightly reduced.

Although the question of the conditions which led to the appearance of this structure seemed extremely interesting, nevertheless it was considered wise to leave it on one side for the moment and to commence with what might be termed a more or less detailed "morphological" examination. From this it was not difficult to see that the character of the Widmanstätten figures changed several times in a given area, sometimes showing triangles, sometimes squares, but they are precisely the figures that would be expected in different sections of a regular octahedron the four systems of cleavages of which were parallel to the four pairs of its surfaces, an arrangement known for a long time in the case of meteorites.[5] Thus it was the octahedral crystallisation of iron which was made manifest by the distribution of the structural elements between the cleavage planes during the recrystallisation.[6] The octahedral crystallisation of alloys of iron is generally admitted,[7] and the greater part of the iron-carbon diagram belongs to the type of diagrams

[3] "Sur la Cristallographie du Fer," Paris, 1900, p. 24, figs. 24 and 25. The same observation was made in 1905 by Profs. Arnold and McWilliam in their memoir, "The Thermal Transformation of Carbon Steel," Journ. of the Iron and Steel Institute, 1905, No. II., p. 35.

[4] "Sur la reproduction artificielle de la structure de Widmanstätten dans ier au carbone," N. T. Belaiew, *Revue de Métallurgie*, 1910, p. 510.

[5] See Figs 7, 8, 9, 10, 11, 12, and 13, in the previously mentioned paper they are also reproduced in M. Sauveur's book, "The Metallography of Iron and Steel," Lesson x., figs. 7–13.

[6] "When a liquid or solid deposits successively several solid phases, the secondary and tertiary deposits often preferentially lodge between certain of the cleavage planes (plans cristallographiques) of the primary deposit, and thus illustrate its structure." "Sur la Cristallisation du Fer," Osmond et Cartaud, *Revue de Métallurgie*, 1906, p. 658.—*Note by* Editor, Proc. Inst. of Metals.

[7] See also "Sur la crystallisation et structure des aciers refroidis lentement," N. T. Belaiew, *Revue de Métallurgie*, 1912, p. 321.

in which there is recrystallisation in the solid state.

Following the brilliant theory of Osmond, the alloys of iron and of nickel in the case of meteorites ought to follow an analogous diagram.

Not long since this theory was entirely confirmed by the beautiful experiments of Benedicks. We see that in the two cases, in that of meteorites as well as in that of terrestrial iron, the appearance of these Widmanstätten figures is connected with two fundamental facts—the character of the primary octahedral crystallisation, and the separation of the solid solution into different phases during recrystallisation.

This structure, therefore, is not in the least confined to iron and its alloys; it might be equally well encountered in each alloy or each metal which crystallises in the regular system, and in which, after solidification, the crystallised solid solution throws out secondary deposits, that is to say, is subject to recrystallisation. In a pure metal there would be an allotropic change in the solid state, as, for example, the iron shown in Fig. 4—in an alloy, the separation of a new phase; and as diagrams of this kind are well known, it ought not to be at all difficult to find examples of the Widmanstätten structure in alloys other than iron.

To this class of alloys belong, for example, the different alloys of copper, particularly the brasses and bronzes. Gulliver, in his interesting volume on metallic alloys,[8] gives numerous examples of this, mentioning the separation of $SnCu_3$ in the alloys of copper and tin, of $SbCu_2$ in those of copper and antimony, of the constituent beta in brasses with about 35 per cent. of zinc (see Gulliver, Fig. 200), or of delta in the alloys with 70 to 75 per cent. of zinc (see Gulliver, Figs. 205 and 206). The author is able to reproduce here a photograph (Fig. 5) of a brass containing 55·1 per cent. of copper (cooled in sand and annealed), which was kindly sent to him by M. L. Guillet. This photograph has great interest, as it shows the action of reheating on the Widmanstätten structure.

Fig. 6 serves as another example of this structure, for which the author is indebted to M. Chouriguine; it represents an alloy of platinum-aluminium. M. Chouriguine,[9] in studying these alloys, found a transformation in the solid state, and this transformation manifested itself in a very marked Widmanstätten structure.

It is perhaps useful to remark that the first condition, that is to say, the primary octahedral crystallisation, is not difficult to find, for the majority of metals and alloys crystallise either in the regular or in the hexagonal system. In the last case the character of the Widmanstätten figures may differ in detail whilst preserving the same general aspect, as can be seen from Fig. 7,[10] representing a sample of zinc after melting and slow cooling.

These few examples, though taken somewhat haphazard, serve nevertheless as illustrations of the great extent to which the Widmanstätten structure exists in different alloys and metals. In the alloys of iron the Widmanstätten structure has an important industrial interest, as it gives rise to very poor mechanical properties in the case of cast steels and in overheated steels.

The chief object of this brief communication is to direct the attention of metallurgists and engineers to the study of alloys, other than iron, from the point of view of the production and the removal of the Widmanstätten structure.

8 "Metallic Alloys," G. H. Gulliver.

9 "Sur les alliages du platine avec l'aluminium," by M. Chouriguine. *Revue de Métallurgie*, 1912, p. 8735.

10 This photograph was taken by M. Timothéieff.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BELFAST.—Prof. R. H. Yapp has been appointed professor of botany in the Queen's University, Mr. C. W. Valentine professor of education, and Sir Hiram Shaw Wilkinson pro-Chancellor of the University.

GLASGOW.—Dr. W. J. Dilling, of Aberdeen, has been appointed to the new "Robert Pollok" lectureship, for research in materia medica and pharmacology, at the University of Glasgow.

The University Court has given leave of absence to Mr. A. Stevens, assistant in the department of geography, in order that he may accompany Sir Ernest Shackleton's Antarctic Expedition as geologist. The Court has also placed at his disposal a petrological microscopic equipment for the purposes of the expedition.

Temporary arrangement have been made for carrying on the work of a considerable number of the lecturers, assistants, and examiners, who, in consequence of the war, are absent on duty or detained abroad.

DR. D. A. CAMPBELL, of Halifax, has, says *Science*, promised 12,000*l.* to endow a chair of anatomy at Dalhousie University, Halifax, in memory of his son, the late Dr. George Campbell.

THE council of the Senate of the University of Cambridge has offered to professors, teachers, and students of the University of Louvain such facilities in the way of access to libraries, laboratories, and lectures, together with the use of lecture-rooms, as may secure the continuity of the work of that University during the present crisis. Hospitality in the way of living accommodation and so forth will probably be offered by the individual colleges and by private residents. The professors of the University of Oxford have offered a home for the winter to the young children of the professors of the University of Louvain; and the academic staff of University College (University of London) offers hospitality to about seventy members of French and Belgian universities, whether professors, teachers, or students, men or women, who may find it necessary to take refuge in this country.

A WELL illustrated prospectus for the present session of the Municipal Technical Institute, Belfast, has been issued. The chief object of the institute is to provide instruction in the principles of the arts and sciences which bear upon the trades and industries of Belfast, and to show by experiment how these principles may be applied to their advancement. The evening classes are designed for persons engaged during the day in handicrafts or business who desire to supplement and develop the knowledge and experience they have gained in the workshop and warehouse. It is satisfactory to notice that the prospectus insists that the successful prosecution of special studies is in proportion to the student's knowledge at the beginning of such work of the elements of mathematics and drawing. The day technical course provides instruction in the science and technology of mechanical and electrial engineering, the textile industries, and pure and applied chemistry; and it gives a sound training to youths who aim at filling responsible positions in these departments of activity. We notice that the Queen's University of Belfast and the Belfast Corporation have entered into an agreement whereby the institute is recognised as a college in which students of the University may study to qualify for a degree or diploma in science of the University. It is impossible in view of the completeness and multiplicity of the arrangements which have been made to meet the needs of every class of student, to mention them all, but attention