sectivorous plants have been written, the lack of a recent and comprehensive treatment of these plants would in itself make the present volume worth while. When to this is added the intensive research of the author for more than a decade, "The Carnivorous Plants" becomes an especially valuable book. Professor Lloyd states in the preface that his interest in these plants began with work on *Utricularia gibba,* but that the treatise under consideration is based on material collected and received from many sources.

There is one relatively short chapter on carnivorous fungi, in which we read of "loop snares," "eel-bob snares" and "adhesive organs." Each of the other thirteen chapters deals with one or more of the fifteen angiospermous genera that stoop to conquer flesh—often, though by no means always, that of insects. These fifteen genera, which occur in six different families, include some 450 species, of which, however, *Utricularia* has 275, *Drosera* 90 and *Nepenthes* 65. Five of the genera are monotypic.

The kinds of traps, in addition to the snares of the fungi, are classified as "pitfalls" (pitcher plants) as in *Sarracenia, Darlingtonia, Nepenthes,* etc., "lobster pot" as in *Genlisea,* "bird lime or fly-paper traps"—passive as in *Byblis* and *Drosophyllum,* active as in *Pinguicula* and *Drosera,* "steel-trap" as in *Dionaea* and *Aldrovanda,* and "mousetrap" as in *Utricularia,* etc. Lures are also present, which may take the form of odors in *Sarracenia* and *Drosophyllum,* nectar secretion in *Nepenthes,* attractive colors in *Sarracenia* and *Darlingtonia* and of brilliant points of reflected light in *Pinguicula* and *Drosera.*

Each of the chapters is really an intensive study of the structure, development, mechanisms and interpretations of the various genera. The treatment accorded to *Drosera* and *Utricularia* is especially inclusive, a separate chapter of thirty-eight pages being devoted to the *Utricularia* trap. The literature cited at the end of each chapter is extensive; this indicates the interest that these plants have aroused for a very long time and testifies to the assiduity of the author. In addition to eleven text figures, there are thirty-eight plates, each with numerous illustrations.

Every one who reads about these plants wants to know whether their carnivorous habits really benefit them. This topic is discussed in detail in the chapter on *Drosera,* and abundant evidence for the affirmative conclusion is assembled. In the introduction also this subject is considered. "From the purely physiological point of view the carnivorous plants are concerned in a somewhat special way in the acquisition of nutrient substances containing protein, possibly vitamins and perhaps the salts of potassium and phosphorus, and even others. In this way they receive some profit, though what they receive is no *sine qua non,* as it is with many other plants."

Professor Lloyd has written a scholarly, complete, authoritative volume—one that will take its place fittingly on the library shelf beside Charles Darwin's "Insectivorous Plants," published in 1873. The author writes with clarity, with conviction and on occasion with a touch of humor. And if, at times, his presentation seems intricate and involved, as in the *Utricularia* trap, so is the subject.

EDWIN B. MATZKE
COLUMBIA UNIVERSITY

REPORTS

MEDAL DAY AT THE FRANKLIN INSTITUTE

AN American and a Russian scientist share the highest honors of The Franklin Institute this year. The selection of Dr. William David Coolidge, vice-president and director of research for the General Electric Company; and Dr. Peter Kapitza, director of the Institute for Physical Problems, Academy of Sciences, Union of Soviet Socialist Republics, to receive the Franklin Medal was based upon work in physical science or technology, without regard to country, which in the opinion of the institute, acting through its Committee on science and arts, has done most to advance a knowledge of physical science or its applications.

Dr. Coolidge received the Franklin Medal "in recognition of his scientific discoveries, which have profoundly affected the welfare of humanity, especially in the field of the manufacture of ductile tungsten and in the field of improved apparatus for the production and control of x-rays"; and Dr. Kapitza "in recognition of his remarkable contributions to experimental physics and also to theoretical physics, especially in the fields of magnetism and low temperatures."

Since the founding of the Franklin Gold Medal in 1914, the face of which carries a medallion of Benjamin Franklin done from the Thomas Sully portrait of Franklin owned by The Franklin Institute, it has been awarded by the institute to such figures as Thomas A. Edison, Guglielmo Marconi, Charles Fabry, Pieter Zeeman, James H. Jeans, Orville Wright, Albert Einstein and Charles F. Kettering.

Dr. Coolidge has won many scientific awards, among them the Howard N. Potts and the Louis Edward Levy Medals of The Franklin Institute, and an honorary M.D. degree from the University of Zurich. Interested in mechanical problems and principles since his youth on a farm in Hudson, Mass., Coolidge won a scholarship to the Massachusetts Institute of Technology in 1895. Upon graduating from that institution he continued his studies abroad and in 1899 was awarded his Ph.D. at the University of Leipzig. After six years of research work and teaching he accepted a research position in the physical chemistry laboratories of the General Electric Company.

His x-ray tube has changed x-ray technique from an art to a science, enormously extending the range, utility and effectiveness of x-rays. In developing the x-ray tube from an inexact device to its present form —a tube with the highest possible vacum in which an electron stream from a filament, heated by an auxiliary current, can be directed upon a tungsten target by a separately controlled voltage—he has completely revolutionized the use of x-rays, creating the science of radiology. He has developed the tube to a point where it can operate on much higher voltages. The greater penetrating power which results is now used in cancer research. In achieving this, Coolidge applied the cascade principle, which is now used in equipment for radiographic examination of steel castings and welds, to discover internal defects.

The modern incandescent lamp, because of Coolidge's development of the drawn tungsten filament and Langmuir's contribution of filling the lamp with gas, has saved our country over a billion dollars a year in lighting bills. Tungsten, always a brittle metal because of its crystalline structure, became both ductile and fibrous as a result of Coolidge's researches and tireless effort.

From his home in Schenectady, N. Y., Coolidge sent a daughter to study and then teach biology; she later married a biologist. His son is studying economics at Columbia University. Hobbies interesting Dr. Coolidge are color photography, both still and motion picture, and astronomy. Impatient of carelessness or superficiality because of his own perceptive qualities of mind which go quickly to essential and crucial facts, he nevertheless possesses a keen sense of humor. It is understandable to consider Coolidge the 1940 selection of the National Association of Manufacturers as one of the "Modern Pioneers," and a winner of the Duddell Medal of the Physical Society of London. He is a member of many scientific societies and organizations.

Peter Kapitza, the son of the late General Leonid Kapitza of the Russian Imperial Army, was born at Kronstadt, Russia, in June, 1894. Electrical engineering training at Petrograd Polytechnical Institute was followed by further study at Cambridge University, England. From 1924 until 1932 Kapitza was assistant director of magnetic research at the Cavendish Laboratory, Cambridge, England. He held the Royal Society Messel research professorship as well as being director of the Royal Society Mond Laboratory for research at low temperatures. The Franklin Institute awarded him a Franklin Medal in 1944 " in recognition of his remarkable contributions to experimental physics and also to theoretical physics, especially in the fields of magnetism and low temperatures."

Dr. Kapitza's great work has been the invention of a method of producing extraordinarily high magnetic fields, many times greater than were previously thought possible, and the development of ingenious methods for making magnetic measurements of various kinds upon small pieces of matter exposed for a small fraction of a second to such fields. The results obtained provide important information about the structure and the behavior of the atoms of ferromagnetic, paramagnetic and diamagnetic substances.

He also designed and constructed a machine for making liquid air and liquid hydrogen which is much more efficient and smaller than any machine yet developed. It is believed that the Russian Army has used liquid air and applications of Kapitza's researches for military purposes.

Other prominent men in scientific and industrial fields who received medals at The Franklin Institute Medal Day ceremonies include Dr. Roger Adams, head of the department of chemistry (now on leave), University of Illinois, Urbana, Illinois. Dr. Adams received the Elliott Cresson Medal award for his notable work in organic chemistry.

The John Price Wetherill Medal was awarded, posthumously, to Richard C. duPont, president, All American Aviation, Inc., Wilmington, Del., "for his development of a successful and practical 'on the wing' air mail and glider pick-up apparatus"; and to Willem Fredrik Westendorp, Research Laboratory, General Electric Company, Schenectady, N. Y., "for his development of a successful high-voltage, low-frequency resonance transformer of relatively small size and light weight, which is shock-proof, efficient in operation and particularly suitable for use in high voltage portable x-ray units."

Two Philadelphians, Frank B. Allen and J. Stogdell Stokes, of the Allen-Sherman-Hoff and Stokes-and Smith companies, respectively, were awarded the Edward Longstreth Medal, Allen, for the development of the hydroseal pump, and Stokes for developing new machinery used in making paper boxes. Edward E. Simmons, Jr., of Sacramento, Calif., was awarded the Edward Longstreth Medal for his invention of the SR-4 Strain Gage, now in wide industrial use.

The Frank P. Brown Medal was awarded to Dr. Harvey Clayton Rentschler, director of research, Lamp Division, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J., "in consideration of his application of a source of bactericidal radiation in air conditioning systems in a scientific and practical manner."

Dr. Walther Emil Ludwig Mathesius, president and director of the Geneva Steel Company, Geneva, Utah, received the Francis J. Clamer Medal for outstanding achievements in the field of metallurgy, particularly for contributions in blast furnace practice.

The George R. Henderson Medal was awarded to Joseph Burroughs Ennis, senior vice-president, American Locomotive Company, New York, "in consideration of his accomplishments in locomotive engineering and important contributions in the field of locomotive design."

For his paper on "The Theory of Suspension Bridges," which appeared in the March and April, 1943, issues of the *Journal of the Franklin Institute*, Professor Stephen P. Timoshenko, department of theoretical and applied mechanics, Stanford University, Palo Alto, Calif., was awarded the Louis E. Levy Medal.

A Certificate of Merit was given to the Western Union Telegraph Company, New York, "for the development of the reperforator switching system, a contribution to the greater accuracy and speed of telegraphic service."

HENRY BUTLER ALLEN,
Secretary and Director, the Franklin Institute

SPECIAL ARTICLES

THE INFLUENCE OF IRON OXIDE ON WEAR OF RUBBING SURFACES

IN the course of an investigation of wear under boundary lubrication the condition was produced which permits hard and soft ferrous surfaces to rub under very heavy loads at a moderate speed without rapid wear despite the absence of special wear-inhibitors in the hydrocarbon lubricant. The tenacious layers of iron-oxide which slowly develop under the lubricant and cover the rubbing surfaces were studied with the aid of a microscope and their ability to reduce wear was related to the hardness or imbedability of the surfaces. The following summarizes some of the experiments:

In the first experiments a modified Timken machine[1] was used, in which a stationary block of mild steel or of cast-iron, with a wearing face measuring one by ten millimeters was aligned with its longer edge perpendicular to the direction of rotation of a polished hard steel cylindrical ring measuring five centimeters in diameter by ten millimeters wide. The ring was turned upon its axis with a peripheral speed of 209 centimeters per second while pressure was applied to the block and a plentiful supply of lubricant flowed over both parts.

Failure due to the adhesion and transfer of metal from the block to the ring by welding would occur instantly unless the apparent bearing pressure was very light (20 to 30 kg/cm^2). If the initial pressure was gradually increased from this low figure, a worn-in state could be developed, in the course of several days, whereby a pressure of 2 or 3 thousand kilograms per square centimeter could be borne without failure. Wear-in or break-in was materially assisted by frequently repolishing the ring to remove particles of metal which had been transferred to it. No attempt was made to polish the block. After the break-in process was complete, welding ceased and further polishing was not necessary.

The rate of wear of a properly broken-in mild-steel or cast-iron block was so low that no loss of weight could be detected by reweighing the block to 0.2 mg after a day or two of high-pressure operation (2,000 to 3,000 kg/cm^2). In some experiments a slight gain in weight of both the ring and the block was noticed after prolonged operation; this is attributed to the accumulation of iron-oxide.

In further experiments similar attempts to break-in hard steel blocks were unsuccessful; failure occurred from seizure at pressures below 800 kg/cm^2.

Observations of a similar type were made during experiments with the four-ball wear machine, an adaptation of Boerlage's apparatus.[2] In this machine, three stationary balls of hard steel, of cast iron or of mild-steel clamped in a cup and covered with the lubricant, were pressed upward with a measured force against a hard steel ball spinning on a vertical axis. When heavy loads (60 kg or more) were applied, there was an immediate transfer of metal to the spinning ball, and rapid wear of the stationary balls occurred when an ordinary mineral oil was the lubricant at these loads. However, with a very light load (7 kg), no welding was observed; the sliding action appeared to be smooth, and the wear occurring could be determined by measuring scar diameters at predetermined intervals of time. Such measurements are given in Table 1.

During the break-in period the contact areas of the soft stationary balls rapidly expanded, probably by plastic flow, until the contact pressures reached the approximate range of 2,000 to 3,000 kg/cm^2, depending upon temperature. However, the scars in the more elastic stationary balls did not expand so rapidly

[1] Timken Roller Bearing Company, Canton, Ohio.

[2] *Engineering*, 136: 46, 1933; 144: 1, 1937.