chyme, however, is soon neutralized by the alkaline bile and pancreatic juices, and then the free acid in the stomach produces again an inhibition of the sphincter tonus and another quantity of chyme is driven out. This hypothesis has been tested by Cannon in numerous ways. He has shown, for example, that anything which delays the appearance of free acid delays the onset of the discharge from the stomach; that hastening the appearance of free acid hastens the time of discharge; and by means of a fistula, he was able to observe that the appearance of free acid closely precedes the first gastric discharge into the duodenum. In addition, Cannon showed that free acid causes opening of the pylorus in the *excised* stomach of a cat, thus proving that the control of the pylorus is independent of the central nervous system and resides probably in the local nerve plexus. Free acid, therefore, above the gastric sphincter causes it to relax, and this explains why carbohydrates leave the stomach much earlier than proteids, for both these food-classes stimulate the secretion of gastric juice, as Pavlov has shown, but the proteids unite with the acid as it is produced, forming acid albumen; there is thus no free acid available for a considerable period of time, and, as shown above, free acid is necessary to cause a relaxation of the pylorus. There is no such difficulty with carbohydrates; as soon as the free acid appears the pylorus relaxes, and the crackers, potato-mush, or whatever carbohydrate was fed, is at once transferred to the gut by the peristaltic waves of the stomach.

The evidence that free acid *below* the sphincter, in the duodenum, causes closure of the pylorus, is just as conclusive, for various investigators had shown that acid in the duodenum slows the output of chyme from the stomach, and this must be due to an effect on the pylorus, for Cannon demonstrated that gastric peristalsis was not stopped during this condition. Another support was furnished by the observation of Pavlov that acid solutions leave the stomach much more slowly in dogs with a pancreatic fistula than in normal animals. This is easily explained by the fact that absence of the alkaline pancreatic juice permits the chyme to remain acid in the duodenum for a longer period, and thus the stimulus which causes closure of the pylorus remains effective until the food material becomes neutral or alkaline. Cannon studied the effects of ligation of the larger pancreatic and bile ducts on the rate of discharge from the stomach and gives a chart which shows the marked delay caused by this interference. The stimulus which causes the closure of the pylorus is mediated through the myenteric nerve plexus, for after severance of the entire muscular coats of the duodenum just below the pylorus, Cannon found that the discharge of the stomach content was considerably more rapid than in normal animals: the acid chyme undoubtedly still produced its usual stimulus in the duodenum, but this stimulus could not reach its destination, the pyloric sphincter, because its path had been destroyed.

From the foregoing it will be seen that Cannon's theory seems adequately and simply to explain one of the most remarkable functions in the body, and it is of theoretical interest that the same agent may exert diametrically opposite effects, the sign of this effect being dependent upon the locus of the stimulation.

It may be said, in short, that this concise monograph by Professor Cannon gives a balanced and authoritative view of the present state of our knowledge regarding the motor mechanism of digestion under normal and experimentally modified conditions. In addition, the reader will find that the presentation is lucid and that dogmatic statements are absent.

JOHN AUER

ROCKEFELLER INSTITUTE

CHEMICAL TEXT-BOOKS

The Elements of Qualitative Chemical Analysis with Special Consideration of the Application of the Laws of Equilibrium and of the Modern Theories of Solution. By JULIUS STIEGLITZ, Professor of Chemistry in the University of Chicago. Parts I. and II. Fundamental Principles and their Ap-

plication. Parts III. and IV. Laboratory Manual. New York, The Century Co. 1911.

As the appearance of Ostwald's "Foundations of Analytical Chemistry" in 1894 showed the way by which it would be possible to transform analytical chemistry from a somewhat mechanical process to a scientific system based on definite laws, and as the investigations of A. A. Noyes and Bray furnished the facts necessary to enable one to select the methods most exact and rapid, so the appearance of this work has marked a milestone in the progress of the science of qualitative and quantitative analysis. In this work the author has collected and applied the observations and deductions which have resulted from the researches of the last score of years in the field of physical chemistry and has furnished a rational explanation for reactions which have hitherto been merely empirical. The work is divided into two parts, the theoretical and the applied. How inspiring it would be if a teacher could always start with a class already trained in physics and mathematics and, with more than the usual time at his disposal, use this method, knowing that he was turning out thinking chemists instead of mechanical analysts. Unfortunately in many cases neither the time nor the previous training of the students is such as will enable him to use this book to advantage, so far as the undergraduate student is concerned, but this is the fault, not of the book, but of conditions governing the methods of instruction and arrangement of courses in different institutions.

Part I. of Vol. I. contains a discussion of the fundamental principles which lie at the foundation of analyses, such as ionization, chemical equilibrium and the law of mass action, osmotic pressure, the colloidal condition and the conditions governing precipitation. All of these questions are discussed in a very clear manner with constant reference to examples in the way of reactions in qualitative analysis. In Part II. we find a general discussion of the methods used in testing for the metallic ions with a detailed statement of each step in the process, great emphasis being placed on the reasons for each step and upon the bearing of the dissociation theory and the law of mass action upon the question under consideration. The theory of the separation of some of the metals by the precipitation with hydrogen sulphide and the theory of complex ions, as well as a discussion of the process of oxidation and reduction, the latter being regarded as involving essentially the loss or gain of electrons, are treated in a very thorough manner.

Although the views here expressed regarding oxidation and reduction may not be generally accepted the subject is admirably presented from the author's point of view.

In Vol. II. we find a discussion of the reactions of the individual metals and acids, especially those reactions which are made use of in qualitative analysis and a very full and clear course in systematic analysis. It would be very desirable if every student of chemistry could follow the course mapped out in this book and work out all the reactions according to the principles given in Vol. I.; but in many instances the time alloted to a course in qualitative analysis is too short to permit the use of such a detailed method.

Every teacher of chemistry and every advanced student of chemistry should study carefully the material contained in this book.

To one who is or is to be a chemist its value can not be overestimated. To the beginner in qualitative analysis its thoroughness and scope should be an inspiration and lead to the very desirable conception of quantitative chemistry as much more than mechanical proficiency in manipulation.

A Handbook of Organic Analysis, Qualitative and Quantitative. By H. T. Clarke, B.Sc. (Lond.), Lecturer on Stereochemistry in University College, London. With an introduction by J. Norman Collie. Longmans, Green & Co.

The Identification of Organic Compounds. By G. B. Neave, M.A., D.Sc. (St. Andrew), and I. M. Heilbron, Ph.D. (Leipzig), F.I.C., Lecturers and Demonstrators, Department of Chemistry, Glasgow and West

of Scotland Technical College. New York, Van Nostrand Co. $1.25 net.

In the first of these volumes efforts have been made to supply the organic chemist with a scheme of analysis and identification of the groups and compounds comparable to the scheme used for the identification of the metallic ions and acid groups. A system of this kind has been greatly needed; but, owing to the great similarity of organic compounds, so far as their constituents are concerned, and to the great diversity, so far as their behavior is concerned, up to the present has not been successfully developed.

By classifying the substances according to the elements they contain and by studying their action with water, alkali, acid, reducing agents, etc., the authors have been able to separate the substances generally met with into groups which in turn are subdivisions of classes. Having reached this point, the exact division to which the substance belongs can be determined by specific tests. Detailed methods are given for testing for the different classes of compounds, and a table of many of the more important substances with their physical and chemical properties serves as a valuable and handy reference. While this scheme of analysis may seem very crude as compared with the one we use in organic chemistry, it is a step in the right direction and worthy of careful study and testing.

The second of these books has the same object in view, but is on a less systematic and comprehensive scale. The general reactions seem too few and indefinite and the special reactions not specific enough to enable one to identify organic compounds by its aid unless considerable reference is made to other records.

Contemporary Chemistry. A Survey of the Present State, Methods and Tendencies of Chemical Science. By E. E. FOURNIER D'ALBE, B.Sc.; A.R.C.S.; M.R.I.A., author of "The Electron Theory, etc." New York, D. Van Nostrand Co. $1.25 net.

The author has written a very interesting "birds-eye view of the whole field of modern chemistry." While not intended as a history of chemistry, all the recent discoveries of importance have been included and their importance and relations to other phenomena have been pointed out. One who has worked in some other science than chemistry, as well as students of this subject, will find this book instructive and well worth reading.

Progressive Problems in General Chemistry. By CHARLES BASKERVILLE, Ph.D., Professor of Chemistry, and W. L. ESTABROOKE, Ph.D., Instructor in Chemistry, College of the City of New York. Heath & Co. 1910.

The authors have brought together a large number of problems covering all the phases of chemical action. This book will furnish the teacher a mine of material from which he may select examples to meet the needs of the students as the different subjects are studied and so test their understanding of the principles involved. The solution of problems, such as these, is of special value in the early stages of the study of chemistry and especially with young students, as it demands the power of applying the facts and reasoning from them and not simply the ability to commit facts and reactions to memory. The value of this work might be increased by adding at the beginning of each subject a general statement as to the methods of solving the problems in this section and the principles involved for the aid of those who are not sufficiently familiar with the subject to work it out entirely independently.

J. E. GILPIN
THE JOHNS HOPKINS UNIVERSITY

Bibliography of Non-Euclidean Geometry, including the Theory of Parallels, the Foundations of Geometry, and Space of n Dimensions. By DUNCAN M. Y. SOMMERVILLE. London, Harrison and Sons. 1911. 8vo. Pp. xii + 403.

In these days, when a non-Newtonian mechanics, based on the principle of relativity, is forcing itself upon the attention of the scientific world, it is instructive to notice how valuable the non-Euclidean and n-dimensional

geometries have become, although it is only about forty years since they began to be appreciated thoroughly and studied systematically. The vast and increasing interest which these subjects have aroused is indicated by the fact that Sommerville's Bibliography contains the titles of about 2,300 works on non-Euclidean geometry, of which nearly 800 were published in the decade 1901–10, and 1,800 works on hyperspace, of which 700 belong to the same decade. Let us glance briefly at a few of the principal ways in which these sciences have shown themselves to be of importance, not only in mathematics, but also in the related domains of mechanics, logic, psychology and epistemology.

In the first place, a flood of light has been thrown on the epistemological problem of the nature of our spatial concepts. Kant's famous doctrine of the *a priori* synthetic nature of these concepts is seriously threatened by the modern geometry, and will require considerable modification, if it is not entirely rejected.

In the realm of psychology, also, these theories have a decided bearing on the distinction between the perceptual space of experience and observation and the conceptual idealized space of mathematics proper. The former space has a physiological basis, principally visual and tactual, and the theorems of its geometry can have only an approximate meaning. Now the striking fact is that this natural geometry of experience is much more nearly non-Euclidean than Euclidean. For instance, as Mach observes, the space of tactual perception, namely, the skin, corresponds roughly to a two-dimensional Riemannian space. Moreover, with all the refinements of astronomical observation the space of visual perception can obviously never be proved to be Euclidean.

The recent developments of deductive logic as typified by the symbolic logic of Peano and Bertrand Russell unquestionably owe much to non-Euclidean geometry; and they in turn have helped to make the foundations of geometry secure at last, after two thousand years of misplaced confidence in Euclid.

In the domain of mechanics, if in addition to the three Cartesian coordinates of a moving particle we interpret the time as a fourth coordinate, we obtain a space of four dimensions, and thus establish a useful correspondence between three-dimensional kinetics and four-dimensional geometry. Now the remarkable thing about this correspondence is that whether the original kinetics is Newtonian or non-Newtonian, the corresponding geometry is in each case of a non-Euclidean type.

Perhaps the highest significance, however, of these seemingly pathological theories is due to the light which they shed on other, less suspicious branches of mathematics. For instance, the geometry of hyperspace provides a convenient language in which to express the theory of functions of several variables; and in particular the projective geometry of n-space is closely connected with the algebra of forms, or quantics, involving $n+1$ variables. Moreover, the point-geometry of 4-space helps us to understand the sphere-geometry of ordinary 3-space, because the spheres of 3-space form a four-dimensional aggregate.

Non-Euclidean geometry, also, derives its chief importance from its bearing on Euclidean geometry. It often discloses unsuspected bonds of relation between apparently disconnected Euclidean developments. It brings out the inner meaning of the process of building metric geometry on the basis of projective geometry. It gives a clear insight into the theory of surfaces of constant curvature. Of great value is the correspondence between the group of projective transformations which leave a quadric surface invariant and the group of non-Euclidean movements. Another correspondence of similar importance is that which exists between the group of conformal point-transformations of a Euclidean 3-space and the group of movements of a non-Euclidean 4-space.

Sommerville's Bibliography consists of three parts, a chronological catalogue, a subject index, and an author index. In the chronological catalogue the titles of the works published in each year are arranged alphabetically according to the authors. Later editions, translations and reviews are included.

In the subject index no titles are given, but references are given to the year and author, so that the corresponding title can be easily found in the chronological catalogue.

It is obvious that a scientific bibliography like this serves a very useful purpose to the student and investigator, especially when it is well arranged and possesses a high degree of completeness, as is the case here. With Sommerville's book at his command the worker in the field of non-Euclidean or n-dimensional geometry is unusually well equipped for referring quickly to the literature of his subject.

ARTHUR RANUM
CORNELL UNIVERSITY

Report on the Dune-Areas of New Zealand, their Geology, Botany and Reclamation. By L. COCKAYNE, Ph.D., F.L.S., Department of Lands, New Zealand. Printed by John Mackay, government printer. 1911.

Because of extensive dune-areas and the impending danger to valuable lands from encroachment, the Dominion government commissioned Dr. Cockayne to conduct a careful investigation of the dune conditions in New Zealand and to embody certain recommendations as to the reclamation of the dune lands and the protection of threatened territory in a formal report. This report, which is an extension of the author's earlier researches, we now have from the government printer. The paper is divided into two parts; the first deals with the geology and botany of the dune-areas and the second with various methods of reclamation. In Part I. the geology of these dynamic habitats is very excellently handled under such subheads as: The Material of Dunes, Dune Building on the Coast, The Effect of Solid, Flexible and Inflexible Obstacles, and the Effect of Climate, General Topography of the Dune-areas in New Zealand, Movements of Dunes and Dune-sand. There are more than 300,000 acres of dune lands in North and South Islands, where occur chains of sandhills of irregular form, which are generally divided in places by basin-like hollows of greater or less extent. The wind plays a great part in constantly changing the form of the dunes, the position of the hills, and in modifying the slope angles. Hills in all stages of growth and decay, and basins in the process of being hollowed out or being filled up appear on every side. The wider dune areas appear like seas of sand with the ridges as more or less stationary billows with their scanty vegetation.

Under "Botany" is treated such ecological matters as: Climatic Factors, Heat, Light, Moisture, Soil, Topography and Biotic Factors. The most characteristic plants with their growth-forms and adaptations are treated in considerable detail. The leading dune plants in New Zealand are: *Spinifex hirsutus* (Gramineæ); *Scirpus frondosus* (Cyperaceæ); *Euphorbia glauca* (Euphorbiaceæ); *Carex pumila* (Cyperaceæ); *Calystegia Soldanella* (Convolvulaceæ); and *Arundo conspicua* (Gramineæ). These plants are distinguished as "sand-binders" in distinction to the following which are called "sand-collectors": *Caprosoma acerosa* (Rubiaceæ); *Pimelea arenaria* (Thymelæaceæ); *Cassinia leptophylla, C. fulvida, C. retorta* (Compositæ); *Festuca littoralis* (Gramineæ); *Calamagrostis Billardieri* (Gramineæ); and *Scirpus nodosus* (Cyperaceæ).

The commoner plant associations represented are: Sand-Grass Dunes, Pes Capræ Dunes, Shrub Dunes, Lakes and Swamps, Dry Hollows and Stony Plain. The various dune species are noted in tabular form with various ecological notes. This list includes 147 species of which 82 are endemic, 43 Australian and 15 South American. Fifty-one families and 104 genera are represented in this number.

The methods in vogue the world over for the artificial fixation of dunes are based upon those which nature herself uses and these are here enumerated as fifteen "fundamental principles" with which plant ecologists are more or less familiar. Marram-Grass, *Ammophila arenaria,* and the Tree-Lupin, *Lupinus arboreus,* are noted as the best of the "sand fixers" for the region under consideration. The efficiency of these two species is compared in considerable detail. Under "Methods of Reclamation" the methods of preparing and

planting Marram-Grass and Tree-Lupin are discussed in detail and suggestions are included for the post-planting management of the plantations. The possibility of checking sand movement by means of sand-fences and protection belts is considerably elaborated. Protection belts are merely narrow bands of Marram set at the junction of the advancing sand and the invaded ground. Such a belt is efficient usually for only a few years unless it is constantly watched and repaired.

The report closes with a discussion of afforestation of the dunes, which method seems to the author to be the only means of establishing the desired static condition over the dune complex. Little tree-planting upon the dunes has been done in New Zealand under difficult conditions, but the method is strongly recommended. The more important trees and shrubs for dune afforestation in these islands are as follows: *Olearia Traversii, Pinus pinaster, Pinus halpensis, Araucaria excelsa, Cupressus macrocarpa, Pinus radiata* (most valuable), *Pinus muricata, Tamarix gallica, Lupinus arboreus, Acacia melanoxylon, Salix caspica, Populus deltoides, Populus balsamifera, Populus fastigiata* and *Alnus glutinosa.* Besides these species, all of them promising dune holders, *Pinus laricio, P. pinea, P. Coulteri* and *P. Strobus* grow "quite well" on the dunes of New Zealand. A final list of plants (over 200 species) suitable for dune cultivation in these islands contains useful information as to the habitat, growth-form, etc., for the various species, many of which are North American.

This very interesting and well-written paper is well illustrated by means of sixty-nine halftones and three etchings, and includes a bibliography of sixty-six general works and seventy-three references to the literature of New Zealand Dunes.

Raymond J. Pool
The University of Nebraska

Aerial Navigation. A Popular Treatise on the Growth of Air Craft and on Aeronautical Meteorology. By Albert F. Zahm. New York, D. Appleton & Co. 1911. 8vo. Pp. xvii + 497; 58 illustrations in text and 32 full page plates.

Amid the flood of ephemeral popular and pseudo-scientific books on this subject which have appeared in England and America during the past two years, here is one that rests on a solid foundation, fit to carry the superstructure of subsequent progress. The author, distinguished as a pioneer investigator of aerodynamics in America, has been intimately acquainted with Langley, Chanute and the Wrights, and a close student of aeronautics in Europe. Therefore Dr. Zahm is eminently qualified to write a book, which in character resembles the reviewer's earlier and smaller "Conquest of the Air," a revised edition of which Dr. Zahm's later and more detailed publication seems to render superfluous. However, the most recent achievements in aeronautics chronicled in any book are already antiquated and surpassed when presented to the reader and conclusions based thereon require corresponding modification.

Authors naturally give prominence to those subjects with which they are most familiar and, therefore, while the reviewer accorded first place to the Ocean of Air, Dr. Zahm puts Aeronautical Meteorology last, having compiled this section largely from other authors and thereby somewhat neglected its status in this country. The two preceding divisions of the book are: the Growth of Aerostation, in which both spherical and dirigible balloons are considered, and the Growth of Aviation, treating of early attempts to fly, the modern glider and the power aeroplane. An appendix contains technical papers and three letters of Benjamin Franklin, written from Paris in 1783 describing the first balloons, which are reprinted from "The Conquest of the Air." The author refrains from prophecies concerning future developments of craft either lighter or heavier than air, since progress in the art of aerial navigation has been so rapid as to baffle conjecture concerning their ultimate applications.

In conclusion, it may be said that the work can be recommended, to either the lay or scientific reader, as admirable in its material

and method of presentation. The numerous illustrations are wisely chosen and well rendered and the few errors noticed in the text are mostly typographical. A misleading misprint occurs in the statement that the first successful dirigible balloon in 1885 sailed from Calais to Paris and returned to its place of departure, which really was Chalais-Meudon, a suburb of Paris.

A. LAWRENCE ROTCH [1]
BLUE HILL METEOROLOGICAL OBSERVATORY

SPECIAL ARTICLES

HEATING OF LOCAL AREAS OF GROUND IN CULEBRA CUT, CANAL ZONE [2]

THE marl shales, through which Culebra Cut extends, in the region opposite the Culebra railway station, have, from time to time, on exposure to the atmosphere, become hot. The intensity of this heat has varied from noticeably warm to a temperature sufficient to readily char wood, without, however, causing it to burst into a flame. The duration of this heating has been from a few days to several weeks. These shales are dark, thin bedded, soft and easily crumbled, and some of the layers are largely fine basic tuff, loosely cemented by lime. Other beds contain more carbonaceous material, with some local partings of lignite an inch to a foot or more thick. The relatively unweathered character of these basic sediments is evidence that they were derived from nearby volcanic mountains, and the carbonaceous and lignitic layers in them indicate shallow water and swamp conditions of deposition. The presence of fossil oysters, pelecypods, corals and foraminifera show that these shallow estuaries were marine, and that they existed in early Tertiary time. Dr. T. Wayland Vaughn, of the U. S. Geological Survey, examined some of the specimens on the ground and gave it as his opinion that they are Oligocene in age. The evidence so far points to a shallow water connection between the Atlantic and the Pacific during Oligocene time.

[1] This review was written immediately before the lamented death of Professor Rotch.—ED.

[2] Published by permission of the chairman of the Isthmian Canal Commission.

After exposure to the atmosphere by drilling, or blasting, certain local areas of this formation become, in the course of a few days, warmed up, and as the heating goes on the carbonaceous matter in the shales is gradually oxidized off and they tend to assume a gray to dull reddish color. The first working hypothesis entertained in looking toward a solution of this heating phenomenon was that possibly the heavy blasting had furnished heat enough to break down the calcium carbonate present to the oxide form, and that ground water and atmospheric moisture reacted on this to slake it and thus probably generate sufficient heat to start the oxidation of the carbonaceous material. This hypothesis was, however, rendered untenable by three lines of evidence:

1. The heating was much more local than the calcium carbonate, and the carbonaceous matter.

2. The heating bore no definite relation to the lime and carbon content of particular beds.

3. Colonel Gaillard, in charge of the Division, informs me that in some instances the heat began in the holes some time after they had been drilled, but before the ground had been blasted at all.

Another line of inquiry was suggested by finding a small amount of pyrite in some of the beds which were heating. It was suspected that this, through its oxidation, was a factor in furnishing the initial heat of the action. In April, 1911, samples of the beds then heating were sent to the chemical laboratory of the U. S. Geological Survey with instructions to make qualitative tests for sulphur and other products that might serve, through oxidation, as the mainspring of the action. These tests revealed the presence of sulphuric acid to the amount of 1.92 per cent., also minute crystals of gypsum. This confirmed the hypothesis that pointed to the pyrite present as the substance acted on by atmospheric oxygen to develop the initial heat.

The most aggravated case of heating so far noted is now going on in Culebra Cut, about 350 yards north of the foot of the stair at the observation tower near Culebra Station. The