

gated and developed into a general method for the determination of ring structures. By means of this technique and ingenious modifications of it, such as the oxidation of the fully methylated aldobionic acids in the disaccharide group, the workers of the Birmingham school, under the late Sir Norman Haworth, in a comprehensive series of investigations, determined the structures of the stable methyl glycosides (later termed pyranosides from the six-membered ring present in the molecule), the furanosides and the important naturally occurring disaccharides and trisaccharides such as cellobiose, maltose, sucrose, gentiobiose and raffinose. In many cases alternative methods, analytical and synthetical, afterwards provided confirmatory proof of the accuracy of the results obtained by the methylation method. One of the most versatile of the newer techniques is oxidation by periodic acid, introduced by Malaprade for the oxidative degradation of glycols. Besides numerous important applications in the mono- and oligo-saccharide groups, this reagent is of special value in the study of the complex polysaccharides; for it can be employed to gain quantitative evidence of the presence of end-groups, and, by examination of the hydrolysis products obtained from the oxidized polysaccharide, information can be obtained concerning the mode of linkage of individual residues in the polymer.

Another recent development of the greatest importance to carbohydrate chemistry is the use of chromatography for the quantitative separation of mixtures of sugars, whether unsubstituted or in the form of their methyl ethers. So delicate and accurate has this technique become that for the time being a limiting factor in the study of the complex carbohydrates resides not so much in the separation and classification of the various sugar residues as in the difficulty encountered in hydrolysing the polysaccharides without damage to the component sugars. Besides applying these methods to the undegraded polysaccharides, present-day investigators attempt to simplify their problems by examining the structure of degraded fragments obtained by partial hydrolysis.

In those ways, aided also by highly specialized physico-chemical techniques such as X-ray analysis and sedimentation in the ultracentrifuge, sufficient information may be gained on which to base the general structure of a polysaccharide. In some cases, for example, cellulose, which consists essentially of long chains of β -1,4-linked glucose residues, the structure is known in some detail; but even here there remains a fine structure of great importance to the industrial chemist about which little is yet known. The main structure of the amylose component of starch (α -1,4-linked glucose residues) is also known with some certainty. Much still remains to be learned concerning the amylopectin component of starch with its many branched chains and five per cent of its glucose residues present as end-groups.

Reference has been made to the special problems presented by the xylans, arabans, pectins and alginic acid, and it has been pointed out that, difficult as all these problems are, they are simple in the sense that each polysaccharide contains only one kind of sugar residue. The plant gums and mucilages and many polysaccharides of importance in chemotherapy present much more complex problems in that they contain a variety of sugar residues, and it is therefore necessary to ascertain the order in which these are united together in the molecule. Only a

beginning has yet been made with structural studies on these groups, and Prof. Hirst concludes with a review of the position now reached, with special reference to the chemistry of gum arabic.

STONY METEORITES

DR. W. CAMPBELL SMITH, in his presidential address to Section C (Geology), points out that among the thirteen hundred or so known meteorites recorded in the past hundred and fifty years, some seven hundred and sixty are 'stony meteorites' consisting mainly of ferromagnesian silicates. The elements found in meteorites do not differ from those known on the earth, and the silicate minerals of the stony meteorites are varieties of the same species as those found in basic and ultrabasic igneous rocks.

About ninety per cent of all stony meteorites contain varying proportions of nickel-iron, ranging from 4 to 25 per cent, and these (with half a dozen exceptions) are characterized also by the presence of small, spherical bodies ('chondrules') consisting of pyroxene or olivine, or both together. These meteorites are called chondrites. Their chondritic structure and nickel-iron content make them quite unlike any known terrestrial rocks. The remaining ten per cent of stony meteorites, containing no chondrules, are called 'achondrites'. Some of these show a partial resemblance in mineral composition and texture to igneous rocks. By applying to them the methods used in the study of igneous rocks and rock-forming minerals, we may hope to obtain some insight into the conditions under which meteorites were first formed and what changes they have since suffered.

One group of the achondrites, the eucrites and howardites, represented by about twenty-five falls, comprise meteorites of which the constituent minerals are feldspar (bytownite-anorthite) and pyroxene (mainly pigeonite). They are, with one exception, intensely brecciated; but they contain many fragments which resemble in texture some ophitic dolerites and basalts, and these are regarded as products of direct crystallization from molten magma.

The other achondrites contain little or no feldspar, consist of magnesium-iron-pyroxenes and olivine, and, except when brecciated, present a holocrystalline granular texture. Their mineral assemblage falls almost wholly within the $MgO-FeO-SiO_2$ system fully investigated experimentally by N. L. Bowen and J. F. Schairer. The conditions of crystallization of the several phases in this system show that one cannot explain the crystalline granular achondrites as the result of direct crystallization from a magma of their own bulk composition. They must be regarded rather as the result of crystal-settling in a differentiating magma. Such a process requires not only bodies of magma of considerable size but also a gravity field sufficient to make settling of crystals in a magma possible. Both requisites imply that the material of these achondritic meteorites formed within a body comparable in size with our earth.

A similar settling of magnesium silicate minerals, but mixed up in some way with nickel-iron, may account for the original materials of the chondritic meteorites; but their subsequent changes in com-

position and structure, resulting first in a transfer of iron between nickel-iron and silicates, and later in the formation of chondrules, are more difficult to explain. G. T. Prior found, as a result of a survey of the chemical composition of stony meteorites, that "the less the amount of nickel-iron in chondritic stones, the richer it is in nickel and the richer in iron are the magnesium silicates". Prior attributed this relationship to progressive oxidation of metallic iron acting for different periods or at different rates. One must suppose that such reactions proceeded in bodies of considerable size which had, owing to different conditions, varying opportunities for interchange between metal and silicate. Such different conditions may imply that the bodies were separate and travelling on different paths. However this may be, the resulting silicates of the chondrites correspond to only part of the achondrite series, ranging from pure enstatite to the hypersthene-olivine assemblages with $\text{MgO}:\text{FeO}$ from $2\frac{1}{2}$ to 4. The more ferri-ferrous magnesian silicates are not represented among chondrites, and nickel-iron is never entirely absent from them.

The chondrules, whether of orthopyroxene or olivine, appear, so far as available evidence goes, to have compositions similar to those of the silicate minerals with which they are found. This implies that they were not formed until after the silicates had reached their present composition.

Many theories have been advanced to explain the formation of chondrules. Some, consisting of radiating enstatite prisms, appear to have crystallized rapidly from globules of molten pyroxene; others with porphyritic and granular olivine crystals in a glassy fine-grained base may have crystallized more slowly from larger parts of the mass which were thereafter broken up and rounded by attrition while still soft. The conditions for their formation may have developed when the course of the bodies broken from the parent planet passed near the sun, which caused intense heating and violent fusion accompanied by ejection of molten globules. After cooling became possible, the chondrules must have been gathered back into the mass from which they came, for the meteorites now consist of chondrules in a matrix of broken fragments of pyroxene and olivine, and of broken chondrules as well, with varying amounts of nickel-iron and troilite, the whole forming a compact though sometimes friable stone.

Subsequent to the first crystallization of the achondrites and later than the formation of chondrules in the chondrites, there occurred, in most stony meteorites, intense brecciation, re-heating (sometimes repeated) and the formation of thin black veins which have been compared to the pseudotachylite veins found in some great granite masses and attributed to crushing in bodies of rock of considerable size. In the case of the chondrites, these effects must have taken place after the break-up of the parent planetary body. There may have been more than one period of break-up, and one must be prepared to consider, as a possible cause both of brecciation and re-heating, violent changes of temperature due to passage close to the sun of masses still of considerable proportions. The final break-up into meteorites of the size known to us from actual falls came at a still later stage.

None of the structures here described is attributable to heating effects caused when meteorites enter the earth's atmosphere. These are restricted to the 'burning away' of the outer part of the meteorite,

disruption with explosive violence, the formation of the peculiar pittings ('thumb-marks') and, last of all, the solidification of a thin glassy crust coating the surface of the stone.

THE SCIENCE AND PRACTICE OF ENTOMOLOGY

ENTOMOLOGY in Great Britain remained for long enough the care of amateurs, and when the scientific teaching of zoology in the universities was being established during the second half of the last century, the insects were largely neglected. That was unfortunate, because the insects compose a majority of the known species of animals; they are exceedingly diverse in form and habit and well suited to illustrate, often in the most vivid form, most of the problems with which the student of living things is concerned. Indeed, at the present time, insects are being used to an ever-increasing extent as a medium for study by chemists and physicists, geneticists, experimental zoologists, physiologists and biochemists; above all, they furnish exceptional material for the study of animal behaviour and ecology. In his presidential address to Section D (Zoology), Dr. V. B. Wigglesworth discusses "The Science and Practice of Entomology".

The period during which zoology became established in the universities of Great Britain was also a period of rapid development in large-scale agriculture and of improvements in communications, with the consequent emergence and dissemination of insect pests. The change was heralded in the 1860's by the transformation of the harmless Colorado beetle into a major pest of agriculture, sweeping across the American continent and, to-day, across Europe. The production of Paris green as an agricultural insecticide was the result, and since that day the insect pests of agriculture have become ever more prominent and the insecticides and other methods of control more powerful. During this same period we have become increasingly aware of the importance of insects in carrying disease to man and his livestock, in consuming large quantities of our stored foods and other produce, and in destroying structural timbers. The insects have surely come into their own—in both pure and applied science.

If this field of science is to be exploited to the full, we must turn out entomologists who know the world of insects in the round; who are at once morphologists, taxonomists, physiologists and field naturalists. These men will find that the world of insects is in a state of flux; that the species tails off into the 'biological race', that species are continually changing in abundance and, apparently, in habits and certainly in the amount of damage to human interests they bring about. It follows that the applied entomologist must be constantly investigating, that *applied entomology is research*. Once a problem has been solved, the preventive procedure can often be incorporated into the practice of the industry in question and the entomologist is no longer required. He will always be confronted with new problems for solution and must therefore always retain the outlook of the investigator.

This thesis has important implications in the field of practice and administration. The dissemination of existing knowledge in the form of advice by the