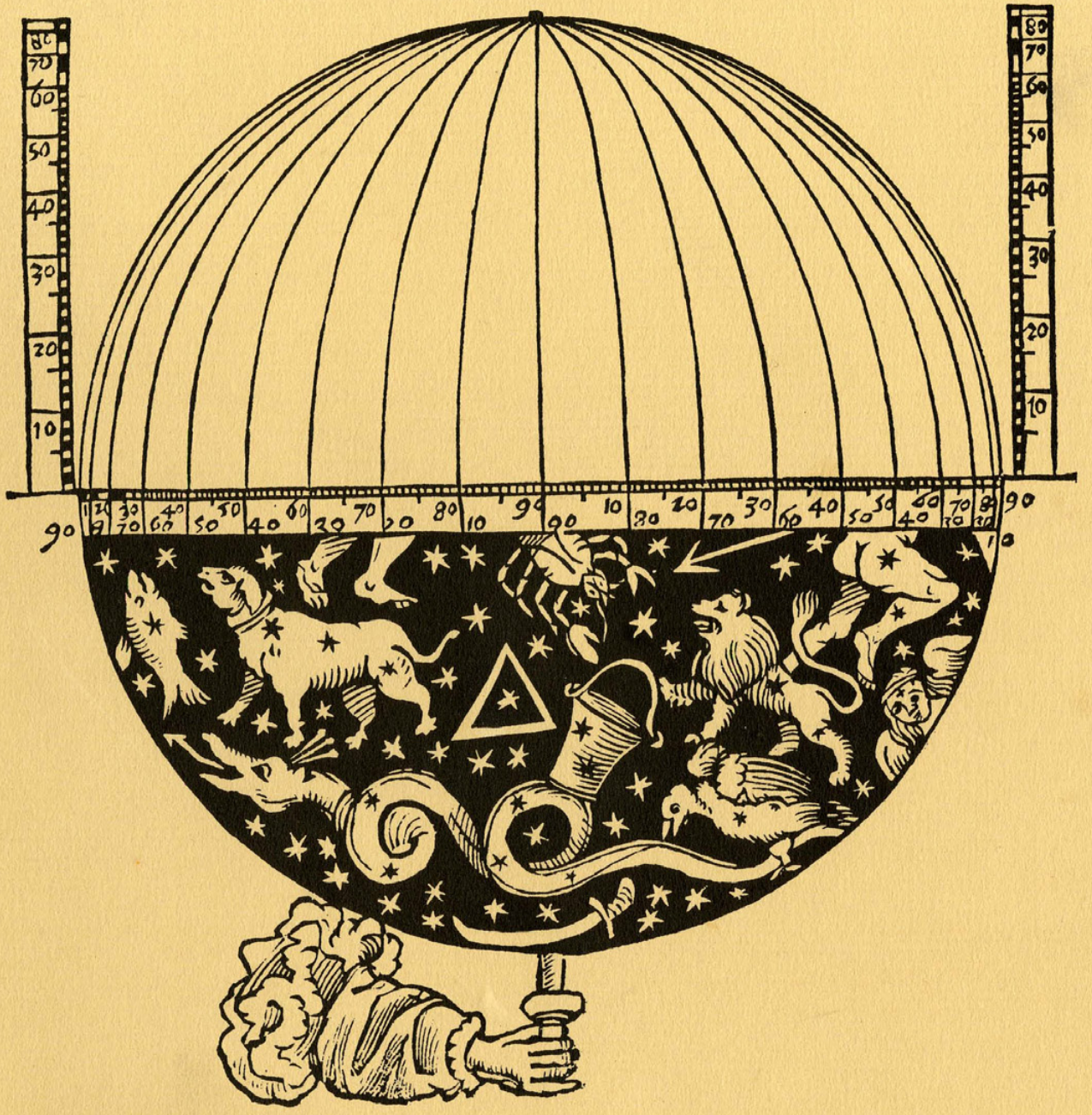

SCIENCE THROUGH THE AGES

A Selection of Pioneer Works
in Science, Technology, Medicine
in the Collections of

THE JOHN CRERAR LIBRARY


THE JOHN CRERAR LIBRARY
GREAT IS THE GIFT
THAT BRINGETH KNOWLEDGE
1894
CHICAGO

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THE JOHN CRERAR LIBRARY

An Exhibit Held at The Cultural Center
of The Chicago Public Library
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PREFACE

Nearly 90 years ago, Chicago businessman John Crerar made provision in his Will for the "erection, creation, maintenance and endowment of a Free Public Library to be called The John Crerar Library." It is unlikely that he could have foreseen the eminence which his institution would attain; from the beginning, however, the Trustees whom he also named in the Will intended that a high level of excellence be sought. The breadth of that intent was proposed by the Library's first President, Norman Williams:

"I do not sympathize with the suggestion that only the newest and latest publications be selected. Such a library would have neither beginning nor end. The student, every student, requires and demands a knowledge of the history of the subject he pursues, and should have at hand the means of investigation from the beginnings."

At the outset, the decision was made by the Trustees that the Library should fill a significant need in the field of scholarship by specializing in science, technology and medicine. It became the first great privately endowed research library devoted to these subjects. Over the years, Crerar has prided itself on fulfilling the needs of researchers and scholars across the country and around the world for "the newest and latest publications" in many specialties and languages. But the "means of investigation from the beginnings" have also been acquired, in substantial and highly renowned holdings of the landmark works from which the present exhibit has been drawn.

From time to time, the Library has mounted selective exhibits of its treaures, usually emphasizing a particular theme or discipline. Definitive bibliographies in the history of science and of industry have also been published. It has not for some time—if ever—brought together a showing with the breadth and depth of the present display, described in this catalog. The occasion has several objectives: To remind the citizens of Chicago that the Library is a major cultural and intellectual institution freely accessible to all; to inform recent arrivals of the Library's resources and services; and to demonstrate dimensions of scope and richness which perhaps few have recognized.

To make the appropriate selections, undertake the necessary research and prepare background text and annotations, there could have been no more fortunate designation than the retired Executive Director of the Library, Herman H. Henkle, who must also be credited with the perceptive acquisition of many of our prize holdings. Assisting him in the process of selection and in the editing of the text has been our Associate Librarian, J. Walter Shelton. Board members Mrs. Robert W. Reneker and Kenneth Nebenzahl have provided a fitting opening occasion, sponsored by Crerar Library Associates, and were instrumental in obtaining most of the necessary support for mounting the exhibit. Acknowledgment for this major support is gratefully made to the Field Foundation of Illinois, Inc.

We are doubly indebted to the Chicago Public Library for permission to mount the exhibit in the beautiful physical facilities of the Cultural Center, and for the valuable assistance of Mr. Thomas A. Orlando, Curator of Special Collections at the Center. Design of the catalog demonstrates the taste and skill of Ms. Lynn Martin. And, finally, the tasks of coordinating, arranging, expediting and ensuring success fell upon and were ably fulfilled by our present Executive Director and Librarian, William S. Budington. It is with great satisfaction that the Library presents itself, through this exhibit, as a principal information and cultural resource in the fields of science, technology and medicine, for Chicago, the nation, the world.

Oliver W. Tuthill
President

INTRODUCTION

For thousands of years man has been observing himself, his immediate surroundings and the universe around him, and speculating on the meaning of what he has seen. Within the great ancient civilizations, especially those of Greece and Rome, the observations were often very precise and accurate despite the absence of developed instrumentation which did not follow until centuries later. Fortunately many of the observations and speculations were recorded. They were passed down to us through manuscript copies into the 15th and 16th centuries, and with the invention of printing in the mid-15th century could be widely distributed during the Renaissance period in western Europe.

These records stimulated an interest in every field of learning. The advancement of knowledge of all fields of science, technology and medicine is illustrated by the books presented in this catalog with emphasis on the 16th, 17th and 18th centuries. They indicate many of the advances on which the development of modern sciences was based. They illustrate also the ways changes in interpretation of earlier observations and new discoveries have gradually led us to a better understanding of natural phenomena through improved methods of research.

In viewing an array of great contributions in the history of science, it is well to keep in mind that they form a kind of continuum. An important characteristic of modern science, as differentiated from the arts, general literature and religion, is that it is "progressive." In the general nature of science, each new discovery is in some degree based on previous discoveries and in turn serves as the basis for other discoveries to come. The way in which this progress takes place is succinctly described by Sir William Dampier in his: *A History of Science and its Relations with Philosophy and Religion* (1930). In discussing the proposals of Francis Bacon (1561-1626) for scientific research, with emphasis primarily on collection of facts, Dampier states "that advances in science are seldom achieved by the pure Baconian method." He continues as follows:

"At an early stage insight and imagination must come into play; a tentative hypothesis must be framed in accordance with the facts, a mental process called induction; its practical consequences must next be deduced mathematically or by other logical reasoning, and tested by observation or experiment. If discrepancies appear, a new guess must be made, and a second hypothesis framed, and so on till one is found that is in accordance with, or as we say 'explains', not only the primary facts but also all those brought out by the experiments specially made to test it. The hypothesis may then be advanced to the rank of a theory, which may serve to co-ordinate and simplify knowledge, perhaps for many years. But it is seldom, if ever, safe to say that a theory is the only possible one which fits the facts; it is merely an affair of probability. Indeed the facts themselves may increase in number and complexity as new knowledge comes to hand, and the theory may have to be modified or superseded by one more suitable to the enlarged vision of a later time."

One of the major objectives of this exhibit on the history of science is to show in some degree the way in which scientific publications of the past illustrate this tendency of science in general and of each of the several branches of science to expand man's knowledge of the natural world. The limitations of the exhibit space prevent the inclusion of many of the stepping stones, but those that are displayed offer many outstanding examples. Relatively few of the scientific publications through the centuries announce major advances which may be viewed as landmarks. While most of the books in this exhibit are in the landmark category, some are lesser works of the great scientists, and others are the work of minor and relatively obscure authors, thus dramatizing the progressive and expansive nature of scientific thought.

In achieving the above objective, the exhibit also demonstrates the breadth and depth of Crerar Library's collections in the history of science. In some instances, the library lacks one or more of the important works of a scientist, but these tend to be the exceptions. It is interesting to note the frequency with which an author's continued research leads to new editions of his work during his lifetime. The

annotations for each book in the exhibit attempt not only to identify the principal contributions of the author, but also to give some indication of the resources of the library for further study. At one time or another, every researcher, whether in academic department or industrial laboratory, finds it useful to check back on the content of earlier publications in the field of research.

Because of the combination in the Crerar collections of the whole range of the physical and biological sciences and their applications in medicine, engineering and much of agriculture, the significance of the whole is greater than the sum of its parts. This is illustrated by items in the exhibit by classical authors represented in more than one field: Huygens in both mathematics and physics; Napier in both mathematics and technology; Galileo in both astronomy and physics; Boyle in both physics and chemistry; Borelli in both physics and zoology; Davy in both chemistry and technology; and Agricola in both geology and technology. Many other examples could have been included.

The advantages of a research library which covers all fields of the basic and applied sciences become even more apparent when consideration is given to the intersections and overlapping of the various sciences in the literature and particularly in the periodical literature. In viewing the history of science, one first notes that most of the modern sciences had a common ancestor, "natural philosophy." Even in the beginning, however, some individuals followed special bents of interest. There were many facets of the environment: the plant life, the animal life, the characteristics and behavior of inanimate phenomena such as fire and the winds and the heavenly bodies, which were under common observation of all. Naturally, development of the special sciences was gradual, but by the nineteenth century the major divisions, aside from mathematics, had become astronomy, physics, chemistry, geology, botany and zoology. It is under these categories that the books in this exhibit are organized, with a brief statement at the beginning of each section noting the scope of the subject.

No such simple grouping of "landmarks" would be possible for an exhibit extending into the 20th century. Already by the last quarter of the 19th century, the compound microscope had generated a completely new scientific discipline, bacteriology. Even before this, numerous facets of living matter common to both botany and zoology required the more general term, biology.

With the great surge of scientific developments in the 20th century, the boundaries between the conventional divisions of science have been often completely obscured, and the knowledge of two and often more of the broader disciplines has been requisite to the solution of some problems being subjected to formal research. Physics, chemistry and biology become increasingly merged in modern science and in their applications to practical problems. Evidence of this is provided in any research library by the frequency with which the periodical literature of several disciplines is called for in connection with one research subject.

It may be of interest to those viewing this exhibit to have some account of the way in which the Crerar collections have been developed. Since its incorporation in 1894, it has been the policy of the library to acquire both current and historical materials in all of the sciences. By the time Crerar entered the field, more than three centuries of active publication had passed. An organized effort to acquire the most essential historical materials was made by the first librarian, Clement Walker Andrews. He first compiled an extensive desiderata list of periodicals and concentrated on the acquisition of titles on that list. By the time of his retirement in 1928, all of the titles on that list had been acquired, including the major titles published since the first such publications began in the late 17th century.

Unfortunately, no such desiderata list for the acquisition of important older books was compiled, and good guides for such purchases did not exist. However, intensive effort was made through the years to acquire titles offered in the catalogs of antiquarian book dealers, and many very notable purchases were made by both Dr. Andrews and his successor, J. Christian Bay. During the 1950s and 1960s a somewhat more organized attempt was made to fill in specific gaps, but by this time prices of historical items were rising so rapidly that funds were inadequate to make all of the purchases that might have

been possible. With the aid of gift funds, however, items of major importance were acquired.

In the notes accompanying each item in this catalog, two objectives have been followed. First, a note is given of the contributions made by the title exhibited and by other works of the author to the progress of science. Second, attention is called to the holdings of the library which are available for further research on the contributions of each author. Both the other editions and other works by each author as well as the collateral publications about each author's work represent important resources for historical studies.

An additional note can be added here that is not covered by the annotations. From 1665 until the present time, an increasing proportion of the reports of scientific research has appeared in scientific periodicals. This frequently means that for many authors during the late 17th century and during the 18th, 19th and 20th centuries which have followed, other of their writings are available in the collections in periodical literature. This fact can be illustrated by just one example from the exhibit. Under *Physics*, there is exhibited a work by Charles Augustin Coulomb, a leading French physicist of the late 18th century. Not only was the "book" made of extracts from the *Mémoires de l'Académie des Sciences de Paris*, but other important writings by Coulomb appeared in that journal and also in the *Mémoires de l'Institut Natural des Sciences et Arts*, all of which are in the periodical collections of the library.

One truth shines clearly in viewing our exhibit of landmarks in the history of science: all great discoveries here recorded have had impact on man. Our views of the universe, our understanding of the living world of which we are a part, and our concept of our proper place in the scheme of things have gradually changed. We can still appreciate and be influenced by the ideas of the ancient worlds of Greece and Rome, but it is impossible for the informed person to hold the same views of the earth and its occupants and of the universe that were the common heritage of the residents of Greek and Roman society. We cannot help but be impressed by the social and humanistic elements in the many faceted sides of scientific progress.

Herman H. Henkle

Chicago, August 1978

SCIENCE THROUGH THE AGES

GENERAL SCIENCE

"General science" like "general education" is a nebulous term, largely bibliothecal in origin and convenient for describing publications that include all or several of the sciences. In its origins early in the history of human learning, it was just one word to describe the study of the natural world. Aristotle and Pliny, whose works are exhibited, were examples from the Greek and Roman worlds of writers who were interested in all knowledge.

In its use in this section of the exhibit, general science presents examples in three areas: (1) individual authors whose preoccupation was with all of science—Aristotle, Pliny and Leonardo da Vinci; (2) writers whose concern was the intellectual approach, the methods, applicable to science in general—Bacon and Descartes; and (3) publications such as the proceedings of scientific societies, scientific periodicals and encyclopedias, which incorporate materials on all of the sciences. As in all of the other sections of the exhibit, the examples displayed here must be viewed as only symbols of a broad and complex range of scientific literature in each area.

1

Aristoteles, 384-322 B.C.

[Opera Graece]

Venice, 1495-1498; 5 vols.

Aristotle was the most noted of the great Greek scholars who attempted to cover all of human knowledge. Son of the physician to Philip, King of Macedon, he studied for many years under Plato in Athens. He was private tutor to Alexander the Great, and later established his own Lyceum in Athens. One of his famous pupils was Theophrastus, the Greek botanist, who succeeded Aristotle as head of the Lyceum. Aristotle made contributions to the physical sciences, especially astronomy; but he was primarily a biologist. Charles Singer, the British historian of science, calls attention to the accuracy of Aristotle's observations of certain fish. A major contribution was the precision and formal logic which he applied to all of science. His work stood for many centuries as the major compilation of all of the knowledge produced in the ancient world.

Aristotle's complete works first appeared in print in 1472-1474. Crerar's earliest edition is the one exhibited, purchased in 1915, and is noted for the beauty of its Greek text. Three volumes of this set are in stamped pigskin with the original bosses. Other editions of his complete works are in the collections, including *The Works of Aristotle* translated into English, Oxford, 1908-1931, in 11 volumes. The collections of the library include seventy Aristotle entries (sixteen before 1600) representing more than 100 volumes; and there are fifty works with commentaries on Aristotle.

2

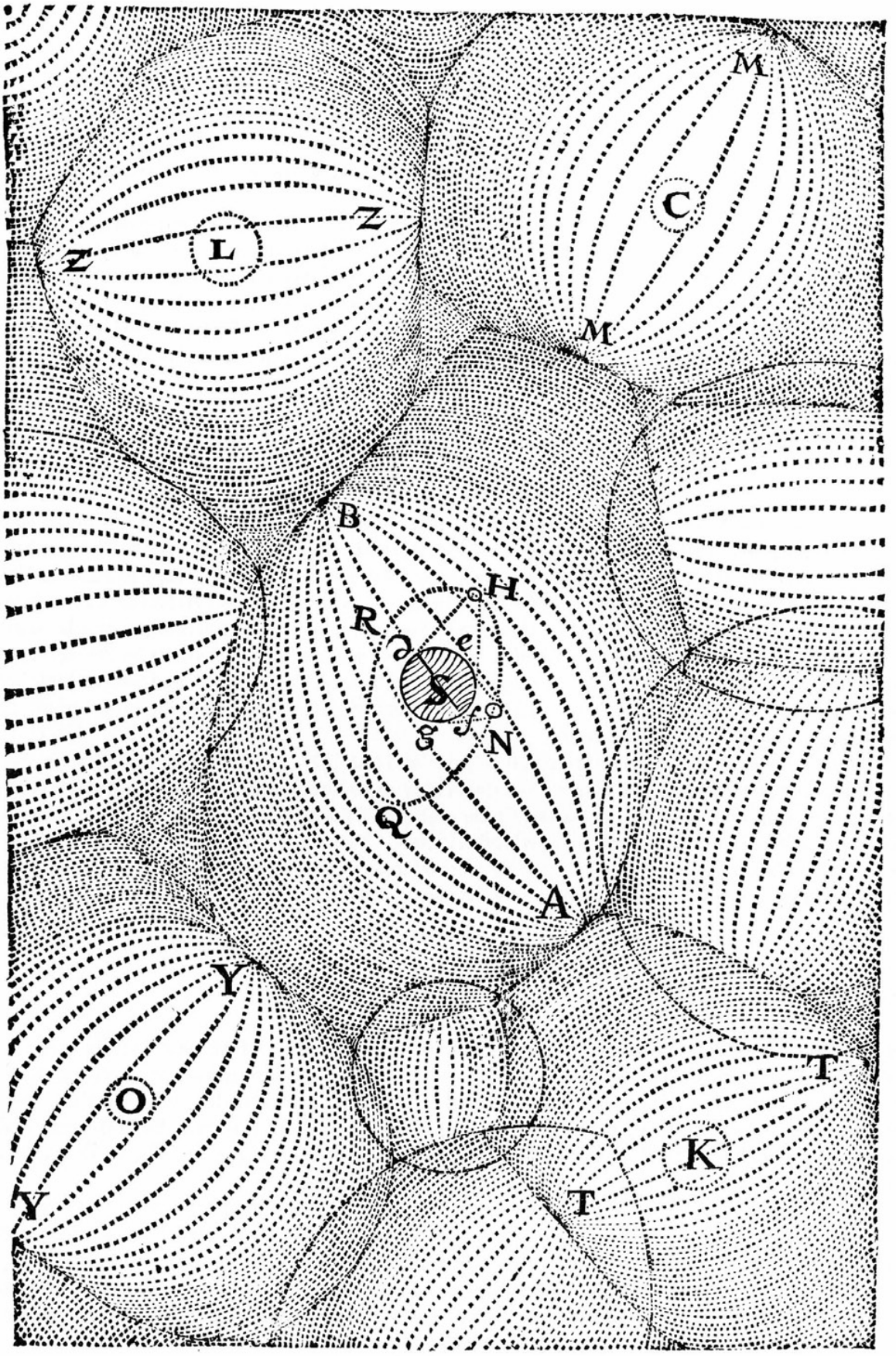
Caius Plinius Secundus, 23-79

Naturalis Historiae

Venice, 1472

This is an encyclopedia covering the whole of scientific knowledge of its time, which made many references to Greek and Roman writers, some of whose works are no longer known. Anthropology and geography, botany and zoology, and practical arts in medicine, fruit-growing, wine-making, and uses of metals were all encompassed in the treatise. Not all of the content was fact. Both the real and the imaginary were included; the lion and the unicorn were given equal recognition. The work is primarily a compilation.

As in the case of the works of Aristotle, Crerar did not acquire the first printing of this work, commonly referred to as *Historia Naturalis*, which was printed in Venice in 1469. The edition of 1472, however, produced in Venice by the famous printer, Nicolaus Jenson, was purchased in 1915. Some thirty Pliny titles are in the collections, including eight different multivolume editions, two in English. Displayed here, from the 1472 edition, are two pages of the Latin text, with the printer's indications (by small letters) of the initials that were to have been added by hand.



6. René Descartes. *Principia Philosophiae*. 1644.
Descartes' concept of gravitational force, exemplified by Saturn.

3 & 4

Leonardo da Vinci, 1452-1519

I Manoscriti e i Disegni

Rome, 1923-1941; 5 vols.

Quaderni d'Anatomia

Christiania, 1911-1916; 6 vols.

Leonardo da Vinci has been variously referred to as a "universal genius," "the first modern man," and "the best representative of the Renaissance artist-naturalists." Sir William Dampier wrote of him: "A painter, sculptor, engineer, architect, physicist, biologist, and philosopher was Leonardo, and in each role he was supreme. Perhaps no man in the history of the world shows such a record." Unfortunately, the scientific work of Leonardo was not published within his lifetime; and his notebooks were not produced until the past century. Nevertheless, no general exhibit on the history of science would be adequate without examples of his work. Two examples are exhibited here. The first is his conception of the air screw, a progenitor of the helicopter. The second is Leonardo's drawing of a human fetus in the womb, in sharp contrast to the more crude, and inaccurate, anatomical drawings of the time.

The Crerar collections contain all of the major facsimile reproductions of Leonardo's scientific notebooks. There are more than seventy volumes of facsimiles and printed works, and an equal number of books that deal with his life and works. Acquisitions have been largely limited to materials of scientific interest. In fact, one major Crerar Library purchase was made jointly with the Art Institute of Chicago, with volumes on Leonardo's paintings going to the Institute's library.

5

Francis Bacon, Viscount St. Albans, 1561-1626

The Twoo Bookes of Francis Bacon.
Of the Proficience and Advancement of
Learning Divine and Humane

London, 1605

Bacon was one of the first of the great philosophers of modern times to promote the study of the sciences. His emphasis was on the making of observations and collecting facts; he overlooked the importance of the hypothesis as a guide to research. His ideas were expanded in a later edition and included his concept of the classification of the sciences. The latter, in particular, greatly influenced the French encyclopedists of the eighteenth century; but Bacon's philosophy, though far in advance of his time, had relatively little influence on his contemporaries.

The Crerar collections contain both this and the expanded 1640 edition of the "Advancement of Learning." Altogether, there are fifty-five titles of works by and about Bacon, including several editions of his *Works*, the Latin edition of 1665 and English editions of 1753, 1825-1834 (in 16 volumes), and 1887-1901.

6 & 7

René Descartes, 1596-1650

Principia Philosophiae

Amsterdam, 1644

The Methods, Meditations, and Selections
from the Principles of Descartes

Translated from the original texts

Edinburgh, 1880

Descartes' major contribution to the sciences was his concept of scientific investigation. One of his "principles" (VI) was: "That we possess a free-will, by which we can withhold our assent from that which is doubtful, and thus avoid error." He introduced the importance of the hypothesis as the basis of observation and experiment. In his "Discourse on Method," which follows the introduction in the

second of the works exhibited, one of his first observations is: "For to be possessed of a vigorous mind is not enough; the prime requisite is rightly to apply it." Included in his ideas on correct application was emphasis on the necessity of mathematical proof.

The first edition of Descartes' *Discours de la Méthode* (1637) is not in the Crerar collections, but does appear in the collected edition of his *Oeuvres*, published in 1824-1826 in eleven volumes, and republished in 1897-1909. More than thirty of his works are in the collections, four published in his lifetime and fifteen others before 1700, including his *De Humane Figuris* (1664).

8

Accademia del Cimento, Florence
Saggi di Naturali Esperienze fatte nell' Accademia del Cimento
Florence, 1691

The Accademia del Cimento of Florence, in 1651, was one of the first scientific academies established in Italy. It was a predecessor of the Royal Society of London, incorporated by Charles II in 1662, and the Académie des Sciences founded in Paris in 1666 by Louis XIV. These societies provided a means to bring men together to discuss new ideas and discoveries and to promote their progress. This publication issued by the Academy in Florence is the record of reports presented by members to the Academy.

The Crerar collections lack the first (1666) issue of the *Saggi*... but do include the 1691 and later editions. The *Philosophical Transactions* of the Royal Society of London and comparable publications of other great academies and societies are represented in the collections, for the most part in complete sets. The contribution of these publications to the advancement of science can hardly be overemphasized.

9

Acta Eruditorum
Leipzig, 1682-1731

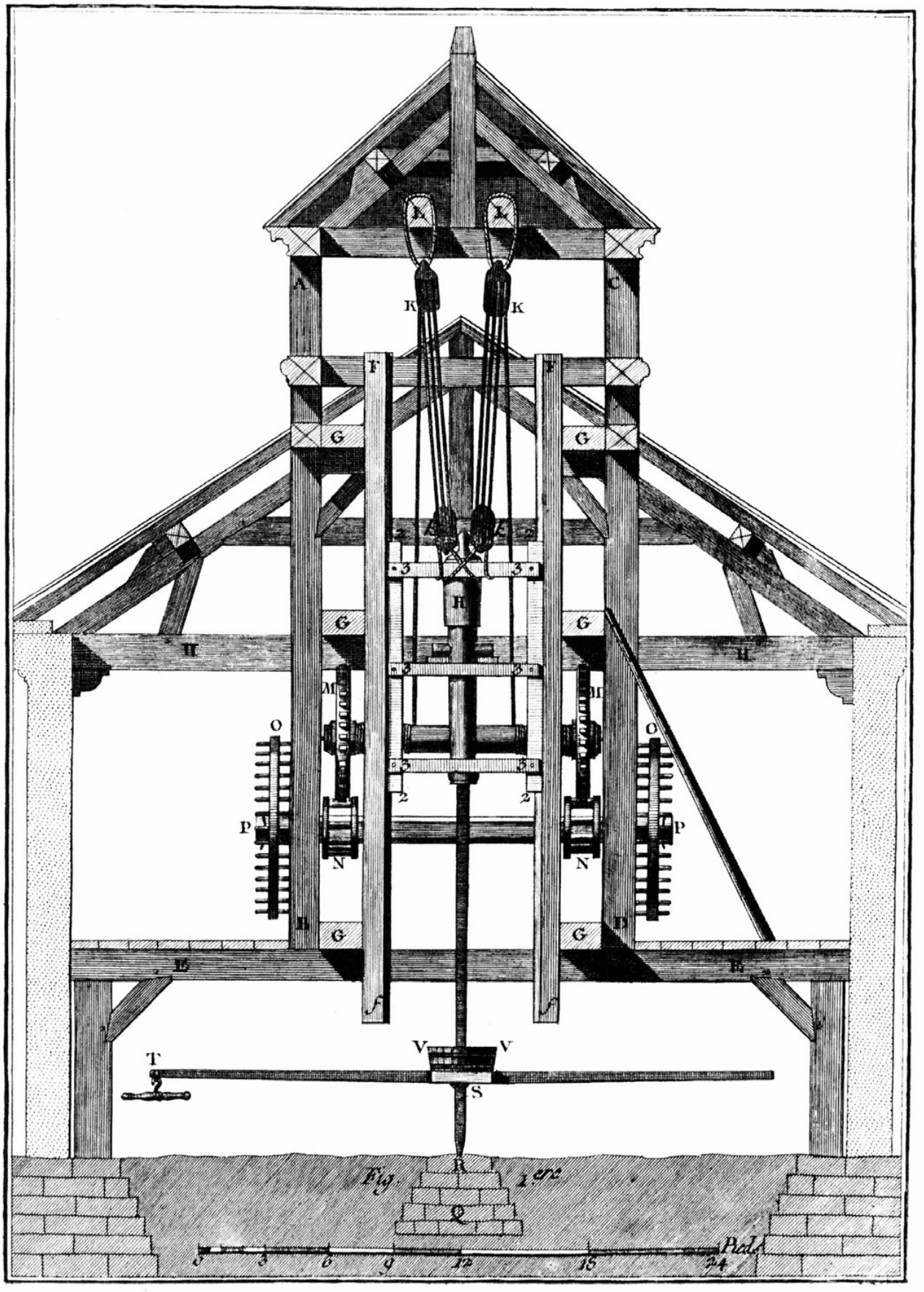
Like the proceedings and transactions of the scientific societies and academies, the scientific periodicals are the record of "front line" advancement of science. The *Acta Eruditorum* was the first independent scientific periodical. With its supplements, new series and indexes, it continued publication for a full century, 1682-1782, to a total of 125 volumes, which are bound in the Crerar collections in 100 volumes.

The volume exhibited appeared in 1684, and contained the article by Gottfried Wilhelm von Leibnitz (1646-1716) with his announcement of the discovery of the differential calculus. In our own time, the scientific periodical, or journal, is the dominant form of scientific publication, especially for reporting progress and new discoveries resulting from scientific research. More than 10,000 titles are received by Crerar currently, representing all of the special branches of science, technology and medicine.

10

Denis Diderot, 1713-1784
Jean de Rond d'Alembert, 1717-1783
Encyclopédie, ou Dictionnaire Raisonné des Sciences, des Arts, et des Métiers
Paris, 1751-1780; 17 vols., with Atlas of 11 vols., and Supplement of 4 vols. with an Atlas

The major contribution of this ambitious publishing project of the eighteenth century was collecting and focusing attention on the many different fields of knowledge of the time. It has been credited as being the most influential publication of the 1700s. The chief editor, Diderot, was himself encyclopedic —a novelist, dramatist and writer on art, literature and science. His great contribution was in enlisting the assistance of the major writers on many subjects to produce a remarkable compendium. Many important scientists contributed to the *Encyclopédie*, including Euler, whose individual work is exhibited under Mathematics. The joint editor, d'Alembert, was a French philosopher and mathematician, and



11. *Encyclopédie Méthodique*. 1782-1832.
Equipment used in drilling and polishing of cannons.

contributed articles in these fields and in literature. It was during the course of publication of this great French encyclopedia that the first edition of the *Encyclopaedia Britannica* was published in three volumes in Edinburgh (1771).

11

Encyclopédie Méthodique

Paris; Liege, 1782-1832; 186 vols.

This interesting encyclopedia is essentially a republication of the Diderot-d'Alembert *Encyclopédie*, with the text and plates regrouped by special fields of science and other subjects. Examples are *Arts et Métiers Mécanique* in eight volumes (1782-1791); *Mathématique* in three volumes (1784-1789); and *Ornithologie* in three volumes (1790-1823). Its purchase was made jointly by Crerar and Newberry libraries. The volumes on subjects related to the humanities are in Newberry; and the remaining volumes related to the sciences, technology, and medicine are in Crerar. The volume exhibited is opened at a plate illustrating the construction of the wheel for wagons and carriages.

(Note: Major sources differ in the number of volumes in a complete set. The *National Union Catalog—Pre 1956* describes a set with 199 v.; the *Catalogue of the . . . British Museum (Natural History)* describes the set as having 196 volumes bound in 186.)

MATHEMATICS

Mathematics has been referred to as the "handmaiden of science" in the sense that its language, concepts and logic are essential to the development of the other sciences. At the same time, it is not a branch of the natural sciences, but stands alone as an entirely independent field of knowledge. While much of its origin had utilitarian motives, abstract mathematics can be pursued without having any concern at all with science. Mathematics developed early in both the new world and the old, illustrated by the accuracy of the Maya Indian calendar and the use of geometry by the early Egyptians in the measurement of land. Pure mathematics engaged the interest of such Greek philosophers as Euclid, Apollonius and Archimedes, represented in the exhibit by the works of Euclid on geometry and of Apollonius on conic sections. Space permits only the barest representation of the growth of mathematics in modern times, with only Tartaglia from the 16th century; Hulsius, Napier, and Huygens from the 17th; and Bernoulli and Euler from the 18th. Such giants as Newton could be here, but find their places in other parts of the exhibit. Still another to be acknowledged is Joseph Louis de La Grange (1736-1813), perhaps the greatest mathematician in the late 18th century, whose works are well represented in the Crerar Library collections.

12 & 13

Euclides, *ca.* 323-*ca.* 275 B.C.
Opus Elementarum . . .
in Artem Geometriae
Venice, 1482
Euclidis Sex Primi
Elementarum Geometricorum
Rerumque Mathematicorum
Christophori Grienbergi
Rome, 1619

The origins of geometry date back at least to the sixth century B.C., when Thales originated the science of deductive geometry from empirical rules for land-surveying used in Egypt. Existing knowledge of geometry was collected, expanded and systematized by Euclid of Alexandria about 300 B.C., and from his contributions has come a work that has had a reign almost comparable to that of the Bible. There are reputed to be more than a thousand different editions of Euclid's *Elements* in many languages. No fewer than 75 editions appeared before 1700, in Latin and Greek, and in Arabic, Dutch, English, French, German, Italian and Spanish. Many of these exist in very few copies. The 1619, small pocket edition exhibited, is not recorded in the *National Union Catalog—Pre 1956*, although a later edition (1636) by Christoph Grienberger does appear in that record.

The Crerar collections have 48 catalog entries including various editions of Euclid's works and numerous commentaries. His *Opera Omnia* (Leipzig, 1883-1916) in eight volumes is in Greek and Latin. The 1482 edition is opened at pages showing marginal geometric figures and a good display of the Roman type and initial letters used by the printer, Erhardt Ratdolt.

14

Compendium Euclidis Curiosi;
or, Geometrical Operations
London, 1677

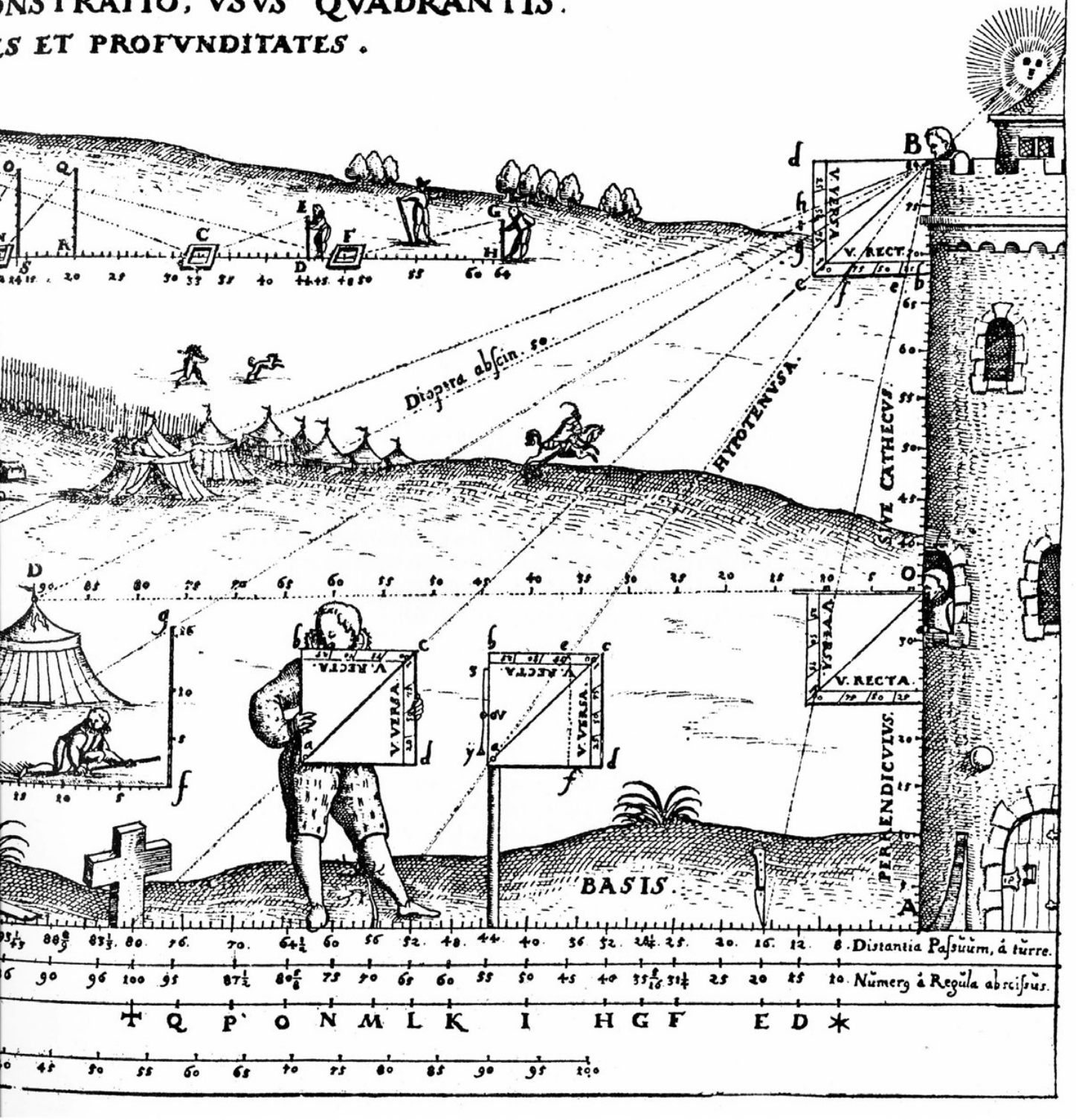
This item is exhibited as an example of early application of Euclid's propositions—one of two copies recorded in the *National Union Catalog—Pre 1956*. The volume is opened at the title-page to display the engraving of mathematical instruments.

17. Levinus Hulsius. *Tractat der mechanischen Instrumenten*. 1603-1607.
Use of the quadrant for determining elevation.

PRIMA.

ONSTRATIO, VSVS QVADRANTIS.

ES ET PROFVNDITATES.



15

Apollonius of Perga, *ca.* 260-200 B.C.

Conicorum Libri Quattuor

Bologna, 1566

Appolonius followed Euclid and Archimedes in the study of conic sections, but his work represents the classical treatise on the subject. He identified the ellipse, the parabola and the hyperbola and gave them their names, and demonstrated that all could be considered as sections of one cone. His original work consisted of eight books, only the first four of which are included in this first printing of his work. The fifth, sixth and seventh books were not published until 1661; and the eighth book is recorded as lost. The geometry of conic sections was used in the development of seventeenth century astronomy.

Only a handful of Apollonius titles appear in the Crerar catalog, two of which are an English edition (1896) and a French edition (1923) of his *Conics*. The item exhibited is opened at illustrations and mathematical analysis of hyperbolic curves.

16

Niccolo Tartaglia, 1506?-1559

Nova Scientia Inventa da Nicolo Tartalea

Vinegia, 1537

The author of this work was trained as a practical engineer and applied mathematics to the operation of artillery. He anticipated Galileo's laws of falling bodies by demonstrating that the trajectory of a missile fired from a cannon was not a straight line, as was then assumed. Although he taught in universities, he did not know Latin, so his works, mostly published in Italian, were not given proper recognition by the scholarly world. He made other important contributions to mathematics.

Three of the half dozen Tartaglia titles in the collections are in Italian; one deals primarily with military engineering, including chapters on the compass and the balance. An edition of Euclid's geometry published in Vinegia, 1543, contains commentaries by Tartaglia. The volume exhibited is opened at the title page on which an illustration suggests the trajectory of a cannon ball.

17

Levinus Hulsius, d. 1606

Tractat der mechanischen Instrumenten

Frankfurt, 1603-1607; 4 pts.

This obscure work by Hulsius is exhibited as an example of an early work on mathematical instruments. Only the first four of fourteen parts projected were published. Hulsius was born in Ghent, Belgium, and went to Germany in his early manhood about 1590. His untimely death cut short his work, and part four was published after his death by his widow.

18

John Napier, 1550-1617

A Description of the
Admirable Table of Logarithms

London, 1616

The title page of this small but very significant work states also that the logarithms were "Invented and published in Latin by that Honorable L [ord] John Napier, Baron of Murchiston, and translated into English by the late learned and famous mathematician Edward Wright." The invention of logarithms in 1614 was a brilliant method of simplifying calculation, an aid greatly needed for the expanding physical sciences. They served as the basic mathematical element in the slide rule developed by Oughtred only eight years later in 1622.

The first publication of the logarithms was in Edinburgh, 1614, under the Latin title *Mirifici*

Logarithmorum Canonis Descriptio. This classic is not in the Crerar collections, but the almost equally rare English translation was acquired in 1915. The Crerar copy was formerly in the author's own private library. It is opened here at the first of about ninety pages of logarithms.

19

Christiaan Huygens van Zuylichem, 1629-1695

De Circuli Magnitudine Inventa

Leyden, 1654

Huygens was a Dutch mathematician, astronomer and physicist and is represented in this exhibit under both mathematics and physics. Among his mathematical writings was this work, in which Huygens made the closest approximation so far obtained to the ratio between the circumference and diameter of a circle. This copy of the title was formerly in the private library of Dr. Herbert McLean Evans, the principal sponsor of a celebrated exhibit of first editions in the history of science at the University of California in Berkeley in 1934.

A note on Huygens in the Crerar collections appears with No. 39 under Physics.

20

Jacques Bernoulli, 1654-1705

Ars Conjectandi

Basel, 1713

In this book, the calculus of probability and the theory of combinations are developed by Jacques Bernoulli. He died before the book was completed, and it was published posthumously. Bernoulli was a member of a family, first in Antwerp and then in Basel, eight of whose members were distinguished mathematicians. He was the first to use the term "integral" in the solution of Leibnitz's problem of the isochronous curve. The logarithmic spiral was engraved on his tombstone in the Basel cathedral, at his request.

The Crerar Library collections contain ten works under Jacques Bernoulli, including his *Opera*, Geneva, 1744, in two volumes. The volume exhibited is opened at text and a plate dealing with the mathematics of complex curves.

21

Leonhard Euler, 1707-1783

Methodus Inviendi Lineas Curvas

Lausanne & Geneva, 1744

Euler was a Swiss scientist whose contributions were broadly based in mathematics and the physical sciences. He began publishing in his twenties and was only 37 years old when the book exhibited was published. Through this work he is credited with creating the calculus of variations. He wrote on other branches of mathematics and also on astronomy, hydrodynamics, optics, gunnery and the general principles of natural philosophy. During the course of his productive career, he served as a professor in St. Petersburg (1730-1741) and Berlin (1741-1766). He was a prolific writer of papers and books and continued his contributions even into a long period of blindness.

The work of Euler is well represented in the Crerar Library by a special collection with more than fifty books by him, half of which were published during his lifetime. There are also twenty books with biographical information and commentaries on his work.

ASTRONOMY

The study of the heavenly bodies may be viewed as the oldest of the sciences. Observations of the heavens began deep in the recesses of history, and many were made by primitive peoples in both the old and the new worlds. Astronomical observations can be traced back to Babylonian culture more than twenty centuries before the Christian era. Although observations of the sun, moon and stars were long associated with astrology, they also led to such practical matters as recording the passage of time and development of the calendar. By the sixth century B.C., it was possible to predict eclipses of the sun and moon. The concept of the sun as the center of the universe was proposed by the Greek philosopher, Aristarchus, as early as the fourth century B.C., but the time was premature; and the belief that the sun, moon and stars revolved about the earth was the established doctrine for another eighteen centuries.

Nevertheless, many observations during the Greek, Roman and Arabic periods prior to the Renaissance developed a substantial body of knowledge about the heavenly bodies. One of the works which came out of the Alexandrian period in the second century A.D. was the *Almagest* of Claudius Ptolemy, which influenced astronomy until the time of Copernicus in the 16th century. One of the explanations of the slow development of knowledge of astronomy was the lack of the telescope and other astronomical instruments. With the development of these, many of the misconceptions of earlier periods were corrected, and advancement of knowledge in the field was rapid. And it was finally possible to break the ties between astronomy and the beliefs of astrology and religion. Here, again, the examples are very selective and illustrate development only into the 17th century.

22

Johannes Mueller, Regiomontanus, 1436-1476

Epitoma in Almagestum Ptolomaei

Venice, 1496

The *Almagest* of Ptolemy had been known since the 12th century only through a poor translation in Arabic. Georgius Peuerbach, a 15th century scholar, was commissioned to produce and edit the correct text. He died before the work was completed, and it was finished by his student, Johannes Mueller, commonly referred to as Regiomontanus. This represents the first printed edition of the *Almagest*. It represents, also, the background of astronomical knowledge against which modern astronomy developed. The large woodcut exhibited appears on the verso of the third leaf and shows Ptolemy and Regiomontanus seated under the zodiac on an armillary sphere. Regiomontanus' commentaries also appeared in Ptolemy's *Geographicae* (1525) and in several editions of Sacrobosco's *Sphaera Mundi* also exhibited here.

The Crerar collections have the works of both Regiomontanus and Ptolemy well represented. Thirteen other works relating to Regiomontanus are here; and more than thirty five works by and about Ptolemy are in the collections, including his *Quadripartitum. Centiloquium cum commento Haly*, Venice, 1484.

23 & 24

Johannes de Sacrobosco, ca. 1200-1256

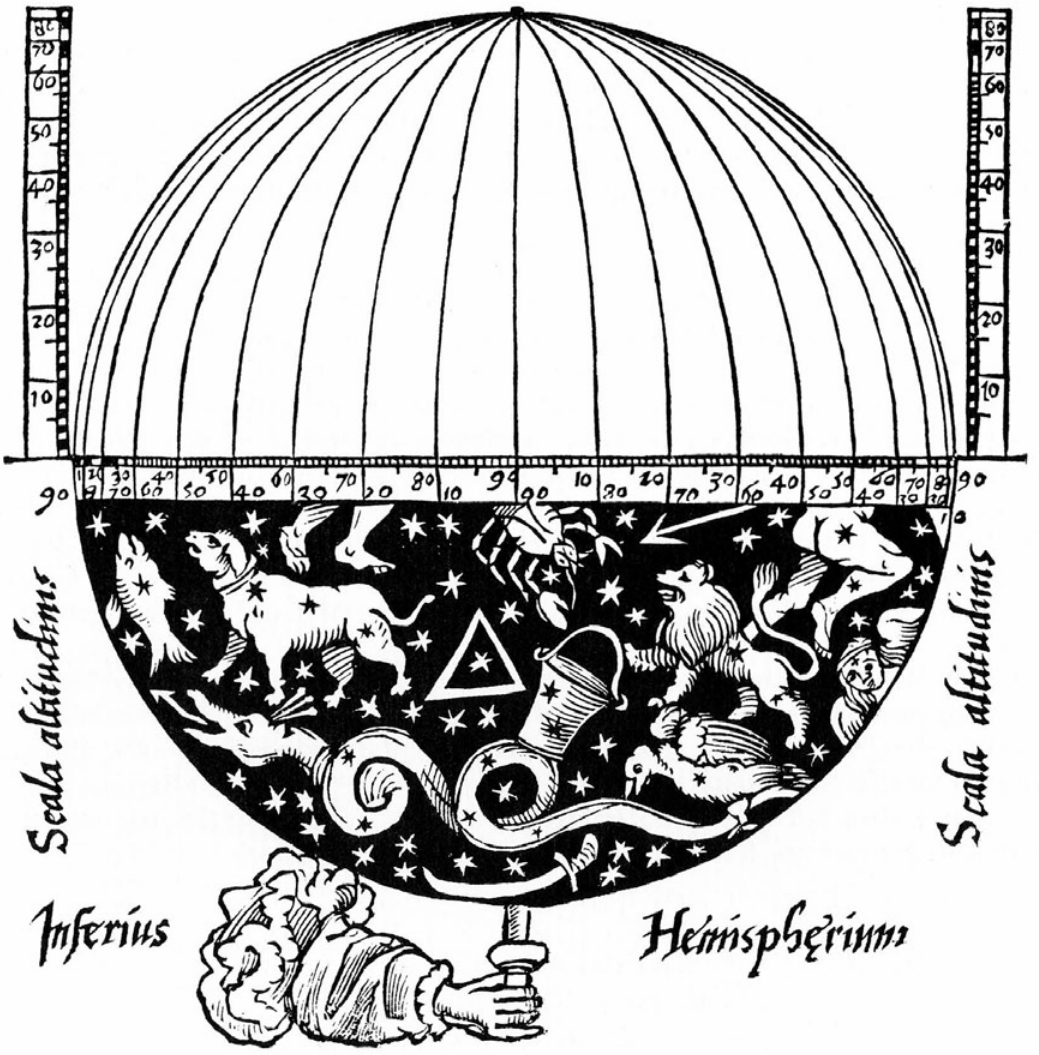
De Sphaera Mundi

Venice, 1488

Sphaera . . . Emendata

Lyon, 1578

De Sphaera Mundi is an elementary treatise on astronomy written about 1230 by an Englishman, John Halifax or John of Holywood, more commonly known as Sacrobosco. It was a widely popular book, being frequently copied during its manuscript period and having wide use in universities. After the invention of printing, it appeared in some seventy editions between its first printing and the middle of the 17th century. Although the work is rooted in Ptolemaic astronomy, it is important to note that this



25. Petrus Apianus. *Cosmographia*. 1540.
Zodiac showing constellations visible in the southern hemisphere.

most widely used textbook on astronomy for two centuries before Columbus did teach that the earth is round. It was one of the earliest books to use "volvelles" or rotating illustrations, for which see Apianus below.

Crerar Library collections include the first incunable edition, published in 1482, and three others published by 1500, as well as twenty other early editions, mostly with some variation of "Sphaera" in the title, and several with volvelles. The 1578 edition is exhibited to show the illustrations intended to be cut out and mounted as volvelles on pages 32 and 55 of the volume.

25

Petrus Apianus, 1495-1552

Cosmographia

Antwerp, 1540

Apianus was a German cosmographer and mathematician noted for his knowledge of astronomy. Outstanding in this field was his *Astronomicarum Caesarium*, published at Ingolstadt in 1540, where

Apianus was serving as professor of mathematics. This striking work was illustrated with thirty-five plates containing volvelles. Unfortunately the astronomy was based on medieval geocentric concepts. The work is not in Crerar Library collections; but his better known work, *Cosmographia*, also published in 1540, is in the collections in seven editions between 1540 and 1584. All but one of these contain volvelles as illustrations, the first of which is displayed here. Still another interesting work by Apianus is his *Quadranus Apianus Astronomicus*, published in Ingolstadt in 1532. The special volvelle type of illustrations designed by Apianus were first used in this work. With this volume, there is also in the collections a German text describing the Apianus "geometrical" instruments, by Galgemair, published in 1616.

26

Nicolaus Copernicus, 1473-1543

De Revolutionibus Orbium Coelestium, Libri VI

Nuremberg, 1543

Exhibited here is a special copy of one of the handful of the greatest classics in the history of science. By declaring the heretical heliocentric theory of our planetary system, it revolutionized astronomy and caused a major shift in the human view of the universe. The author was a Polish physician, cleric and scientist, who as a young man lectured on mathematics and astronomy in Rome. When he was in his late thirties, he became canon of the cathedral in Frauenberg, East Prussia. His new theories were probably completed about 1530. They received prior announcement by a pupil of Copernicus, Georg Joachim Rheticus (1514-1576), by publication in 1540. Copernicus' own edition did not appear until the year of his death.

The copy of *De Revolutionibus* . . . in the Crerar collections was censored by the 1620 rules of the Inquisition, demonstrating that after nearly a hundred years the new concepts of the universe were still being resisted by the Church. Also in the Crerar collections is the third edition of the Copernicus classic, published under the title, *Astronomia Instaurata, libris sex comprehensa, qui De Revolutionibus Orbium Coelestium*, Amsterdam, 1617. The Rheticus title is in the collections only in the 1621 edition. There are also thirty-five titles about the life and works of Copernicus.

27

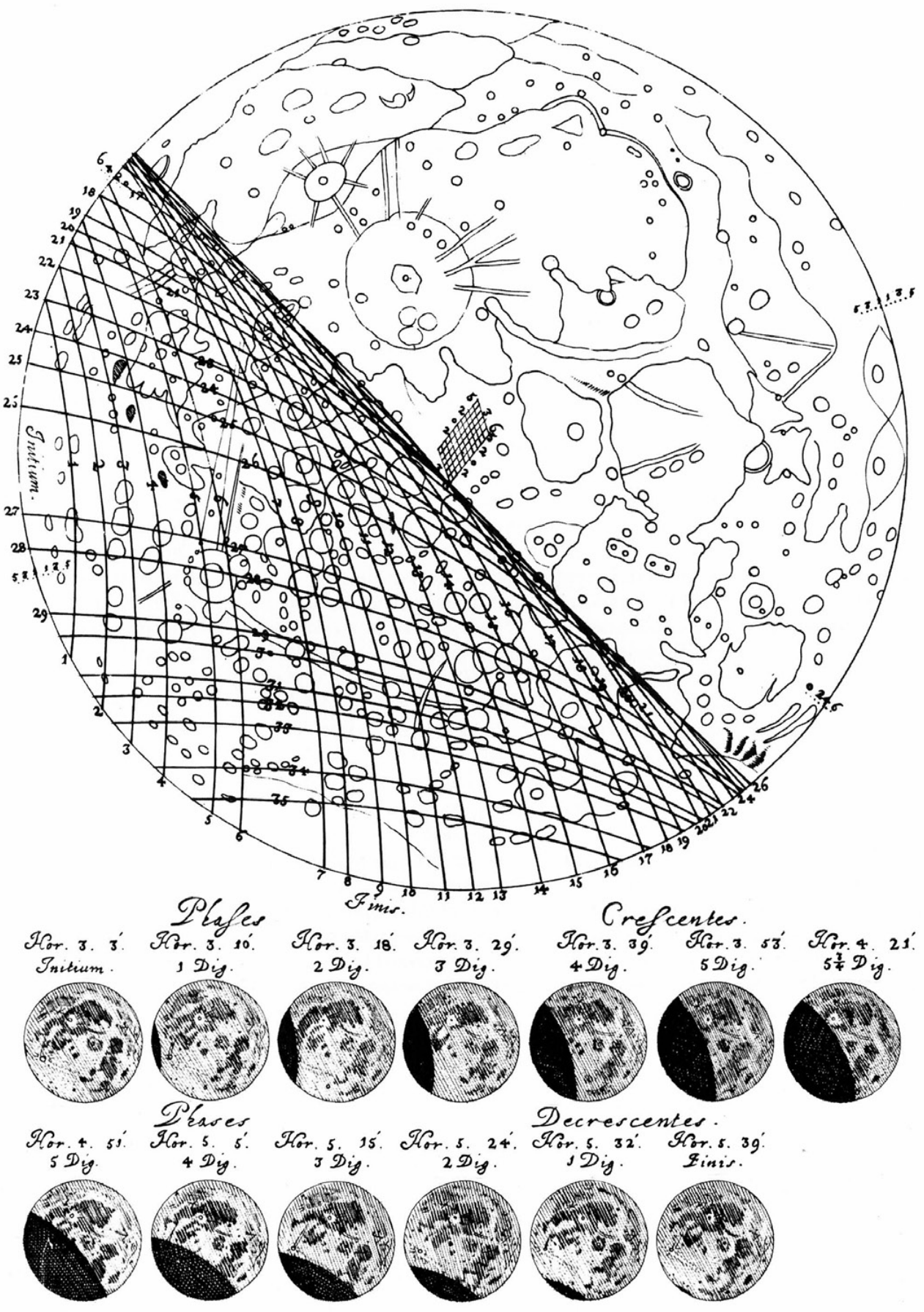
Galileo Galilei, 1564-1642

Dialogo . . . Sopra i due Massimi Sistema del Mondo

Florence, 1632

In 1610, Galileo's book, *Sidereus Nuncius*, announced to the world his observations of the moon and stars through the newly invented telescope—the mountains and valleys on the moon and the countless stars in the Milky Way. It can be said that with this book truly modern astronomy was born. Inevitably it presented evidence in support of the Copernican theory of the heliocentric universe. Then in 1632, Galileo published his Dialog on the System of the World, in full and open support of Copernicus. In the form of a dialog between Aristotle, Ptolemy and Copernicus, he displayed the Copernican theory of the structure of the universe. For its publication, Galileo was tried by the Inquisition and sentenced to permanent house arrest; and his book was placed on the Index of censored works where it remained until 1822. But a still greater work was to follow, which is displayed in the section on Physics.

The Crerar Library collections lack the first (1610) edition of Galileo's great work on astronomy, the *Sidereus Nuncius*. Aside from this lacuna, however, his work is well represented. Some forty Galileo titles are in the collections including the 1653 and 1655 Italian and 1880 English editions of his *Sidereus Nuncius*; three editions before 1700 of his great text book on physics (see No. 34); and seven collected editions of his works, from the *Opere* published in Bologna, 1656, in two volumes, to his *Le Opere* published in Florence, 1891-1909, in twenty volumes. There are also more than seventy-five titles about his life and work, including the biography and fifteen other works by Galileo's biographer and commentator, Antonio Favaro (1847-1922).



29. Johannes Hevelius. *Mercurius in Sole Visus Gedani*. 1662.
A partial eclipse of the moon.

28

Johannes Kepler, 1571-1630

Harmonices Mundi Libri V

Linz, 1619

In the years of his life, Kepler was a contemporary of Galileo, but in terms of his concepts of the universe he was a predecessor. Much of his interpretation of the phenomena of astronomy was metaphysical, and Platonic influences were characteristic in his writings. Yet he was a distinguished mathematician, and was won over to the mathematical simplicity and harmony of the Copernican system. Three conclusions reached by him have come to be known as Kepler's laws: (1) The orbits of planets are ellipses with sun as one focus; (2) The areas covered by any planetary orbit as measured by the straight line between the planet and the sun are proportional to the times; and (3) The squares of the periodic time of each planet is proportional to the cube of its mean distance from the sun.

The first two of these "laws" were developed in his *Astronomia Nova* (1609) in which he published the results of calculations of the orbit of Mars made by Tycho Brahe (1546-1601), the first modern astronomer to record details of planetary motion with a degree of accuracy. The data were bequeathed to Kepler by Brahe with whom he had worked as an assistant. The third law was announced in the work exhibited. The laws served in part as the basis of Sir Isaac Newton's celestial mechanics more than a century later.

Kepler, also another productive scientist, is not represented in the Crerar collections by first editions of all of his works. Most of his writings, however, are represented in some form. First editions are here for his *De Stella Nova in Pede Serpentarii* (1606); *Astronomia Nova* (1609); *Dioptrice . . .* (1611); *Harmonices Mundi* (1616); and *Tabulae Rudolphinae* (1627-1629); as well as his collected works. Altogether, there are twenty-four Kepler titles in the collections and a comparable number about his life and work.

29

Johannes Hevelius, 1611-1687

Mercurius in Sole Visus Gedani,
anno Christiano MDCLXI, d. III Maji . . .
Cui annexa est, Venus in Sole Pariter Visa,
anno 1639, d. 24 Nov. St. V

Gedani, 1662

Hevelius, like Copernicus, was a Polish astronomer. From a finely equipped observatory in his own house, he concentrated his observation on the moon and comets. His *Selenographia*, published in 1647, laid the foundation for study of lunar topography; and his *Cometographia*, 1668, was the first book devoted exclusively to comets. He was the first astronomer to describe the transit of Mercury across the sun. Both the transits of Mercury and of Venus are described in the volume on exhibit. It is opened at the plate which shows the phases of the eclipse of the sun observed on May 3, 1661.

The Crerar collections contain a dozen titles by Hevelius, including the three mentioned above, and five commentaries on his work.

PHYSICS

Physics is the science which is devoted primarily to the study of matter and energy. For each of these it seeks to define quantitatively (that is, in mathematical terms) its nature and the relationships between them. Even in the early periods when it was generally known as natural philosophy, physics sought to explain the structure of the natural world in terms of elementary principles and laws. The understanding of the nature of gravitation, electromagnetism, and more recently nuclear force, is at the center of the field of physics. Its subdisciplines are numerous: acoustics, ballistics, celestial mechanics, electromagnetism, hydrodynamics, kinetic theory of gases, and optics are common examples. In modern physics, fields of study become even more abstruse with such special fields as high energy physics and particle physics. Increasingly, too, there is emphasis on the impingement on other disciplines in such areas as astrophysics, biophysics and geophysics.

An exhibit of books to represent such a complex discipline completely would require more space and more titles than are permitted for this entire exhibit. Hence the selection of items here is limited primarily to a fraction of the field. Nevertheless, there are included here some names that are immortal in the history of man and the records of some observations and discoveries that have opened up whole new vistas in man's search for knowledge.

30

Joannes Taisnier, b. 1509

Opusculum Perpetua Memoria Dignissimum
De Natura Magnetis et Sive Effectibus

Colonia, 1562

The earliest author for the display on physics was selected in part because of his obscurity. Taisnier may represent the large number of other obscure workers in the sciences whose bits of information and ideas have played their part in the growth of knowledge. Only two of his books are in the Crerar collections, this one on magnetism and another published two years earlier on surveying. He also published a book on navigation translated into English about 1579. Both editions are excessively rare.

31

Simon Stevin, 1548-1620

De Beghinselen der Weeghconst De Weegdaet,
Praxis Artis Ponderaria De Beghinseln des Waterwichts

Leyden, 1586

Simon Stevenus, or Stevin, was an ingenious Dutch military engineer and mathematician. Although the idea was suggested earlier, Stevin was credited with introducing the system of decimal fractions. In the collection of works exhibited here, he laid the foundation for the development of statics and hydrostatics. Such matters as the forces involved in the inclined plane, stable and unstable equilibrium, and the stability of floating bodies are all areas to which his writings made important contributions.

The Crerar collections have an even dozen titles by Stevin and about his work, including *The Principal Work of Simon Stevin*, 1955-1956, in five volumes, with the original languages of text—Dutch, Latin, etc.—and English translation on facing pages. The volume exhibited is opened at the famous illustration of his frictionless chain used in his experiments.

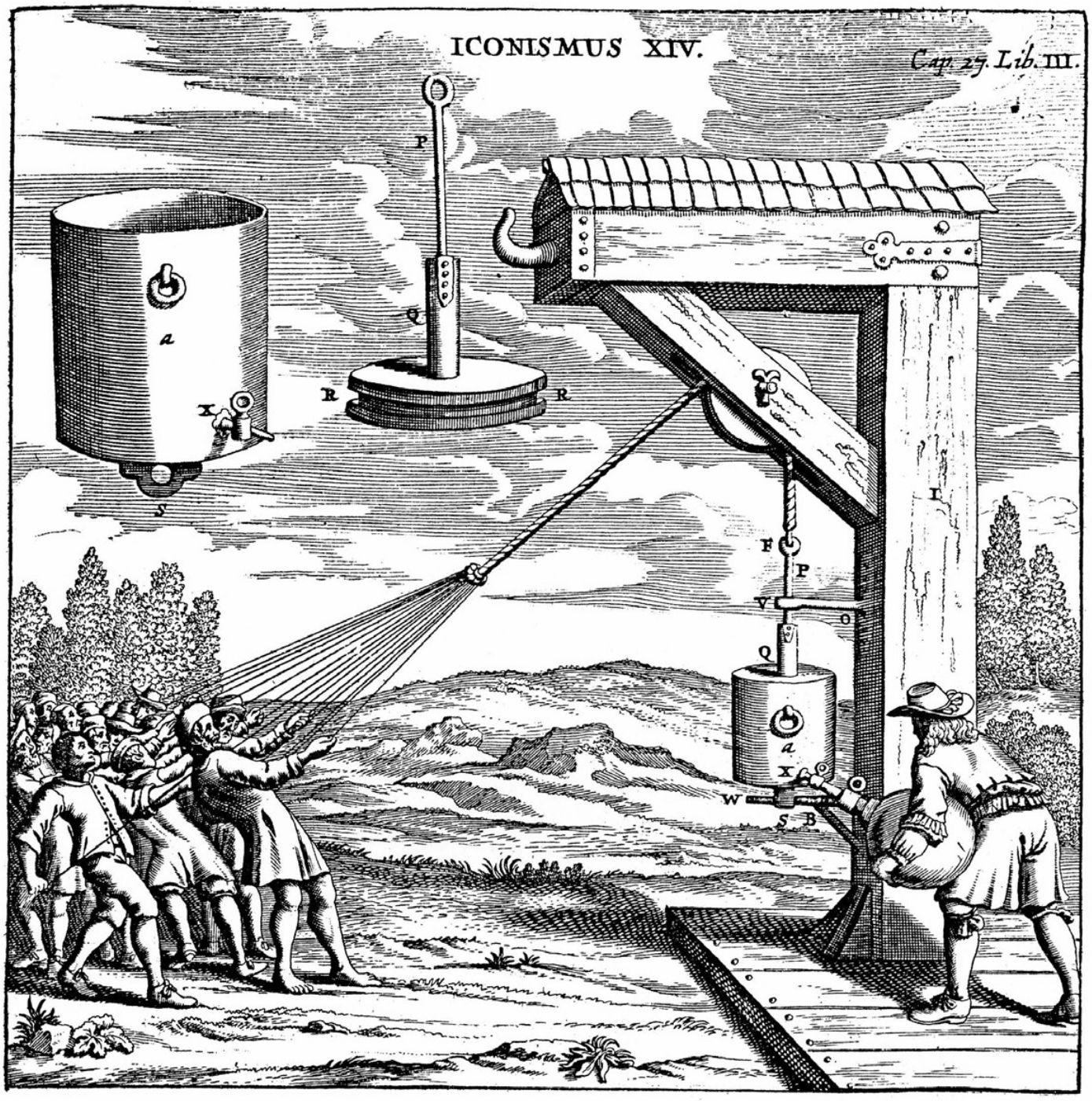
32

William Gilbert, 1540-1603

De Magnete, Magneticisque Corporibus,
et de Magno Magnete Tellure; Physiologia Nova

London, 1600

Viewed by some as the first great scientific work published in England, this work by William Gilbert is



38. Otto von Guericke. *Experimenta Nova*. 1672.
Manual extraction of air from a glass vessel.

the first major treatise on the magnet and electromagnetism. He was among the first to apply the experimental method to such matters. He described the attractive powers of magnets, their orientation to the earth's poles and their possible application to navigation. As physician to Queen Elizabeth, he was a man of great importance in his time.

This and one other title are the only Gilbert items in the collections aside from several later editions of his work on the magnet. The volume displayed is bound in a leaf of manuscript music and is opened at one of the best known title-pages in the history of science.

33

Benedetto Castelli, 1577-1644

Della Misura dell' Acque Correnti

Rome, 1628

One of the less well known scientists of his time, Castelli was a Benedictine monk, and sometimes is described as one of the greatest students of Galileo. In this work, he deals with the principle of continuity for steady flow of water, and made important contributions to hydrodynamics.

The collections contain only this title, and an English translation, "Discourse on the Mensuration of Running Water," in *Mathematical Collections* (1661) by Thomas Salisbury.

34

Galileo Galilei, 1564-1642

Discorsi e Dimostrazioni Matematiche, Intorno à due Nuove Scienze

Leiden, 1638

Prior to his classical work on astronomy, Galileo had been experimenting with various aspects of physics, such as falling bodies. In 1591, when only twenty-seven years old, he had repeated the earlier experiments by Stevin, and dropped ten-pound and one-pound weights from the leaning tower of Pisa, demonstrating that they fell at the same rate of speed, regardless of weight. He had also published in 1612 his work later translated as *Discourse on Bodies in Water*. After his confinement by the Inquisition, he returned to these and similar studies and produced his *Discorsi*. Because of his confinement it was smuggled out of Italy and published in Holland. This is cited as Galileo's greatest work. It was the first modern textbook on physics and established the science of mechanics.

There are three editions of this work in Crerar collections published before 1700, and numerous other works described under No. 27 in the section on Astronomy.

35 & 36

Robert Boyle, 1627-1691

New Experiments Physico-Mechanical, Touching the Air

London, 1662

Experiments and Considerations Touching Colours

London, 1664

In the first edition of his work "Touching the Air" (1660), Boyle described his construction of a new and more efficient air pump and his studies on the "spring of the air." Following criticism of his work by Franciscus Linus, he published this new edition in which he presented conclusions which came to be known as Boyle's Law, namely, that the volume of a gas varies inversely with the pressure, the temperature remaining constant. In addition to his work on the elasticity and compressibility of the air, he also investigated chemistry, electrical phenomena and colors. The second work noted above resulted from his studies of the latter. The work is in three parts: 1. The experimental history of colours begun; 2. Of the nature of whiteness and blackness; and 3. Concerning promiscuous experiments about colours.

Boyle was among the most prolific of authors, producing numerous works within his lifetime. The

Crerar collections contain 115 titles by Boyle, including his collected works (London, 1744) in five volumes, and more than twenty about his work, including a comprehensive bibliography by John F. Fulton, published in 1961.

37

Giovanni Alfonso Borelli, 1608-1679

De Motionibus Naturalibus
a Gravitate Pendentibus

Regio Julio, 1670

This work is credited with being the first work on capillarity and its relation to surface tension. In the study of capillary tubes, the author formulates the law that the height of ascent of liquids in capillary tubes is inversely proportional to their diameters, and that this is independent of air pressure. Borelli is said to have had a quarrel with the Prince Leopold of Tuscany, who wished to incorporate the work in the *Saggi* of the Accademia del Cimento (see No. 8 in the exhibit), but Borelli wished to publish it under his own name.

More than twenty of Borelli's other works are also in the Crerar collections.

38

Otto von Guericke, 1602-1686

Experimenta Nova

Amsterdam, 1672

This interesting work announced the invention of the air pump. It also included an account of the famous Magdeburg hemispheres that required sixteen horses to pull them apart when the air had been evacuated from the hemispheres by Guericke's air pump. Robert Boyle heard about the pump through Kaspar Schott's *Mechanica Hydraulica-Pneumatica* published in 1657. Guericke performed a number of experiments with the vacuum, demonstrating for example that light is transmitted in a vacuum but sound is not.

This work, a German translation of 1894, and two commentaries on Guericke's work are in the Crerar collections.

39

Christiaan Huygens van Zuylichem, 1629-1695

Horologium Oscillatorium

Paris, 1673

This work contains the first mathematical analysis of the pendulum and has been ranked as second in importance only to the *Principia* of Isaac Newton. The work treats many problems of dynamic bodies in motion, and Huygens' theorems relating to centrifugal force in motion aided Newton in determining universal gravitation.

While the above is Huygens' chief work, the collections also contain his earlier work, *De Circuli Magnitudine Inventa* (1654)—No. 19 under Mathematics—, his notable work *Systema Saturnium* (1659) and five collections of his works published from the early 18th century through the late 19th century. There are also about a dozen other titles relating to his work.

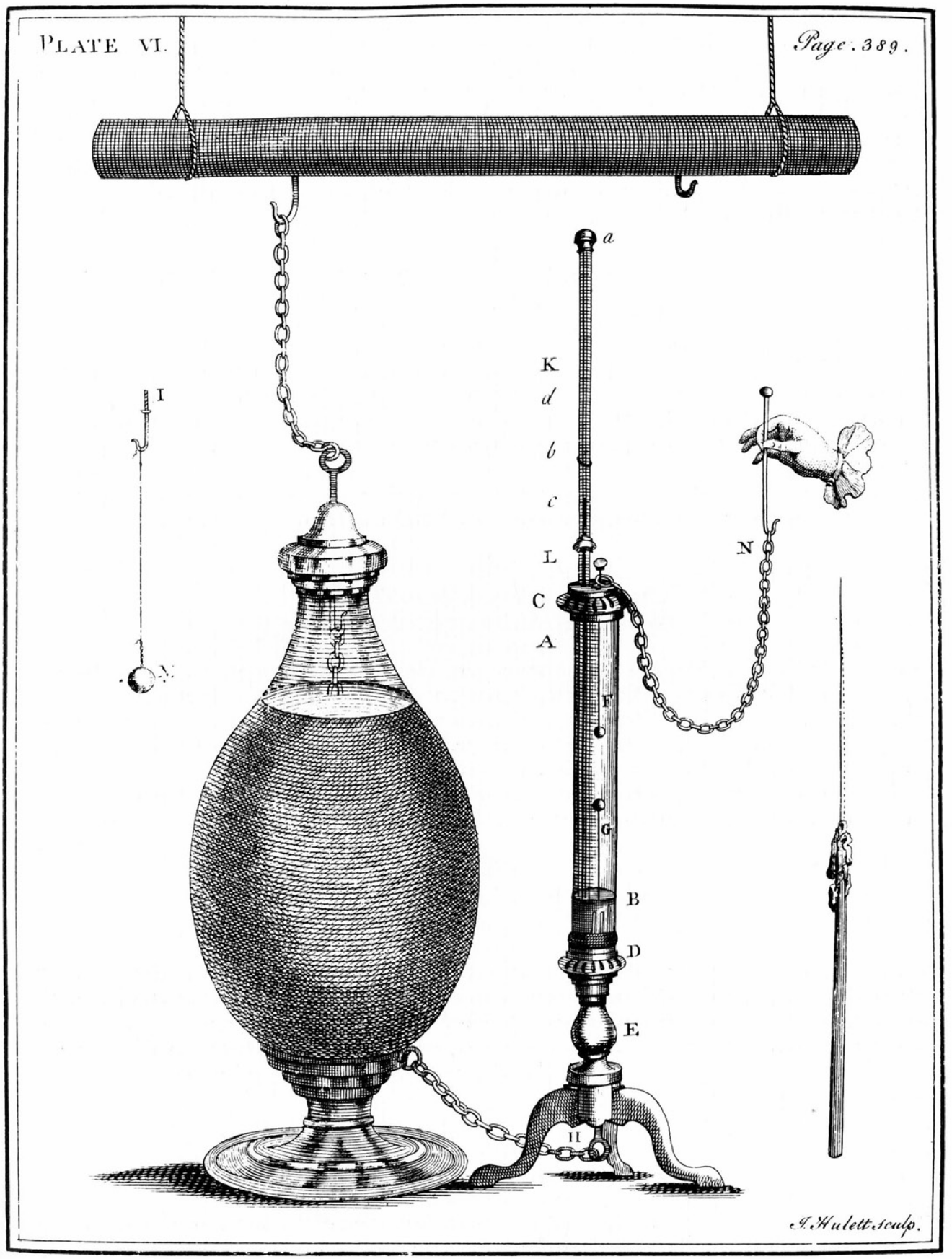
40

Isaac Newton, 1642-1727

Philosophiae Naturalis Principia Mathematica

London, 1687

The contributions of Isaac Newton to the advancement of science were so numerous and so important that little less than an essay would suffice to describe them. The book on exhibit, commonly referred to as the *Principia*, has been described as the most influential scientific publication of the 17th century, and perhaps the single greatest achievement of the human intellect. The major contribution of the work is



41. Benjamin Franklin. *Experiments and Observations on Electricity*. 1769.
Franklin's electrical air thermometer.

Newton's mathematical demonstration of "the principle of universal gravitation, wherein all bodies, of whatever mass, attract one another in proportion to their masses in inverse ratio as the square of the distances between them. This applies to dust particles as to the mightiest celestial bodies, to the tidal movements of water, to the moon in its orbit and to the blaze of the comet."

For the study of Newton's work, the Crerar collections are comprehensive with more than 100 titles in the catalog under Newton's authorship and more than 160 titles about his life and work. The latter include the biography by Sir David Brewster (Edinburgh, 1855) in two volumes, and both editions (1883 and 1907) of the bibliography of Newton's work by George J. Gray, as well as the catalogs of other special collections.

41

Benjamin Franklin, 1706-1790

Experiments and Observations on Electricity

Fourth edition

London, 1769

Soon after the invention of the Leyden jar in 1740, Franklin began his experiments with electricity involving use not only of the Leyden jar but also lightning rods and the kite. He reported his observations in letters to Peter Collison of the Royal Society of London, and they were published in London in 1751. His work attracted much attention; it was translated into French the following year and later into Italian and German.

The Crerar collections lack the 1751 edition, but do have later English editions and those in French and Italian. A number of other Franklin books are here including his collected works.

42

Charles Augustin Coulomb, 1736-1806

Mémoires sul l'Électricité et le Magnetisme

Paris, 1785-1789

Coulomb, Benjamin Franklin and the British scientist, Henry Cavendish, were contemporaries and together established the study of electricity and magnetism as a modern science. Coulomb's experiments were very precise and ranged over numerous aspects of the field, especially electric attraction and repulsion; and his work brought electrostatics to a high degree of perfection. Much of his work appeared first as articles in the *Mémoires* of French scientific societies.

Because of the journal form of many of Coulomb's publications, most if not all will be found in the Crerar collections, which have extensive files of early journals and periodicals.

43

Johann Heinrich Lambert, 1728-1777

Photometria

Augsburg, 1760

A French-German philosopher and scientist, Lambert was born in Alsace. During his career he worked in Basel, Munich and Berlin. He made contributions in the measurement of heat, humidity and light; but his major work was in the measurement of the intensity of light. Through this work he contributed to establishment of the science of photometry. He was greatly influenced by Newton's work on optics.

About a dozen books are in the Crerar collections by and about the work of Lambert.

44

Michael Faraday, 1791-1867

Experimental Researches in Electricity

London, 1839-44 & 1855; 3 vols.

The most notable content of this important work is its description of the generation of electricity by electro-magnetic induction, the means by which nearly all electricity is generated today. The discovery

was first announced by Faraday in 1831 in a paper published in the *Philosophical Transactions* of the Royal Society of London. A note on the title-page of the 1839 volume of the work exhibited states that the volume was reprinted from the *Philosophical Transactions* for 1831-1838. Faraday made many other important discoveries in both physics and chemistry, some of which are still in use today.

The work of Faraday is well represented in the Crerar collections with eighteen titles by him and more than thirty works about him. This first volume of his three volume classic on electricity is rare in its first printing. This copy was formerly in the library of Herbert M. Evans.

45

Hermann Ludwig Ferdinand von Helmholtz, 1821-1894

Über die Erhaltung der Kraft

Berlin, 1847

As a result of his interest in the problem of perpetual motion, Helmholtz formulated the principle of the conservation of energy announced in this work, published when he was only twenty-six years old. He later made major contributions to physiological optics; and he also wrote on mathematical principles of acoustics, theoretical physics and electrodynamics.

More than forty Helmholtz titles are in the Crerar collections, including his classic work on the ophthalmoscope which is in the Senn Collection on medical literature. There are also some thirty titles which deal with his life and works.

CHEMISTRY

Chemistry differs from physics in its special concern for the composition of different kinds of matter. Characteristic appearance and behavior of various substances are within the scope of chemistry, and especially the reactions which take place between substances. The two general fields of chemistry are inorganic chemistry which deals primarily with minerals, and organic chemistry which deals with substances formed in nature, primarily the compounds of carbon. Through electrochemistry, for example, it is infused into the field of physics; and through biochemistry it overlaps both botany and zoology. And in all of its aspects, it approaches its study of matter quantitatively.

Historically, chemistry became established as a modern science somewhat later than astronomy and physics. It required major changes in both knowledge and attitude for it to break with alchemy, the chemistry of the ancients.

46

Vanoccio Biringuccio, 1480-1539

De la Pirotechnia

Venice, 1540

While Biringuccio's book was written primarily for the practicing metallurgist and other technologies such as glass making, type founding and manufacture of gun powder, he also made a number of original contributions to the still nascent field of chemistry, especially in inorganic chemistry. He was the first to mention use of sodium chloride for separating gold and silver from baser metals. One chapter is devoted to alum. He also describes and illustrates furnaces for collecting distillates. The book was also issued in both French and Italian translations.

The Crerar collections contain the 1540 and 1550 editions and the modern English translation as well as a commentary by the 16th century scientist, Alassandro Piccolomini. The work exhibited is opened at illustrations of distillation furnaces.

47

Robert Boyle, 1627-1691

Chymista Scepticus

London, 1662

Boyle's role as a physicist has been described under Nos. 35 & 36. He was active also in the developing field of chemistry, and is chiefly remembered for his *Sceptical Chymist*. His hypothesis was that matter is made up of atoms and clusters of atoms in motion. He denied that the elements are limited to those described by Aristotle: earth, air, fire and water. He was an advocate of raising chemistry to the status of a separate science. It was left, however, for the great French scientist, Lavoisier, to become the founder of modern chemistry, a century later.

The first English edition of the *Sceptical Chymist* (1661), known in only a dozen recorded copies, is lacking from the Crerar collections; but the first Latin edition of 1662 and the second English edition of 1680 are included. Other information on Boyle in the collections appears with Nos. 35 & 36 under Physics.

48

Joseph Black, 1728-1799

Experiments upon Magnesia Alba, Quick-lime, and Other Alcaline Substances

Edinburgh, 1782

Joseph Black was an English chemist, physicist and physician who served for a time as the president of

the Royal Society of London. The experiments described in this work announced the discovery of carbon dioxide, which he described as "fixed air." It grew out of his researches on the composition of the atmosphere. It was first published in *Essays and Observations, Physical and Literary,* read before a society in Edinburgh and published in Edinburgh, 1756. The first separate publication appeared in the volume exhibited. Black also made a major advance in the theory of heat by developing the concept of specific heat.

In addition to the above, the Crerar collections include his *Lectures on the Elements of Chemistry,* published posthumously from his manuscripts, London, 1803; and the *Life and Letters* published by Sir William Ramsay, London, 1918.

49

Joseph Priestley, 1733-1804

Experiments and Observations on Different Kinds of Air

London, 1774

A Unitarian minister from Leeds, England, Priestley divided his attention between theological interests and scientific research. He failed to break away from a classic misconception that "phlogiston" was a substance without color, odor, taste or weight which was given off by burning substances. Nevertheless, his interest in respiration and combustion led to the discovery of oxygen, which Priestley called "dephlogisticated air." In addition to his investigations in chemistry, Priestley made important contributions to the knowledge of electricity.

The Crerar collections have more than fifty volumes of writings by and about Priestley. They include six editions of the work exhibited and four editions of his *The History and Present State of Electricity* (1767) as well as several other works.

50

Henry Cavendish, 1731-1810

Experiments on Air

(Royal Society of London. *Philosophical Transactions* v. 74, p. 119-153; v. 75, p. 372-384, fold. pl.)

1784-1785

The researches of Henry Cavendish, here recorded in the *Philosophical Transactions* of the Royal Society of London, provided the first experimental evidence that when inflammable air (hydrogen) is burned in ordinary air, water is a product of the reaction. He had discovered his "inflammable air" in 1765 and demonstrated its explosive power. He was a versatile experimenter, and some of his discoveries on electricity anticipated the work of Coulomb and Faraday reported under Physics.

In addition to his *Philosophical Transactions* papers, the Crerar collections contain his collected papers sponsored by the Royal Society in 1921 in two volumes, and four works with commentaries.

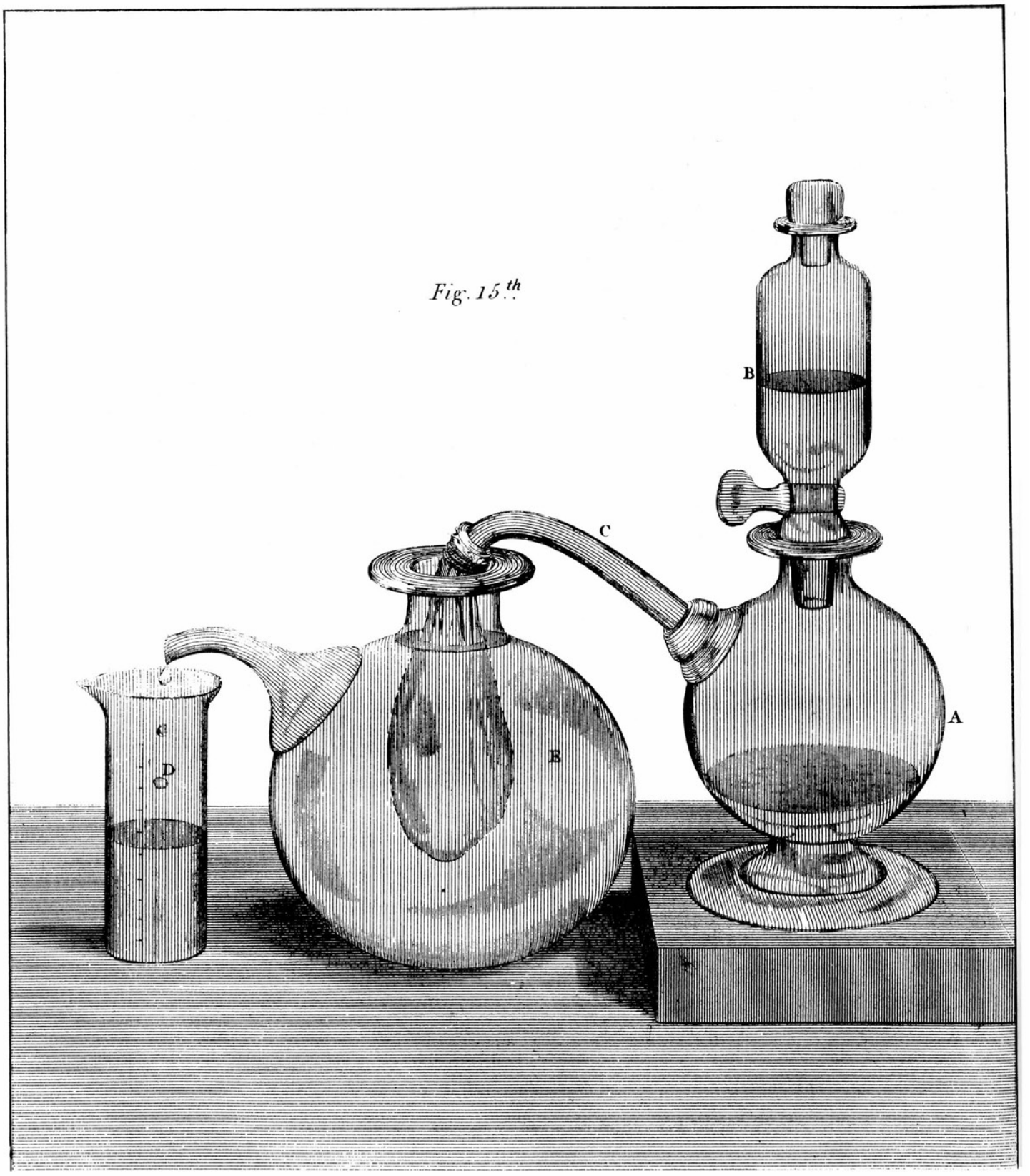
51

Antoine Laurent Lavoisier, 1743-1794

Traité Élémentaire de Chimie

Paris, 1789; 2 vols.

This work firmly established modern chemistry. With it, Lavoisier overthrew the phlogiston theory, made the first attempt to enumerate a true list of chemical elements, provided a major contribution to the understanding of compounds, and clearly identified and named oxygen which had been first discovered by Priestley as dephlogisticated air. He shared with Priestley the discovery that oxygen supports respiration. Lavoisier was also prominent in public affairs. As one of the officers responsible for collecting taxes, he became suspect during the Reign of Terror and was guillotined.



53. Sir Humphry Davy. *Elements of Agricultural Chemistry*. 1813.
Laboratory equipment for soil analysis.

The Crerar collections contain the first three French editions of this work; six editions of the English translation; the *Oeuvres de Lavoisier* (Paris, 1862-1893) in six volumes; and about thirty other titles by and about Lavoisier.

52

John Dalton, 1766-1844

A New System of Chemical Philosophy

London, 1808-1827; 3 vols.

The major contribution of this work was the development of an atomic theory of chemistry. In his own words, the object of the work was "to shew the importance and advantage of ascertaining the relative weights of the ultimate particles, both of simple and compound bodies, the number of the simple elementary particles which constitute one compound particle, and the number of less compound particles which enter into the formation of one compound particle." His calculations of combining weights involved a number of errors, but his general theory was one of the major advances in the history of chemistry.

The Crerar collections contain the above and his *Meteorological Observations and Essays* in two editions (1793 and 1734), as well as fifteen works about him and the recent Dalton bibliography by A. L. Smith (1966).

53

Sir Humphry Davy, 1778-1829

Elements of Agricultural Chemistry

London, 1813

Davy was a very productive English chemist. In his early twenties he became assistant lecturer in chemistry and director of the laboratory at the Royal Institution of Great Britain. Among his various discoveries was identification of sodium, potassium, barium, boron, calcium and strontium. His *Elements of Agricultural Chemistry* resulted from lectures over a period of years as part of his effort to convert farming "from a mere act of blind procedures into a rational system of science."

The Crerar collections contain the first and second English editions and four American editions (1815 to 1846) of the work exhibited; his *Collected Works* (London, 1839-1840) in nine volumes; and a dozen other titles by and about him.

54

Justus von Liebig, 1803-1873

Anleitung zur Analyse organischer Körper

Braunschweig, 1837

One of the leading German chemists of the 19th century, Liebig served as a professor in Giessen, 1824-1852, where he established the first practical teaching laboratory. While in Giessen, he established *Justus Liebig's Annalen der Chemie* (1832), a journal which is still being published. Later he served as professor of chemistry in Munich from 1852 until 1873, the year of his death. His contributions to chemistry were numerous, especially in animal and plant chemistry and in human physiology. One of his published works dealt with food for infants; and he made great advances in development of plant fertilizers, indicating the variety of his contributions in chemistry. In the work exhibited, he developed a combustion method for determining carbon, hydrogen and nitrogen in organic compounds, which is still in use. The first report on the method appeared in *Poggendorf's Annalen der Physik und Chemie* in 1831.

In addition to files of periodicals in which Liebig published, the Crerar collections have a comprehensive collection of his writings, including fifty-five book titles and about forty works containing information about his life and works.

55

Josiah Willard Gibbs, 1839-1903

Equilibrium of Heterogeneous Substances

(Connecticut Academy of Arts and Sciences.
Transactions, 1874/78, p.108-248)

Gibbs, a native of Connecticut and graduate of Yale University where he taught mathematical physics, was one of the most noted of 19th century American scientists. His major scientific contributions were in the field of thermodynamics. In this famous essay he demonstrated by mathematical processes how thermodynamics may be used in the interpretation of chemical processes, and gave the first demonstration of the Phase Rule. It represented a major contribution to physical chemistry. Toward the end of his career, he produced two basic textbooks, one on *Vector Analysis* (1901) and the other on *Elementary Principles in Statistical Mechanics* (1903).

The Crerar collections contain the publications cited above, his collected works, and probably all of his papers which appeared in periodicals.

GEOLOGY

Geology in its broadest terms is the science of the earth: its origins, history, structure and composition. It is interdependent with most of the other sciences. Its origins and early history are the interests of cosmology; and numerous other branches of geology involve scientific investigations of various aspects of the broad discipline. Two examples: Petrology is the branch of geology concerned with the origins, structure and properties of rock. Dynamic geology involves study of the forces causing geological changes such as erosion, the upbuilding of continents and mountains, and volcanology. Similar to the other sciences, the interests in geological problems are deeply rooted in the past, but the modern science of geology was not established until the 18th century. Once a part of geology, mineralogy is now considered to be a separate science.

The five titles included in the exhibit to represent geology offer the barest suggestion of the extensive literature available. Because of its economic importance, geological surveys have been conducted by many countries; and in the United States they have been made not only by the federal government but by many of the state governments. Reports, monographs, atlases and maps by the thousands have resulted from such surveys. The volume of publications from these sources is impressive and exists in a degree more extensive than for any of the other basic sciences.

56

Georg Agricola, 1494-1555

De Ortu et Causis Subterraneorum

Basel, 1558

This 16th century book of Agricola can be viewed as the first handbook on systematic mineralogy. Agricola was born Georg Bauer in the German free state of Saxony. He studied both medicine and chemistry, but became interested in geology and made his great contributions in this field. Much of his contribution to geology is also to be found in his *De Re Metallica* which is exhibited under Technology.

Neither of Agricola's two major works is in the Crerar collections in their original editions, but later editions in Latin and translations into other languages are here. There are seventeen titles in the library's collections by and about Agricola, including his *Opera* (Basel, 1563).

57

Lazzaro Spallanzani, 1729-1799

Voyages dans les Deux Siciles et dans Quelques Parties des Apennins

Traduit de l'Italien par G. Toscan

Paris, 1800; 6 vols.

Spallanzani is known primarily as a biologist, in which he laid the foundations of experimental zoology. He discovered the role of saliva in digestion and made significant progress in disproving the concept of spontaneous generation, generally accepted in his day. However, he also studied and taught physics as well as natural history and made some contributions to geology, especially in study of volcanism.

The Crerar collections have comprehensive coverage of Spallanzani's writings, primarily through purchase of the private library of the Italian scholar, Dino Prandi, whose library of Spallanzani's works was described in his *Bibliografia della Opere di Lazzaro Spallanzani* (Florence, 1952).

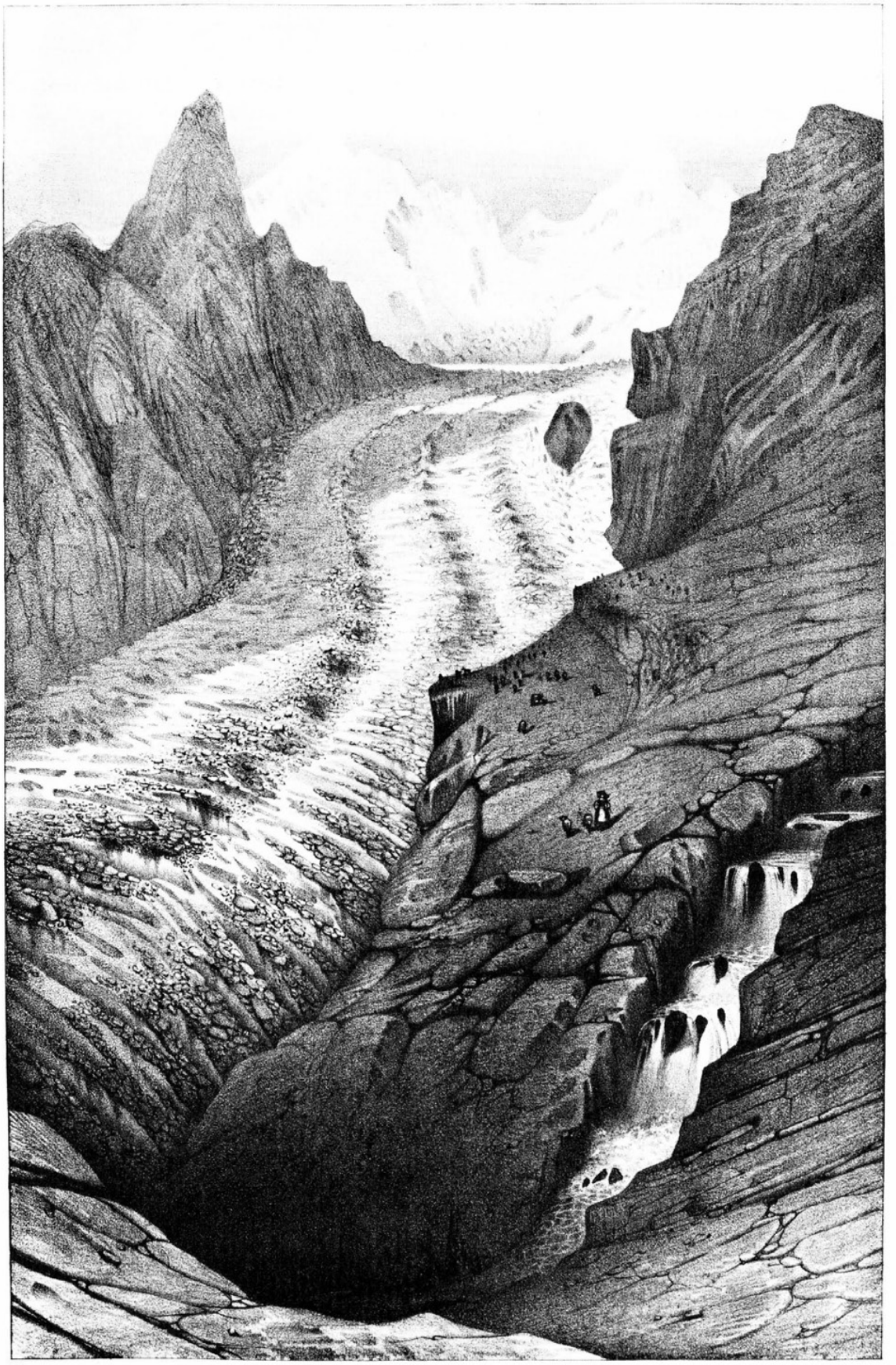
58

Sir Roderick Impey Murchison, 1792-1871

The Silurian System

London, 1839; 2 vols. in 1

After service in the Napoleonic Wars, this British geologist turned his attention to science. During the



59. Louis Agassiz. *Études sur les Glaciers*. 1840.
The Glacier of Zermatt in Switzerland.

1830s he devoted his attention to study of the undifferentiated rock lying below the old red sandstone. This research established the Silurian System of geology. He later worked on the Devonian and Cambrian systems, and researched the geology of Russia and the Ural Mountains and of his native Scotland. Among other important official positions, he served as director general of the British Geological Survey.

The Crerar collections contain this and half-a-dozen other works by Murchison, and a biography of him by a younger contemporary geologist, Sir Archibald Geike.

59

Louis Agassiz, 1807-1873

Études sur les Glaciers

Neuchâtel, 1840; Text and atlas

Louis Agassiz, whose full name was Jean Louis Rodolphe, was a native of Switzerland. His studies in universities of Switzerland and Germany led to a Ph.D. in 1829 and an M.D. in 1830. His early scientific interest in fossil fishes and other marine life led him to the study of geological changes caused by glaciers, at first in his native Switzerland. Through publication of the work exhibited Agassiz became the founder of the science of glacial geology. A visit to America in 1846 led to a professorship of zoology at Harvard University where he became famed as a teacher of younger scientists and as the founder of Harvard's Museum of Vertebrate Zoology. While his principal work in America was in zoology, his work in glaciology continued. Among other publications in the field was his *Glacial Phenomena in Maine* (1867).

Some thirty titles by Agassiz and twenty-five about his work are in the Crerar collections.

60

Matthew Fontaine Maury, 1806-1873

The Physical Geography of the Sea

New York, 1855

A native of Virginia, Maury joined the American Navy in 1825 and had active service at sea. In 1839, a stagecoach accident left him crippled and ended his active naval career. In 1842, he was put in charge of the naval agency which later became the U.S. Naval Observatory and Hydrographic Office. He became widely known for his wind and current charts and oceanographic data. By publication in 1855 of his *The Physical Geography of the Sea* he produced the first major textbook on oceanography. It was published the following year in German.

A dozen titles by Maury are in the Crerar collections, with four other books about him. These include a biography by his daughter and a bio-bibliography by Ralph M. Brown.

BOTANY

Plants which were edible and those with medicinal properties have been known to man almost from the beginning of time. However, the formal origin of what may be considered as primitive botany did not come until the time of the Greeks and especially Theophrastus, a contemporary and student of Aristotle. For example, although such facts as the artificial fertilization of date palms had been known for centuries, it was Theophrastus who first described the behavior of germinating seeds and made a beginning at studying the structure of plants.

During the Renaissance, interest in plants was renewed by rediscovery of Theophrastus and the works of other classical authors including Pliny and the Greek naturalist and physician, Dioscorides, a contemporary of Pliny. Even by the time of Brunfels (1489-1534) and Fuchs (1501-1566), the first botanists included in this exhibit, the science was largely descriptive. On the other hand, the study of botany as in the other sciences, prospered with the development of better nomenclature, better classification, and instrumentation for research, especially the microscope. By the late 17th century and early 18th century, scientific botany was becoming well established. Scientific specialties also developed in botany such as taxonomic botany, plant physiology and disciplines centered in one or another class of plants, for example, dendrology for the scientific study of trees.

61

Otto Brunfels, 1489-1534

Herbarum Vivae Eicones

Strasbourg, 1532

Otto Brunfels, a Carthusian monk converted to protestantism, was the first to produce a work on plants with figures based wholly on observation. As a physician, he collected plants in the neighborhood of Strasbourg and prepared the above work for publication. It is illustrated with more than 280 woodcuts, which clearly represent the plants described.

The Crerar collections contain eight works by and about Brunfels.

62

Leonhard Fuchs, 1501-1566

De Historia Stirpium

Basel, 1542

Like many of the other early botanists, Fuchs was a physician. His work is primarily an herbal, but the high quality of his observations and the beauty and accuracy of his illustrations rank him as one of the great pioneers of modern science. Some 500 different plants are described; the volume is opened at illustrations of two varieties of geraniums. Fuchs is memorialized in botany by the beautiful American plants named Fuchsias.

More than a dozen books by and about Fuchs are in the Crerar collections, including his commentary on the aphorisms of Hippocrates (1544) and a book on human anatomy (1551). This copy of his *De Historia Stirpium* is part of the Nicholas Senn collection of medical literature to which reference is made under the section on Medicine.

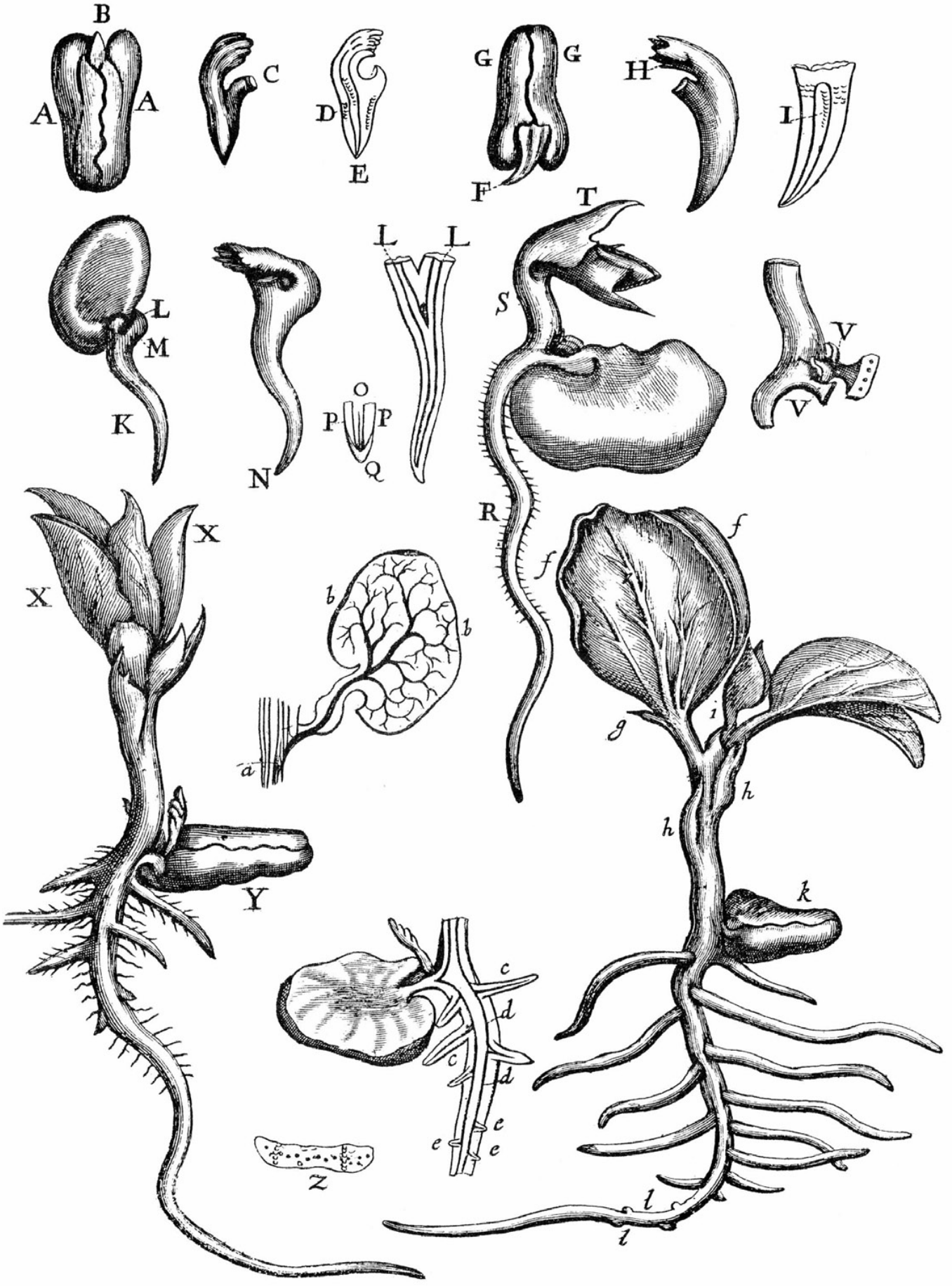
63

Conrad Gesner, 1516-1565

Opera Botanica

Nuremberg, 1754

Conrad Gesner is one of the several giants in the history of science who cannot be classified. He was a physician, a botanist, a zoologist and a bibliographer of major importance. He was a man of great



65. Marcello Malpighi. *Anatome Plantarum*. 1675-1679.
Germination of the lima bean.

erudition and one of the encyclopedists. His *Bibliotheca Universalis* (1545-1549) in 20 volumes was intended to be a catalog of all of the writers who had ever lived, but the work was never completed. He published some botanical work during his lifetime, but his great knowledge of plants was brought together in his *Opera Botanica* which was not published until nearly 200 years after his death. He was one of the first naturalists to show an interest in mountains, and in this work he made the first attempt to give a complete description of alpine flora.

The Crerar collections have a dozen of his publications including *De Raris et Admirandis Herbis* (1555) and sixteen additional titles about his life and work.

64

Nehemiah Grew, 1641-1712

The Anatomy of Vegetables Begun

London, 1672

Although Grew's most noted book was *Anatomy of Plants* (London, 1682), a substantial part of his work was first presented in the title exhibited. It is a work which had taken him seven years to complete. Grew was the first to write on both plant anatomy and physiology. He was aware of plant tissues, but misinterpreted their functions. Grew was educated in Cambridge and Leyden and practiced medicine in London, where he was one of the early Fellows of the Royal Society of London.

Both of Grew's great botanical books are in the Crerar collections, with four other titles or later editions of his work.

65

Marcello Malpighi, 1628-1694

Anatome Plantarum

London, 1675-1679; 2 vols.

Marcello Malpighi was a microscopist of great technical skill and an excellent draftsman, but a poor writer. Hence his anatomy of plants was of high quality, but his interpretation of function was frequently wrong. Some of his observations, however, were important. He showed, for example, that plant galls were not spontaneously generated, as then believed, but are caused by insect larvae. He also prepared drawings of mistletoe on the branch of an apple tree showing penetration of tissue by roots of the mistletoe. On the animal side of natural history he produced a remarkable book on rearing of silkworms; his *Dissertatio Epistolica de Bombyce* (1669) is a landmark in the history of zoology. Malpighi was a professor in both Pisa and Bologna and served for a time as physician to Pope Innocent XII.

The Crerar collections have twenty titles by and about Malpighi, including his classic on the silkworm and two editions of his collected works.

66

Stephen Hales, 1677-1761

Vegetable Staticks;
or, An Account of Some Statical Experiments
on the Sap in Vegetables

London, 1727

An English scientist of broad interests, Stephen Hales' principal contributions lay in the field of physiology—for both plants and animals. His *Vegetable Staticks* was the most important work on functional activity of plants prior to the 19th century. It described many ingenious experiments for measuring the force of upward flow of sap in stems. Somewhat later, his interests in animal physiology centered on circulation and pressure of the blood. He invented a ventilating system and other devices. In 1750 he published *Some Considerations on the Causes of Earthquakes*.

Six of his publications are in the Crerar collections, and there is also a biography.

67

Nikolaus Joseph von Jacquin, 1727-1817

Miscellanea Austriaca ad Botanicam,
Chemiam et Historiam Naturalem Spectantia

Vienna, 1778-1781; 2 vols.

Jacquin represents the many botanists of the 18th century who were describing the plants of their own countries and exploring the world for new plants. He prepared this major work on the flora of Austria. Sent to America by Emperor Francis I, he collected plants for the royal gardens in Vienna and in 1760 published a book on his visit to the Caribbean Islands.

In the collections of the library are four of his other books.

68

Jakob Sturm, 1771-1848

Die Kleearten Deutschlandes in Abbildungen

Nuremberg, 1804

This small book on clovers of Germany was selected as an example of the many monographs on limited areas of natural history. The thirty-three colored plates are the work of Sturm, and the accompanying text is principally the work of Johann Christian Daniel von Schreber (1739-1810), another German botanist.

The small volume is described as part of a larger work on German flora, but this item is the only Sturm work in the Crerar collections.

ZOOLOGY

Like plant life, animal life received its first significant attention by early Greek writers, especially Aristotle (see No. 1 under General Science). And again, as in botany, major advances in the field did not come until the Renaissance and the work of Conrad Gesner in the 16th century. To an extent not matched in the other major fields of science, there have developed in zoology a number of specialty sciences, largely along lines of forms studied. Examples in this exhibit include three of the specialties: entomology, conchology and ornithology. Others are protozoology, herpetology, piscatology and mammalogy.

At least four of the scientists represented in the exhibit of books on botany are equally representative of zoology. Only one—Gesner—is included in both sections. The others are Grew and Malpighi who were users of the microscope on both plants and animals. Grew coined the term, "comparative anatomy" in zoology. The fourth dual field specialist was Hales whose interests in physiology extended into both plant and animal sciences.

69

Conrad Gesner, 1516-1565
Historiae Animalium Liber III
Qui est De Avium Natura
Zurich, 1555

General remarks on Gesner are presented under his name in Botany (No. 63). Although he was known to his contemporaries primarily as a botanist, his observations and accounts of animal life presented one of the founding works of modern zoology. His five volumes published over the period 1551-1587 contain some 4,500 folio pages with almost 1,000 woodcut illustrations. In all, Gesner presented digests of writings by more than 200 authors.

The Crerar collections include two copies of the 1555 volume, one of which has marks of Inquisition censorship.

70

Francesco Redi, 1626?-1697/98
Esperienze Intorno alla
Generazione degl' Insetti
Florence, 1668

A physician and naturalist in Florence, Italy, Redi made the first major attack on the then prevalent belief that life could originate by spontaneous generation. The theory that maggots found in decaying meat were spontaneously generated was demonstrated by closely controlled experiments to be false. Redi proved that they originated from eggs laid by flies. In this work on generation of insects, he also presented results of his observations on ants and mosquitoes, and on parasites of various domestic and wild animals. Redi was one of the group of Italian scientists in the Accademia del Cimento (see No. 8 in this exhibit).

The Crerar collections contain 25 other works by Redi including his *Opere* (Venice, 1742-1760), and five works about him. Among the latter is a bibliography by Dino Prandi (1941).

71

Giovanni Alfonso Borelli, 1608-1679
De Motu Animalium
Leyden, 1685

Borelli, whose fields of interest were primarily physics and astronomy, was another of the group in the

69. Conrad Gesner. *Historiae Animalium Libri III*. 1555.
One of the examples in Gesner's account of Biblical birds.

Accademia del Cimento (see note under No. 37 in Physics). In the great work on the motion of animals, he treats all the movements of the body, both voluntary and involuntary, on a mechanical basis. Through this work, in effect, he established a science of muscular mechanics.

The Crerar collections lack the first edition of this work (1680-1681, in 2 vols.), but includes the 1685 revised edition and later editions as well. Twelve Borelli titles are in the collections.

72

Antony van Leeuwenhoek, 1632-1723

Ontledingen en
Ondekkingen . . . Brieven

Leyden, 1684-1696; Delft, 1696-1718; 10 parts

A native of Delft, where he lived until he died in his 90th year, Leeuwenhoek was a Dutch student of natural history and one of the classical microscopists. He made his own microscopes—some 250 of them—and applied them to a wide range of subjects. He was the first to observe protozoans, bacteria, spermatozoa and the blood-corpuscles of many animals. He was the founder of histology through his study of the microscopic structure of tissues. He observed the metamorphosis of the flea and correctly concluded that the aphis reproduces parthenogenetically, or without the presence of the male. He was elected a foreign member of the Royal Society of London and sent more than 300 letters to the Society describing his observations.

Leeuwenhoek is well represented in the Crerar collections through a dozen of his works, including his *Opera Omnia* (Leyden, 1719-1722) in four volumes, and six books about his work.

73

Jacob Hübner, 1761-1826

Sammlung
Europäischer Schmetterlinge

Augsburg, 1796-[1838]; 789 colored plates

During most of his adult life, Hübner's principal income came from his employment as a designer in a cotton factory in Augsburg, where he was born. The author of the major bibliographical account of Hübner's work, Francis Hemming, stated that "He is assured of a lasting place in the history of science to which he devoted his life." Yet very few references to his work are found in general histories of science. His major contributions were two: (1) important development of the taxonomy of Lepidoptera, and (2) the extraordinary pictorial record of both the larvae and adult forms of a large number of different moths and butterflies. Displayed are the spectacular illustrated title-page and plates with larvae and adults of two species.

The Crerar collections include the above collection in six small folio cases, only the one volume of text being bound; also present is the four volume set of his *Sammlung Exotischer Schmetterlinge* (1806) in the new English facsimile edition with hand colored plates.

74

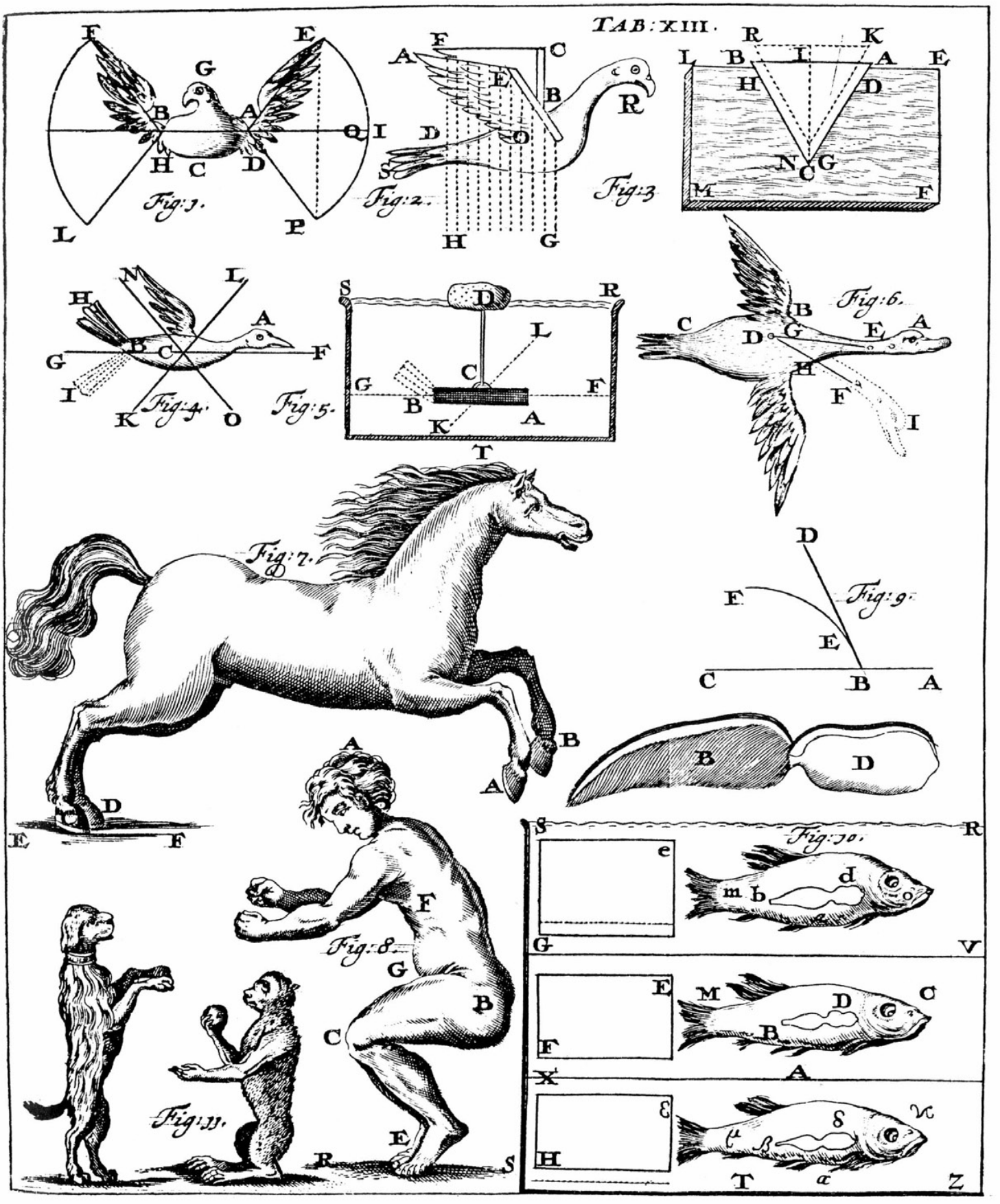
Thomas Bewick, 1753-1828

History of British Birds

Newcastle, 1797-1804; 2 vols.

Thomas Bewick was a celebrated English wood engraver, noted for his illustrations of numerous books. He was a keen observer and a lover of nature and produced books of his own in the field. His most noted work was his *History of British Birds*. His engravings were used to illustrate other works on natural history including his own *A General History of Quadrapeds* in several editions.

Bewick's work is well represented in the Crerar collections by his own work and writings about him.



71. Giovanni Alfonso Borelli. *De Motu Animalium*. 1685.
Illustrations of the center of gravity in moving animals.

75

Thomas Say, 1787-1834

American Conchology, or Descriptions of the Shells of North America

New-Harmony, Indiana, 1830

Thomas Say was an American naturalist. In addition to his own collecting expeditions, he served as naturalist with the expedition of Stephen H. Long to the Rocky Mountains, and in exploration of the upper Mississippi and Minnesota Rivers. His two major publications were the work here exhibited and his *American Entomology* (1824-1828).

The Crerar collections include eight works by Say and two items about his work.

TECHNOLOGY

A commonplace coupling of words is "science and technology". What does each term mean, and what is the relationship between them? In the context of this exhibit, we can risk the danger of oversimplification by quoting Mr. Webster. *Science* is "systematized knowledge derived from observation, study, and experimentation carried on in order to determine the nature or principles of what is being studied." *Technology* is the "science or study of the practical or industrial arts, applied science, etc." Contemplating the definitions, it can be understood that each of the terms sometimes precedes and sometimes follows the other in the affairs relating to man's pursuit of knowledge. Some examples:

1. Archimedes (287-212 B.C.) was an ingenious native of the ancient city of Syracuse, and about 2,200 years ago he invented the screw which will forever bear his name (see No. 77 below). He was variously described as a mathematician (especially in geometry), a physicist, and an inventor in mechanics and hydrostatics. It is hardly possible that he understood all of the laws of mechanics which explain his inventions, but he had ideas, he tried them out, and they worked. It was left for future scientists to explain why.

2. During the Renaissance, curious men were trying to explain the characteristics and behavior of the universe of which the earth is a part; typical examples appear in the Astronomy section of this catalog. Based upon such observations as were possible with the naked eye and upon analyses possible with the existing knowledge of mathematics and mechanics, conclusions were drawn which seemed to be rational explanations. Then came one of the major landmarks of technology, the telescope. See also No. 78 below.

3. Finally, a notable, very modern example may be cited. Crawford H. Greenewalt was president of E.I. du Pont de Nemours & Company; he was also interested in hummingbirds. There is a rich literature on hummingbirds, but the answers to two questions had been lacking—the full explanation of how the hummingbird flies and the explanation of the iridescence of its feathers. With the aid of high-speed stroboscopic photography and the ultra-fine images produced by electronmicroscopy, Mr. Greenewalt found answers to both questions; by his use of technology in the pursuit of answers to scientific questions he produced major landmarks in the history of ornithology. (Greenewalt: *Hummingbirds*. Garden City, N.Y. [1960].)

76

Georg Agricola, 1494-1555

De Re Metallica

Basel, 1657

Although Agricola's fame lies primarily in his contributions to geology, his *De Re Metallica* in particular was devoted very largely to mining equipment and procedures and is one of the great monuments of technology. It may be reasonable to assume that it was Herbert Hoover's interest as a mining engineer that led to the translation of this classic by him and Mrs. Hoover. In any case, the book is a classic in mining engineering as well as in geology; and it was written for practical men, not theorists. It is also worth noting that Agricola's medical education combined with his interest in mines led to his observations on industrial diseases of miners. See also No. 56 under Geology.

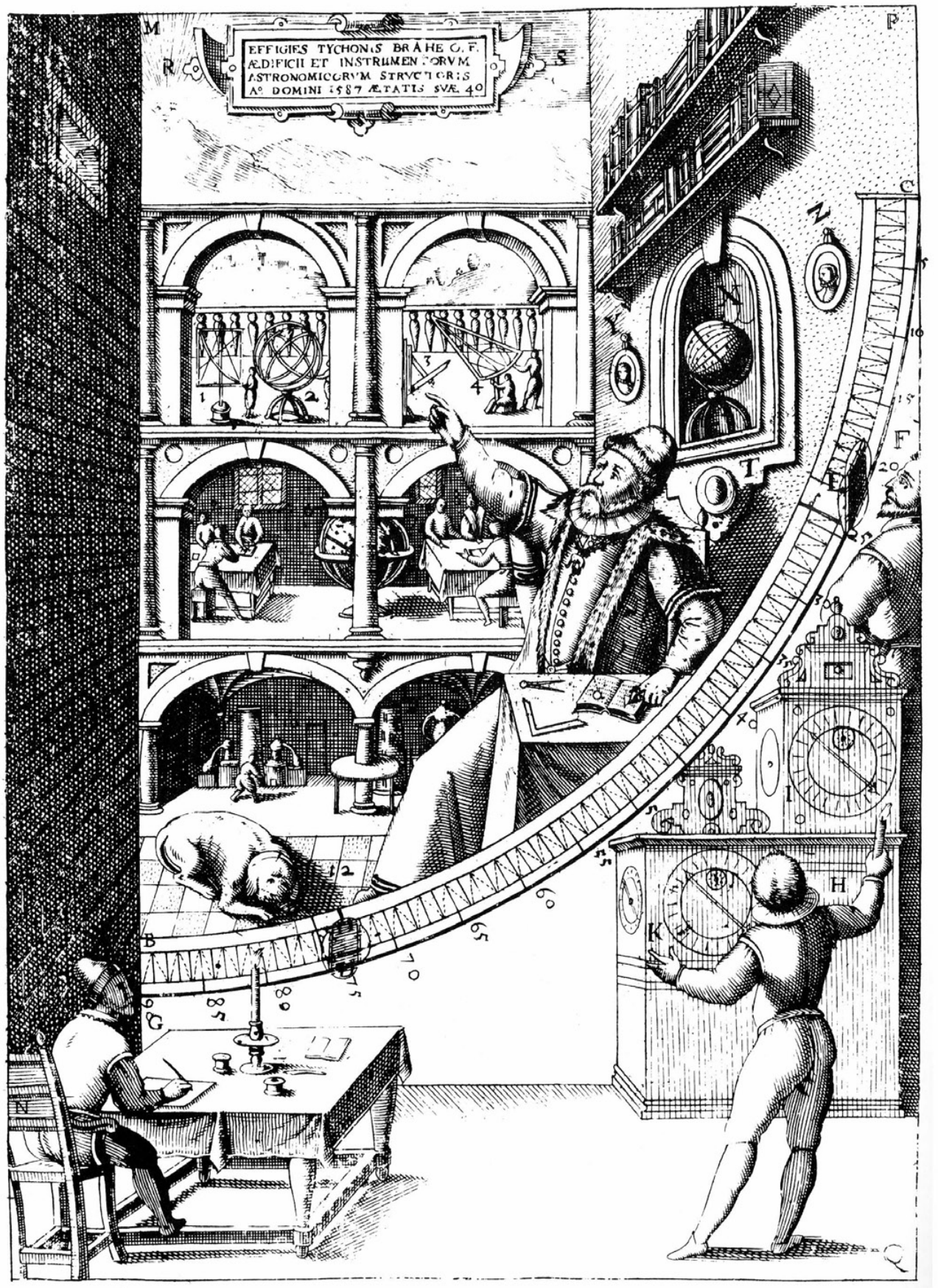
77

Giuseppe Ceredi, fl. 1565

Tre Discorsi Sopra il Modo d'Alzar

Parma, 1567

Ceredi was an obscure Italian inventor about whom little is recorded. We know from this work, which was published anonymously, that he made adaptations of the Archimedian screw as a form of pump



78. Tyge Brahe. *Astronomiae Instauratae Mechanica*. 1602.
The quadrant of Brahe.

for which he obtained a patent. The same principle is used in spiral conveyors in modern times for handling grain, sand and other loose materials.

This book is the only Ceredi item in the Crerar collections, and is possibly the only one ever published by him.

78

Tyge Brahe, 1546-1601

Astronomiae Instauratae Mechanica

Nuremberg, 1602

Tyge (or Tycho, the Latin form) Brahe was a Danish astronomer who was especially noted for his use of improved astronomical instruments which aided observations of his own and other astronomers. The work exhibited relates largely to the construction and equipment of his observatory which he added to his castle on the island of Hven.

In addition to the exhibited work, the collections contain fifteen other Brahe titles including his *Opera Omnia* (1913-1929) in 15 volumes and more than twenty books about his life and work.

79

John Napier, 1550-1617

Rabdologiae seu Numerationis per Virgulas Libri Duo

Edinburgh, 1617

This work is a pioneer attempt to devise a calculating machine by use of marked rods. The term "rabdologiae" is based on the Greek root *rhabdo* for rods. For a time in the 17th century "rabdologie" was used to mean the act of computing with "Napier's bones," or rods.

This copy of the book was a gift to the Crerar collections by a Chicago firm, The Felt & Tarrant Manufacturing Co. In addition to this work, other Napier items in the collections are described in the notes for No. 18 in Mathematics.

80

Denis Papin, 1647-1712

A New Digester or Engine for Softening Bones

London, 1681

This notable book describes an invention which was the forerunner of the autoclave and the modern pressure cooker. Papin demonstrated that when water is heated in a closed vessel it produces pressure to raise a heavy lid. To prevent explosions in his device, he invented a safety valve which was adopted for use on boilers of early steam engines. Papin also participated in improvement of the air pump.

This work and a French translation (1682) and a supplementary work (1687) are in the Levis Collection on Gastronomy, one of the most distinguished special collections in Crerar Library.

81

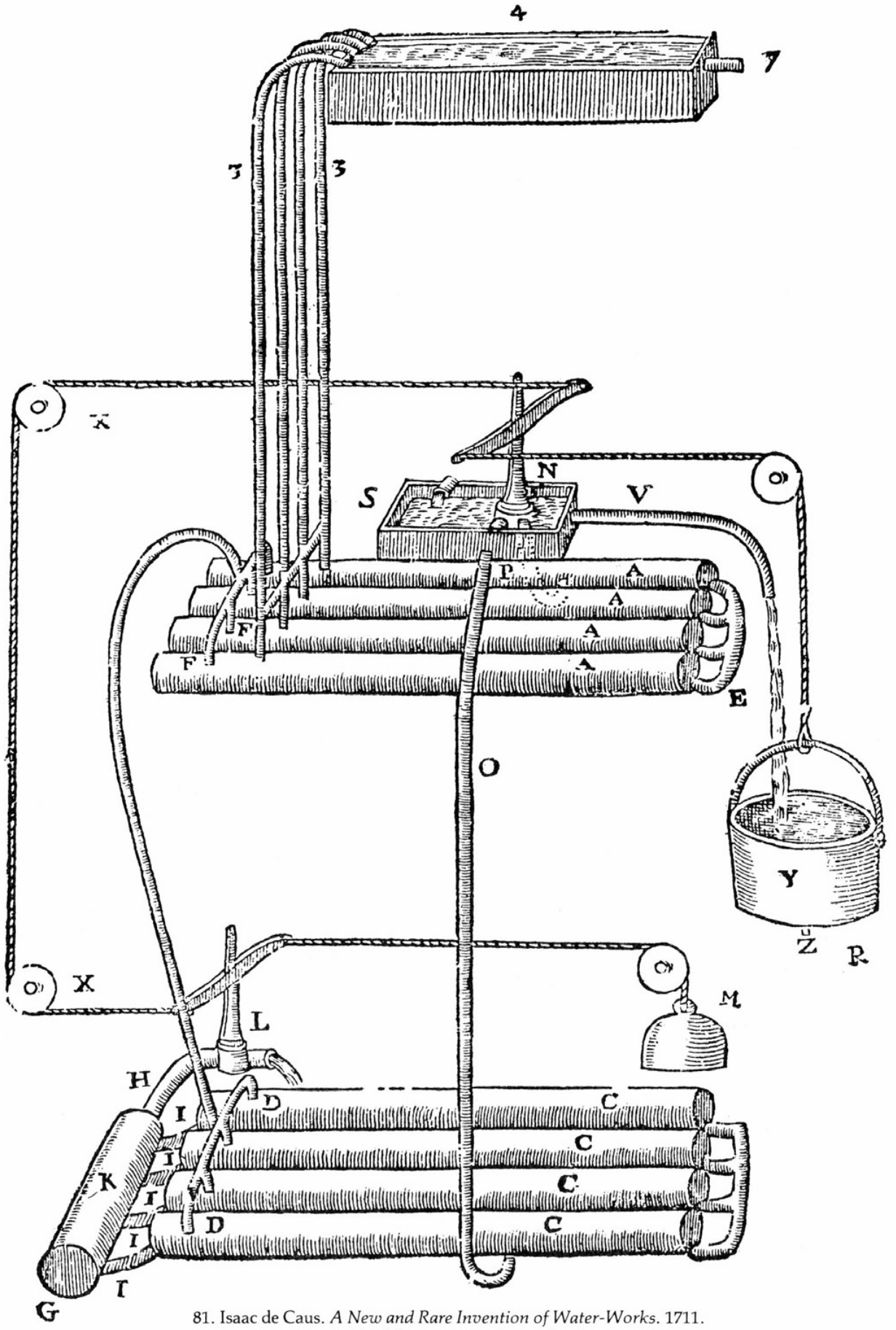
Isaac de Caus, *fl.* 1644

A New and Rare Invention of Water-Works . . . also, A Description of Capt. Savory's Engine for Raising Vast Quantities of Water by Fire

London, 1711

This early work on mechanization of water-works was first published in French in 1659; but did not have the additional section by Capt. Savory on use of a steam engine.

The 1711 edition in the Crerar collections is the only copy recorded in the *National Union Catalog – Pre 1956*.



81. Isaac de Caus. *A New and Rare Invention of Water-Works*. 1711.
Device for lifting water to higher levels.

82 & 83

Oliver Evans, 1755-1819

The Young Mill-Wright & Miller's Guide

Philadelphia, 1795

The Abortion of
the Young Steam Engineer's Guide

Philadelphia, 1805

Oliver Evans was an American inventor of first rank. He invented numerous improvements in milling machinery, including the screw-mill, which were ultimately widely adopted. He was a pioneer in the development of high-pressure steam engines and manufactured many of them. However, his many inventions were adopted too slowly to please him, which accounted for the odd title of his book on steam engines, which had the sub-title: "An investigation of the principles, construction and powers of the steam engine." In 1813, he published a tract advocating repeal of the patent laws under the pseudonym: "Patrick N. I. Elisha, Esq., poet laureate." The *Miller's Guide* went through numerous editions by the mid-19th century; the second edition of his second work was published in 1826 under the title: *The Young Steam Engineer's Guide*. Both books were translated into French.

All of the items mentioned above, excepting only the 4th and 5th among the later editions of the *Miller's Guide*, are in the Crerar collections, as is the excellent *Oliver Evans; A Chronicle of Early American Engineering* (1935), by Greville and Dorothy Bathe.

84

Robert Fulton, 1765-1815

Torpedo War, and Submarine Explosions

New York, 1810

Fulton is most generally remembered for his work with steam boats and steam navigation. One of his earliest publications was *A Treatise on the Improvement of Canal Navigation* (London, 1796) which was translated into French in 1799. Fulton tried to "sell" his ideas about torpedo war to the French government, the British government, and finally the American government in that order. He received a cool reception in all quarters. The copy of the book exhibited is a facsimile reprint by The Swallow Press in Chicago (1971) from a copy of the original edition in the Crerar collections.

The other items mentioned are also in the Crerar collections, as well as more than twenty biographies and other works commenting on his life and work.

85

Sir Humphry Davy, 1778-1829

On the Safety Lamp for Coal Miners;
With Some Researches on Flame

London, 1818

At a time when many fatal mine explosions were happening in British mines, Sir Humphry Davy, the British chemist, was requested to design a safety lamp. This effective invention was the result. Davy left its commercial development to his brother and partner.

A note of the library's holdings of books by and about Davy is given for No. 53 under Chemistry.

MEDICINE

As stated by Fielding H. Garrison in his *An Introduction to the History of Medicine* (4th ed., 1929): "Medicine could not begin to be medicine until it was dissociated from magic and religion;" and "Even today, medicine sometimes partakes of magical and mystic (religious) as well as of scientific elements." Continuing from Garrison: "The most difficult problem which confronts the medical historian is: How did early man acquire correct logical thinking in regard to the treatment of disease?" And then his answer: "It really got its stride among the active minded Greeks."

So we come again to the phenomenal culture of Greece for beginnings as in mathematics, mechanics and the study of living things. And as in these other fields, we find that new progress came very slowly until the cultural awakening of the Renaissance. The advancement in all of the other sciences had impact on progress in medicine. It was not until anatomy, pathology, physiology, bacteriology, pharmacology and biochemistry had developed into modern scientific disciplines that clinical medicine, or the treatment of patients, could become truly an "applied science."

In selecting examples for a very small exhibit on the history of medicine, it is tempting to consider some of the very great advances in the basic medical sciences. This is usually done. Here, however, the selections are made from some of the specialties that have developed in clinical medicine: Pediatrics, Obstetrics, Dermatology, Surgery, Ophthalmology and Cardiology.

In the field of medicine, in particular, The John Crerar Library has been indebted to many physicians for gifts of books—even whole libraries—and funds for purchase of medical literature. The items chosen for this exhibit are notable evidence of these benefactions.

86

Paulus Bagellardus, d. 1492 or 1494

De Infantium
Aegritudinibus et Remediis

Padua, 1472

This small treatise was the first work dealing with children's diseases. It was published twice in the 15th century, Padua, 1472 and 1487. The author referred to earlier writers back to Hippocrates, and described what he believed was the best practice of his time. The book was probably written some years before its publication, during a period of medical practice and teaching. Although there are records of at least two printed medical broadsides before 1470, no medical books were printed until 1471. Probably no more than twenty such books preceded the Bagellardus, and the copy exhibited is the only one recorded in the *National Union Catalog—Pre 1956*.

The 1472 and 1487 editions of this work and one other title are in the Crerar collections. They are all items in the Clifford G. Grulee Collection on Pediatrics donated to The John Crerar Library in 1948. A catalog of the collection, which numbered approximately 4,000 volumes at the time of Dr. Grulee's gift, was published by Crerar in 1959.

87

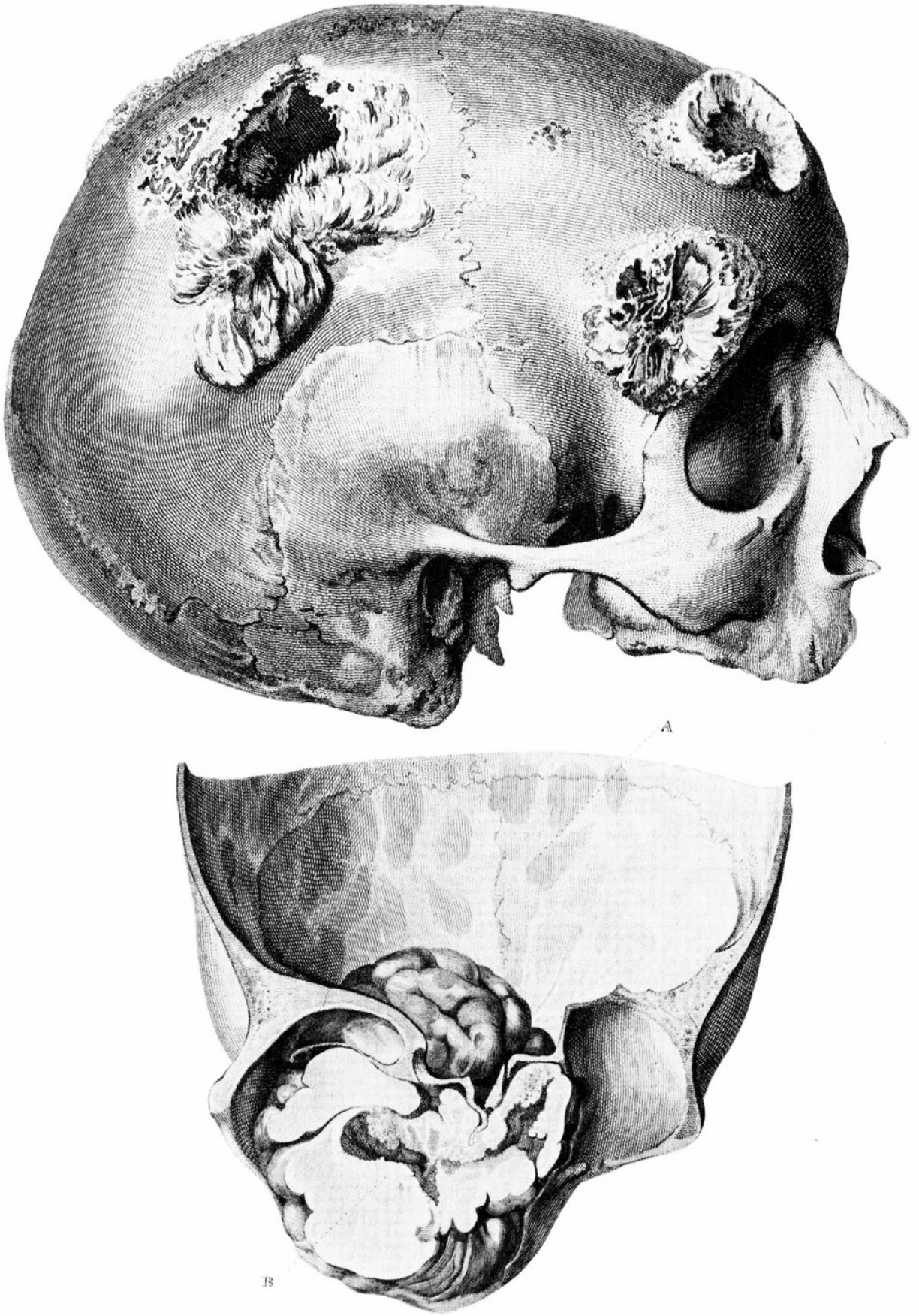
Eucharius Röslin, d. 1526

Der Schwangeren Frauen
und Hebammen Rosengarten

Augsburg, 1528

Röslin issued his little book for lying-in women in 1513. This 1528 edition is exhibited as a work on obstetrics comparable to the Bagellardus on diseases of children. It added very little more to obstetrical knowledge than that which came down from the Greeks.

The Crerar collections have this and a later edition and four other titles by Röslin.



92. Matthew Baillie. *A Series of Engravings . . . to Illustrate Morbid Anatomy.* 1799-1802.
Unidentified disease of the cranium, regarded at the time as possibly cancerous.

88

Samuel Hafenreffer, 1587-1660

Nosodochium, in Quo Cutis

Ulm, 1660

When the first edition of this book was published in 1630, it represented advances in the treatment of diseases of the skin, but illustrates how slowly some of them developed. It was more than a century later that Plenck (the next author in the exhibit) produced a work on skin diseases that approached that of modern dermatology.

This is the only work by Hafenreffer in the Crerar collections. It is one of a large number of medical treatises in the Senn Collection of medical literature. This collection came to Crerar in 1906 as a gift of Dr. Nicholas Senn, one of the leading surgeons in the United States at that time. The collection, numbering more than 11,000 volumes and a large collection of pamphlets, covers the history of medicine from the 15th through the 19th centuries.

89

Joseph Jacob von Plenck, 1738-1807

Doctrina de Morbis Cutaneis

Vienna, 1776

Plenck was known primarily as one of the early dermatologists, and his *Doctrina de Morbis Cutaneis* was the first important work in the field during the 18th century. However, he wrote in other fields; one of his principal works was *Icones Plantarum Medicinalium* (1788-1803) in 7 volumes.

The Crerar collections include both of the above works and thirteen others, four of which are in the Senn collection and two others in the Grulee collection on children's diseases.

90

Filippo Baldini

Metodo di Allattare a Mano i Bambini

Naples, 1784

Baldini was a relatively minor Italian physician of the 18th century, but produced several medical books in the field of Pediatrics. This work on care of infants was published in 1784 as the first volume in a series of monographs. It was later published separately in 1787.

The collection of five monographs and three other titles by Baldini are all in the Clifford G. Grulee Collection described under No. 86.

91

John Hunter, 1728-1793

A Treatise on the Venereal Disease

London, 1786

John Hunter is viewed as the founder of modern experimental and surgical pathology. His two major works in the field were the title exhibited and his: *A Treatise on the Blood, Inflammation and Gunshot Wounds* (1794). Each went through numerous editions and were widely influential.

The Crerar collections have both of the above works in the first and later editions, three other Hunter titles plus editions of his complete works in English and French, and more than thirty other works dealing with Hunter's life and work. Four of the items are in the Senn collection.

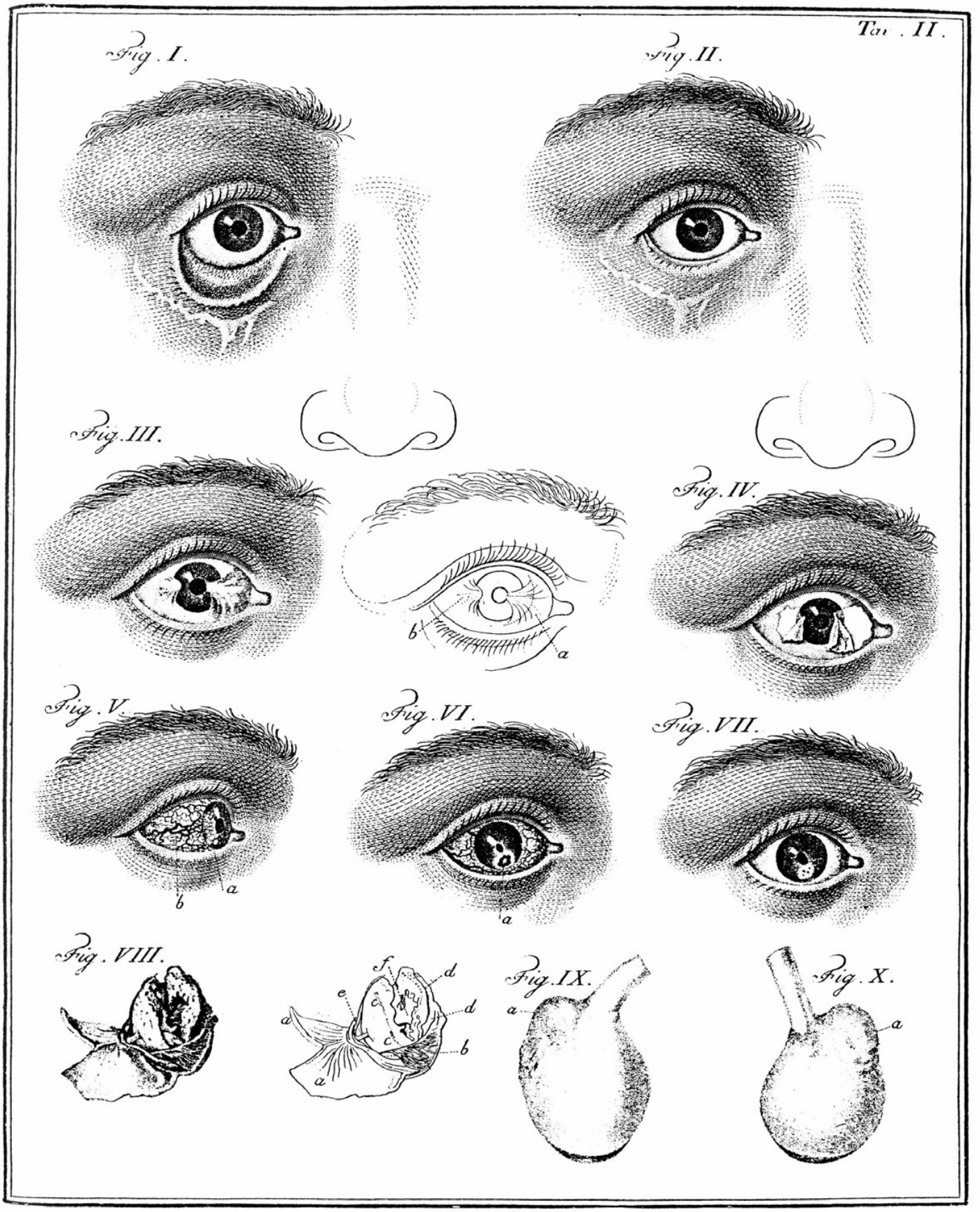
92

Matthew Baillie, 1761-1823

A Series of Engravings . . . to Illustrate Morbid Anatomy

London, 1799-1802; 10 fascicles in 1 vol.

The founder of modern pathologic anatomy was Giovanni Battista Morgagni (1682-1771). The Scottish



94. Antonio Scarpa. *Saggio di Osservazionie d'Esperienze sulle Principali Malatti degli Occhi.* 1801.
Morphology and surgery of the eye.

physician, Baillie, improved on Morgagni's work by his own treatise on *Morbid Anatomy* (1793), in which he made the first attempt to treat pathology as an independent discipline. The work exhibited is an edition of plates issued to illustrate that text.

The item exhibited was purchased through the James G. Kiernan Memorial Fund which was established at Crerar for the acquisition of medical literature. Other Baillie titles in the collections are a second edition of the engravings, the 1793 and four other editions of the text and five titles about the life and work of Baillie.

93

Jean de Carro, 1770-1857

Observations et Expériences sur
l'Inoculation de la Vaccine

Vienna, 1801

Only three years before publication of this book by De Carro, Edward Jenner (1729-1823) had published in England his: *An Inquiry into the Causes and Effects of the Variolae Vaccinae* and launched the now almost completely successful campaign to eradicate smallpox. De Carro was one of Jenner's followers. He was one of the first two physicians to introduce vaccination into Vienna and the first to introduce it into Asia.

The item exhibited was purchased through the Michael L. Lane Fund which was established at Crerar for acquisition of publications in the fields of histology and immunology. In addition to this title, there is only one other Carro item in the collections, a book translated by Carro from Czech into French.

94

Antonio Scarpa, 1747-1832

Saggio di Osservazioni e d'Esperienze sulle
Principali Malattie delgi Occhi

Pavia, 1801

A brilliant physician in Venice, Antonio Scarpa was an anatomist, surgeon, orthopedist and ophthalmologist, and made important contributions in all of these fields. This work was one of his major publications in ophthalmology.

This volume was purchased through the Henry Gradle Memorial Fund established at Crerar for acquisition of publications on the eye and ear. It is part of a special collection of Scarpa's works. Also included is Scarpa's great classic *Tabulae Neurologicae* (Pavia, 1794) which presented the first clear delineation of the nerves of the heart. That volume was purchased through the Nathan Smith Davis, Jr. Fund (see also No. 95).

95

René Théophile Hyacinthe Laennec, 1781-1826

De l'Auscultation Médiate;
ou Traité du Diagnostic des Maladies
des Poumons et du Coeur

Paris, 1819; 2 vols.

Laennec was the most distinguished French internist of his time. His invention of the stethoscope, at first a very simple instrument, revolutionized diagnosis of diseases of the lungs and heart. In this first edition of a major landmark in medicine, and especially in the second edition issued in 1826, Laennec produced what has been ranked as the most important book on diseases of thoracic organs ever written.

The Crerar collections include both the 1819 and 1826 editions which were purchased through the Nathan Smith Davis, Jr. Fund, which was established at Crerar for publications on the lungs,heart and kidneys. The collections also include numerous other editions of this work in French, English and German as well as two of his other titles, and 10 titles about his life and work.

INDEX OF NAMES

Arabic numerals refer to entries in the catalog.

Roman numerals refer to introductory statements preceding subject groups as follows:

I. Introduction
II. General Science *Entry Nos. 1-11*
III. Mathematics *Entry Nos. 12-21*
IV. Astronomy *Entry Nos. 22-29*
V. Physics *Entry Nos. 30-45*
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