

BIBLIOGRAPHY
& NATURAL
HISTORY

*Essays presented at a
Conference convened in June 1964
by Thomas R. Buckman*

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S I D A ricinoides.

H. & A. Bot. 22.

Del. & Sculp.

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Introduction

The purpose of this group of essays and formal papers is to focus attention on some aspects of bibliography in the service of natural history, and possibly to stimulate further studies which may be of mutual usefulness to biologists and historians of science, and also to librarians and museum curators. Bibliography is interpreted rather broadly to include botanical illustration. Further, the intent and style of the contributions reflects the occasion—a meeting of bookmen, scientists and scholars assembled not only to discuss specific examples of the uses of books and manuscripts in the natural sciences, but also to consider some other related matters in a spirit of wit and congeniality. Thus we hope in this volume, as in the conference itself, both to inform and to please.

When Edwin Wolf, 2nd, Librarian of the Library Company of Philadelphia, and then Chairman of the Rare Books Section of the Association of College and Research Libraries, asked me to plan the Section's program for its session in Lawrence, June 25-27, 1964, we agreed immediately on a theme. With few exceptions, we noted, the bibliography of natural history has received little attention in this country, and yet it is indispensable to many biologists and to historians of the natural sciences. Zoologists and botanists require detailed and exact documentation not only of current literature but of the older sources as well, but workers in the descriptive disciplines, especially taxonomy, constantly find that available bibliographical data is inadequate. At the same time we recognized that bibliographical and historical studies in the natural sciences are better developed and have a longer tradition in Northern Europe.

Accordingly it seemed that it might be useful to bring together a number of American specialists and a few of their foreign colleagues from England, Sweden and the Netherlands for an exchange of views which would define the importance of the older literature in the natural sciences and describe how researchers in this field employ bibliography in seeking evidence. Given something less than a year for planning, with modest financial resources, and a program limited to two and a half days, comprehensive coverage of the subject could not be expected, but a strong beginning could be made.

The chief emphasis of the papers presented is botanical, partly because the historical bibliography of botany is generally in better order than that of the other branches of biology, and partly because of the availability of scholars especially concerned with it. The period is largely the eighteenth and early nineteenth centuries in Europe and America, and inevitably the work, the

personality, and the influence of Linnaeus are pervasive, although several of the papers range more widely. I have no doubt that there will be few readers who will be equally absorbed by all of them, but there is much of substance and good humour here for every student of the bibliography of natural history. There is considerable diversity of approach, but each of the contributors writes with authority.

Three related groups of papers emerge.

William T. Stearn in his keynote address presents a broad but detailed view of the uses made by scientists of bibliography in natural history, ranging from a consideration of the sixteenth century naturalists down to modern facsimile publishing of classical floras. Sten Lindroth re-examines the life and work of Linnaeus, classifier extraordinary and one of the great botanical bibliographers, from a refreshingly objective standpoint: dispelling the sacred halo which has surrounded him and prevented a critical assessment of his place in the history of science.

The establishment of Charles Willson Peale's remarkable Museum in Philadelphia, the first institution of any size in this country devoted to natural history is described by John Greene on the basis of his study of the Peale manuscripts. Here is a glimpse of one phase of the earliest American interest in natural history. Jerry Stannard gives an account of another phase, in his paper on the sources for early American botany from its beginnings to the Civil War, suggesting the great breadth of American activity in this field, the variety of available material, and the many opportunities for further work in bibliography and in cultural and historical studies of botanical science in the New World.

Two papers on botanical illustration take us, in the first instance, into the world of Pierre-Joseph Redouté and his royal patrons, and secondly introduce some of the principal *pen ts'ao* studies of China and the related botanical treatises of Japan. Frans Stafleu writes of the historical, artistic and taxonomic importance of Redouté's illustrations, with the precision of a scientist and with the grace and breadth of vision of a humanist. Richard Rudolph reveals an area of study—the botanical iconography of China and Japan—which has been virtually ignored by Western scholars despite the richness of material at hand.

Finally, there are three shorter papers somewhat apart from the botanical center of interest described earlier, but which are nonetheless entirely relevant to the general concerns of the conference.

Robert Mengel reflects on the personal hazards and the professional rewards of bibliographical work in ornithology, that branch of zoology which is best provided with descriptive and enumerative keys to its literature.

Alan Boyden pleads convincingly for the exact and unvarying use of scientific terms in natural history, a subject which of necessity engages the sympathies of bibliographers.

And Jacob Zeitlin documents "the end of the great harvest" in the buying and selling of natural history books, a matter of great concern to all scholars and bookmen who face the task of enriching existing collections, or the far more difficult one of building new ones.

Two of the papers presented at the conference were unfortunately not submitted for publication, but should be noted here to complete the record of proceedings. They are Vivian Lee's "Pursuing the Strawberry Through Literature," a review of the early development of the strawberry based on the horticultural and botanical literature of the seventeenth through nineteenth centuries; and Robert Stauffer's "Editing Darwin's Unpublished Book on Natural Selection."

I am deeply indebted to Foster Mohrhardt, Director of the National Agricultural Library, Washington, D.C., for so ably organizing and moderating a panel discussion on needs and prospects in the bibliography of natural history, following William T. Stearn's opening address.

The panel members were George H. M. Lawrence, Director, Rachel Mc-Masters Miller Hunt Botanical Library, Pittsburgh, who described the projected *Bibliographia Huntiana* to be produced by the Hunt research staff during the next fifteen years, comprising full bibliographical descriptions of sixteen to eighteen thousand titles of botanical works published throughout the world during the period 1730-1840, and including two hundred thousand or more cognate titles in the periodical literature of the same dates; Philip C. Ritterbush, Special Assistant to the Secretary, Smithsonian Institution, Washington, D.C., speaking on the Smithsonian's long-standing interest in developing better control of the data of binomial nomenclature used by systematic biologists, and more adequate taxonomic, floristic and faunistic bibliographies; and Jerry Stannard whose remarks were expanded into the full-length paper presented here.

The conference was jointly sponsored by the University of Kansas, and the Linda Hall Library of Science and Technology, Kansas City, Missouri, where the closing session was held on June 27, 1964. I am especially grateful to Provost James R. Surface of the University of Kansas, and to Dr. Joseph C. Shipman, Director of the Linda Hall Library and to its Trustees for their generous financial support; and to the staff of the University of Kansas Library, particularly Stuart Forth, John Glinka, Alexandra Mason, and Terrence Wil-

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Thomas R. Buckman

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The Use of Bibliography in Natural History

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For those of us who work in the older centres of biological learning, natural history comprises the studies which are more alluringly designated the life sciences in many of the newer foundations. The major problems relating to the recent literature of these sciences lie in documentation and information retrieval, and thus are outside the scope of the present conference. Bibliographical problems comparable with many of those occurring in the literature of the humanities and needing the same approach and techniques for their solution abound, however, in the older literature of natural history, particularly that which remains of practical importance and historic interest for classification and nomenclature. This literature is a store of information which, on account of the enormous number of organisms it records, cannot be continually discarded and replaced; instead new information is continuously added to it. In this opening address I propose to touch upon some applications of bibliography to natural history, particularly those relevant to nomenclature and to a better understanding of the development of botany and zoology embodied in the literature of the last four centuries. The term 'bibliography' I use here in its broad sense, i.e. "the description or knowledge of books in regard to their authors, subjects, editions and history." For me bibliography is important only in so far as its material is important, but it can be interesting, of course, even when its material is really of little consequence. No qualms, however, about the importance of his subject matter need trouble the bibliographer of natural history books. Taken as a whole they represent a superb intellectual achievement. That part of them concerned with taxonomy and systematics records by descriptions and illustrations the characteristics of some 360,000 species of plants, about 250,000 of these being flowering-plants (angiosperms, spermatophytes), and some 1,120,000 species of animals, about 850,000 of these being insects; in all it deals with nearly one and a half million species of organisms. Each has been named, some indeed too many times named, according to a system of nomenclature so linked to classification that knowledge of the name of an organism enables one, admittedly with difficulty on occasion, to obtain further information about it. This knowledge has all been won since the end of the fifteenth century, i.e. since the invention of printing. Indeed it could never have been achieved without the storing and sharing of information and the encouragement to enquiry provided by the printed book.

The Task of the Sixteenth-Century Naturalists

To appreciate the magnitude of this taxonomic achievement one must go back to the sixteenth century, to the years 1542-43 which have been conveniently even if arbitrarily taken as marking the end of the Middle Ages in science because they saw the publication of four important books: in herbalism, Fuchs, *De Historia Stirpium* (1542) and *New Kreüterbuch* (1543); in anatomy, Vesalius, *De Humani Corporis Fabrica* (1543); and in astronomy, Copernicus, *De Revolutionibus Orbium* (1543)—manifesting a direct approach to the natural world. Long before, the printers of Italy, Germany and France had made generally available the great natural history works of antiquity, those of Pliny in the original Latin, those of Aristotle, Theophrastus and Dioscorides in Latin translations. The task of the pioneer naturalists, the *patres*, notably the Swiss Conrad Gessner (1516-65) ‘the father of bibliography,’ the Germans Otho Brunfels (1488-1534) and Leonhart Fuchs (1501-66), and the Englishman William Turner (c.1510-68) ‘the father of British botany’, was to interpret these works in order to establish the correct names of the animals and plants around them, i.e. the names used by the Ancients, and so to gain access to the information recorded under the classical names. These scholars did not set out to discover new knowledge; they found it inevitably if inadvertently when organisms of central and northern Europe failed to agree with those of Italy, Greece and Asia Minor named in classical texts. As stated by Raven in 1953, “this matter of exact nomenclature and identification is one of the plainest differences between the naturalists of the Middle Ages and those of the sixteenth and seventeenth centuries. . . . They must at all costs discover the modern equivalent of the species hallowed by the tradition as ingredients in medicine or predestined to a use and must fix its identity by accurate description and classification . . . This discipline enabled nomenclature to be reasonably standardized, but mere description would hardly have sufficed unless it had been accompanied by the admirable engravings and woodcuts which fixed the identification of most European plants, fishes and birds by the middle of the sixteenth century. Fuchs’s herbal, Salviani’s fishes and Gesner’s animals and birds made it possible for any intelligent student to name what he saw in these departments with some confidence and so to proceed to the comparisons and records necessary for classification . . . providing the necessary material for further and more important research.”

The value of illustrations was all the greater because the vast technical vocabularies of modern biology, stuffed with terms referring to organs then unknown or ignored or not precisely defined, had yet to be created.

Indeed Hans Weiditz, who illustrated Brunfels's *Herbarum vivae Eicones* (1530-36), and Albrecht Meyer, who illustrated Fuchs's *De Historia Stirpium* (1542), made more lasting contributions to natural history by providing figures direct from nature and not copied from copies of copies than did Brunfels and Fuchs who took much of their text from the Ancients. Neither the authors nor their artists knew of the sexuality of plants, which was not established until the second half of the seventeenth century. Consequently they paid little attention to floral details, but their illustrations portray general habit admirably.

Colouring of Sixteenth-Century Herbals

For scientific purposes the value of these illustrations is yet higher when authentically coloured, although aesthetically the plain lines of the uncoloured woodcuts are often more pleasing. A distinction must be made, however, between a copy issued plain and subsequently coloured by its owner, as Fitch and Smith's *Illustrations of the British Flora* have so often been, and a copy issued by the publisher with plates already coloured. A copy with original publisher's colouring represents the original author's material, is authentic, and hence has a quite different value for the interpretation of the text than one subsequently coloured according to the owner's supposition. Thus the illustration of *Consolida major mas* in an authentically coloured copy of Brunfels's *Eicones* (1:76;1530) at the Royal Botanic Gardens, Kew, has the flowers reddish-coloured and undoubtedly represents a form of *Symphytum officinale*. The same woodcut in a copy coloured by an owner which is at the British Museum (Natural History) has yellowish flowers and has consequently been incorrectly identified as *Symphytum tuberosum*. By a fortunate chance a few of Weiditz's original coloured drawings for this herbal have survived; the Basel physician Felix Platter (1536-1614) cut them up and pasted them in his herbarium (now at Bern) as substitutes for specimens. In 1933 a critical investigation by Walter Rytz (Rytz, 1933; see also *Arber*, 1936) led to these drawings being recognized as the originals of Brunfels's herbal. Weiditz's original of this *Symphytum* woodcut (reproduced in Rytz, 1938) has the flowers reddish, as in the Kew copy; indeed the general agreement between the colouring of Weiditz's originals and the woodcuts in the Kew copy establish beyond doubt the authenticity of the latter (see *Sprague*, 1938). Weiditz's coloured drawings must clearly have served as patterns for the colourists.

Fuchs's herbals, *De Historia Stirpium* (1542), and *New Kreüterbuch* (1543), likewise exist in both coloured and uncoloured states, but unfortunately no

original coloured drawings by Albrecht Meyer, which could serve to test the authenticity of the colouring, are known to exist now. Obviously, however, copies coloured for the publisher by reference to the artist's originals will possess many common features unlikely to be found together in a copy independently and privately coloured. Thus by comparison of a number of coloured copies one can establish these common features and then use them as criteria for distinguishing original and later coloured copies. For example, in the text accompanying his woodcut of *Lamium* (*Hist. Stirp.* 469; *New Kreüt.* t. cclxiv) Fuchs states: "the deadnettle is found in three kinds. One, which is properly called *Lamium*, has white flowers, another yellow, the third purple flowers. Because they differ only in the flowers and no distinction appears in their leaves, we have represented all three kinds in one illustration." The woodcut represents three shoots rising from the same root, all essentially alike in uncoloured copies, but the left-hand one in coloured copies has yellow flowers and depicts *Galeobdolon luteum* (*Lamium galeobdolon*), the middle one has reddish flowers and depicts *Lamium maculatum*, the right-hand one has white flowers and depicts *Lamium album*. Probably no-one using Fuchs's herbal would have expected to find these three species growing on one plant! This was simply an economical way of indicating variation, like portraying a rose (*Hist. Stirp.* 657; *New Kreüt.* t. cclxxiv) with red and pink, single and double flowers, i.e. *Rosa gallica* and *R. canina*, all on the same bush, a carnation (*Hist. Stirp.* 354; *New Kreüt.* t. cc) with red, pink and white flowers on different shoots of the same tuft, a plum tree (*Hist. Stirp.* 403; *New Kreüt.* t. ccxxvi) with yellow, blue and reddish fruits on the same tree, or a cherry tree (*Hist. Stirp.* 425; *New Kreüt.* t. ccxxxix) in flower and fruit at the same time, the cherries black and red. Such peculiarities distinguish original coloured copies from privately coloured ones. They are found in copies at the Cambridge University Library, the Lindley Library of the Royal Horticultural Society, the Linnean Society of London, Winchester Cathedral Library, the Chelsea Physic Garden and the Missouri Botanical Garden.

Illustrations and Descriptions

The production of such drawings and woodcuts was a slow and costly business: an artist copied the original drawing on to a block of wood of pear, apple, medlar or quince, then a woodcarver or 'Formschneider' cut away the wood around the lines of the drawing so as to leave a raised design to take the ink. Hence illustrations, then as now, tended to be used time and time again, being sometimes associated with a different

text. The woodblocks of Fuchs's 1542 herbal were used down to 1774. The illustrations of Turner's *New Herball* (1551-68) appeared originally in an octavo edition (1545) of Fuchs's herbal. Most of the woodcuts in the first edition of Gerard's *Herball* (1597) came from Tabernaemontanus's *Eicones* (1590) printed at Frankfurt am Main by Nicolaus Basse, those of the second edition (1633) from Dodoens's *Pemptades* (1583) and other works printed at Antwerp by Christopher Plantin; among these are a few, as Agnes Arber has pointed out (*Arber*, 1938), derived from the Codex Aniciae Iulianae made at Constantinople in 517 A.D. Finan (1950), dealing with the copying and borrowing of woodcuts of maize (*Zea mays*), found that the woodcuts in forty-seven illustrated herbals published between 1542 and 1674 could be traced to originals in seven herbals. This is a matter of some consequence when studying the early history of plants because it means that the illustration and text in a given work may not necessarily refer to the same plant. Moreover, in the process of copying, significant details may have become obscured. This can only be ascertained by comparison of illustrations in a number of different herbals.

The illustrations in the herbals of Brunfels and Fuchs, being excellently drawn from living specimens, provided sure reference points for identification of many species occurring outside as well as inside Germany. Thus they portrayed some 230 British species together with various cultivated plants; no illustration of a number of these made from a British-grown plant was published before the late seventeenth century. The woodcuts in Gessner's monumental *Historia Animalium* (1551-87) enabled people to recognize almost at a glance the mammals, birds and fishes associated with standard names. The development of the art of describing plants and animals made unnecessary an illustration of every one, since a few illustrations could serve to represent the main members of a group and the others could be distinguished in words. The sixteenth-century pioneers of plant description, Tragus (Hieronymus Bock, 1498-1554) writing in German, and Valerius Cordus (1515-44) and Carolus Clusius (Charles de l'Escluse, 1525-1609) writing in Latin, successfully noted significant features, so that their plants can usually be identified with certainty—see, for example, Sprague and Sprague's commentary (1939) on the herbal of Valerius Cordus—but undoubtedly their lack of a precise terminology handicapped their work. Moreover, since a picture gives an immediate overall impression such as a mass of analytical detail expressed in words cannot convey, good illustration remains an element in biological progress. As Martin Lister wrote in 1682, "Naturall History is much injured, through the little encouragement which is given to the

Artist, whose noble performances can never be enough rewarded, being not only necessary, but the very beauty and life of this kind of learning." Over the years the number of illustrated books has steadily increased in accordance with progressively more efficient and cheaper methods of reproduction. The woodcut line, dependent upon the strength of raised fibres along the grain of a woodblock, is, according to A. H. Church (1919), about 250 μ broad and too stout for portraying organs less than 1-2mm in diameter. However, naturalists paid little attention to such minutiae before the seventeenth century, by which time the copper engraving with its finer lines had superseded the woodcut in book illustration generally and could meet the exacting demands of scientific illustrators and of the makers of beautiful books down to the nineteenth century, when the lithograph and the steel engraving replaced it. The development of the folio volume with copper-engraved hand-coloured illustrations of plants, birds and insects took place in the eighteenth century. The major development of descriptive botanical terminology through the work of the Swedish naturalist Carl Linnaeus (1707-78) belongs to the same period. The two are linked.

Influence of Linnaeus

Paradoxically Linnaeus, who lived in war-impoverished Sweden, a country without good illustrators and good printers, nevertheless provided through his economically produced encyclopaedic works the stimulus for the publication of finely illustrated natural history books elsewhere. By summarizing what was known, Linnaeus's works made it possible to recognize as new the organisms for which he had published no diagnostic characters. His systematic and comprehensive listing of plants in the *Species Plantarum* (1753, etc.) and of animals as well as plants in the *Systema Naturae* (10th ed., 1758-59) came at the right time to serve as a basis for the expansion of the biological sciences fostered by European exploration and colonization in the tropics and elsewhere. His binomial nomenclature for species labelled these organisms concisely and conveniently. However, during most of his life Linnaeus used several-word specific names which sought to express the characters of species. Thus for the species which he named *Lobelia cardinalis* in 1753, Linnaeus had earlier (in 1738) introduced the diagnostic phrase-name *Lobelia caule erecto, foliis lanceolatis serratis, spica terminali*, 'Lobelia with erect stem, lanceolate serrate leaves, terminal spike'. As the number of known species increased, such names became longer and hence more and more difficult to keep in mind. Linnaeus's introduction of the binomial system as an alternative

method of naming connects closely with his bibliographical method, as Heller (1964) has made clear.

Linnaeus's first contribution to enumerative bibliography is his *Bibliotheca botanica* (Amsterdam, 1736), which lists 295 botanical works. His *Bibliotheca botanica* groups writers about plants and their works in 16 classes, passing from the Patres to the Commentatores, Ichniographi, Descriptores, Monographi, Curiosi, Adonistae, Floristae, Peregrinatores, Philosophi, Systematici, Nomenclatores, Anatomici, Hortulani, Medici, and ending with the Anomali or 'awkward squad', in which he included poets, theologians and librarians! In Heaven Linnaeus must surely have set about classifying the Angels! Each book is listed under the Latin or Latinized name of its author and concisely described, a specimen entry being:

Rajus Johannes

Catal. pl. Angliae & insular. adjacentium

— Lond. 1670. 8vo.

— Lond. 1677. 8vo.

Fasciculus Stirp. Brit. post Catalog.

— Lond. 1688. 8vo. p. 27

Linnaeus provided an essentially similar bibliography in the introduction to his *Hortus Cliffortianus* (1738).

Linnaean Abbreviations and Citations

Linnaeus did not simply list books. Like his successor and peer in bibliography Albrecht von Haller (1708-77), the author of *Bibliotheca anatomica* (1774-77) and *Bibliotheca botanica* (1774-75), Linnaeus read them, used them, cited them. His method of citation is economical and indeed peculiar, being based on the same principles of genus and species as he used in naming organisms (see Stearn, 1959; Heller, 1964), but with a very important difference. Since one can describe an individual book but not satisfactorily define it, there is no temptation to use other than a simple designation when citing a given book. Linnaeus's citations are two-word; thus the citation *Clus. hist.* stands for Charles de l'Escluse's *Rariorum Plantarum Historiae* (1601) and *Clus. pan.* for his *Rariorum aliquot Stirpium per Pannoniam . . . Historia* (1583). Linnaeus explained his method in his *Critica botanica* no. 322 (1738): "in every citation the Author's name should be given in an abbreviated form, corresponding to the generic name of a plant, and his works corresponding to the specific name, since a particular author often owes his fame to more than one book. For if anyone quotes an author without mentioning the work, I am left in doubt, and so are others, which book he meant: for

instance, if Plumier is cited, is it his Genera, or his Species, or his Descriptions of Plants or his Ferns?" Linnaeus accordingly distinguished these as *Plum. gen.*, *Plum. spec.*, *Plum. amer.* and *Plum. fil.* He considered it unwise to name even a deceased author who owed his fame to a single work without mentioning that work, since another author with the same surname might later become famous. Thus he cited Kiggelaer's only work, *Horti Beaumontiani exoticarum Plantarum Catalogus* (1690), as *Kigg. beaum.* Moreover "if the 'specific' name be given without the 'generic', that is the name of the book without the author's name, still worse obscurity is caused. For instance if I cite 'Hortus Lugduno-Batavus' and I do not add the author's name, who is to know whether I mean Voorst, Schuyl, Hermann, Boerhaave, or someone else?" Thus Linnaeus distinguished *Boerh. lugdb.* and *Herm. lugdb.* "As it has not been a common practice to mention one's own name, and it is thought hardly becoming or gentlemanly to do so, authors have been accustomed merely to give the names of their books. For instance, Dillenius, referring to his 'Catalogus Gissensis', wrote *C.G.*, or referred to his edition of Ray's 'Synopsis' as *R.S.*, or to his 'Hortus Elthamensis' simply as *Hort. Eltham.*" In like manner Linnaeus cited his own works as *Fl. Lapp.*, *Gen. pl.*, *Hort. cliff.*, *Fl. succ.*, *It. oel.*, *It. gotl.*, *Fl. zeyl.*, *Hort. ups.*, *Pl. camtsch.*, *Pl. hybr.*, *Diss. euph.* etc. "But it does not follow that other botanists are under any obligation to refer to a book in the same way. They ought to cite in the form *Dillen. elth.*, *Dill. gissens.*, *Dill. gener.*: and so in other cases . . . Again the name of a book should be abbreviated into a single word . . . We add page-references, in order that the plant may be more easily found by the reader, but chiefly in order that he may see that we have consulted the passages cited and compared the plants." The number of page-references which one finds to be incorrect shows, however, that the latter is by no means a reliable deduction! Linnaeus used the same binomial system of citation when referring to the serial publications of academies and societies, e.g. *Act. angl.*, *Act. bonon.*, *Act. goett.*, *Act. paris.* etc. He evidently regarded all such publications, whether entitled *Abhandlungen*, *Commentarii*, *Handlingar*, *Mémoires* or *Transactions* as species of the genus *Acta*. He then distinguished the individual species of the genus by adding a geographical epithet. Thus the *Philosophical Transactions* of the Royal Society of London being an English species of the genus *Acta*, he designated them *Acta anglica* which in his *Genera Plantarum* (see Stearn, 1960) he further abbreviated to *A.A.* The *Mémoires* of the Paris Académie Royale des Sciences, being a French species, he termed *Acta gallorum*, further abbreviated to *A.G.* This is simple and logical but hardly convenient to the uninitiated. Indeed explanations are

nowadays needed for most of the abbreviations used by the earlier authors in citing literature. Few librarians when asked to produce the work cited as *Ger. emac.* would immediately recognize this as the second edition (1636) of John Gerard's *Herball* which was amended by Thomas Johnson and partially reprinted by Marcus M. Woodward in 1927 and again in 1964. Few indeed would know where to look for explanations of such cryptic references. Most of those used in botanical books of the eighteenth century have been covered in the introductions accompanying recent facsimiles of Linnaeus's *Species Plantarum* (1753), *Genera Plantarum* (1754), *Mantissa* (1767, 1771), L'Héritier's *Sertum Anglicum* (1778-92), Jussieu's *Genera Plantarum* (1789) and Robert Brown's *Prodromus Florae Novae Hollandiae* (1810). Nevertheless bibliographers can still help botanists and, even more, zoologists by identifying the titles all too concisely or cryptically mentioned in other works of the period and by providing details of author, title, place of publication and date as in the introductions mentioned. Without such guides to the meaning of abbreviations, search in these old works can be a time-consuming and frustrating business.

Some of these abbreviations defy immediate elucidation. Examples are provided by the citations *List. loqu.* and *List. mut.* used by Linnaeus in *Systema Naturae*, ed. 10, vol. 1 (1758) when dealing with the Insecta; these have been painstakingly and successfully investigated by J. L. Heller (1962). The word *List.* evidently refers to Martin Lister (c.1638-1712); *loqu.* is presumably *loquens* (speaking) and *mut.* presumably *mutus* (dumb); a citation such as '*List. loqu.* 387. *mut.* t.17f.14' would then refer to Lister speaking on p. 387, but dumb on plate 17 figure 14, certainly a peculiar bibliographical situation! These page-references fit only one work by Lister, namely an Appendix to John Ray's posthumous *Historia Insectorum* (1710) entitled *Appendix de Scarabeis Britannicis*. The abbreviation *mut.* is always followed by a reference to an illustration. The note *mutae cum Goedartio* in Linnaeus's *Fauna Suecica* (1746) led Heller to identify *List. mut.* with four plates bearing neither numbers nor names, and hence *mutae*, at the end of Lister's 1685 edition of Goedart's *De Insectis*. Linnaeus cited his *List. mut.*, however, with plate and figure numbers. The explanation of this apparent contradiction is that Linnaeus himself added plate and figure numbers in ink to his own copy and then cited these numerals as if they had been published on the plates themselves. When a plate contained 18 figures, he cited it as t.18; when one had 31 figures, he cited it as t.31. The individual figures he numbered horizontally from left to right beginning at the top of the plate. Only by consultation of Linnaeus's library at the Linnean

Society of London could this have been solved. Heller (1962) has published reproductions of these plates with the numbers added by Linnaeus. Thus bibliographical investigation has provided valuable keys for the interpretation of literature relevant to the typification of Linnaean names.

Linnaean and other Dissertations

Much of Linnaeus's work first appeared in dissertations or student theses: a total of 186, collected together and republished, sometimes unchanged, sometimes with important alterations or additions, in his *Amoenitates academicae* (1749-90). These present a number of bibliographical problems very relevant to their use and a right understanding of their content. When nowadays one reads that a particular paper or book is a 'thesis submitted in partial fulfillment of the requirements for the degree of doctor of philosophy' at the University of So-and-so, one naturally assumes it to be the work of the person named as its author. If this person were later proved not to have written the thesis at all or to have had only a minor share in its production although he paid for the printing, one might accuse him of cheating or suspect sharp practice somewhere. Thus the attribution to Linnaeus of the authorship of theses bearing the names of his students seems odd. In fact there is nothing at all irregular about this because such theses were produced according to an academic procedure of medieval character accepted in Swedish universities down to 1852 and in the German university of Tübingen until about 1860, but which never crossed the Atlantic; they are not comparable to modern theses.

Medieval universities loved arguments and public disputations. What people argued about did not greatly matter so long as they had material for a wordy battle. A scholar Luis Vives wrote of students in 1531: "they dispute before dinner; they dispute during dinner; they dispute after dinner; they dispute in private and in public, at all times and in every place." The really great occasion was when a foreign scholar arrived and challenged the local scholars to a debate. Thus the Scotsman James Crichton in 1581 engaged the scholars of Padua in a public disputation which lasted four days. Rabelais gives a caricature of such a debate in his account of one between Panurge and Thaumaste the Englishman (*Pantagruel* II, cap. 18-20).

The winner received all the money the contestants had deposited before the debate. Probably the spectators also gambled on the result. Hence, as pointed out by Sarton (1957), "the actual disputation was as full of risks and surprises as a boxing match . . . a good deal of eloquence and acting were mixed up with

the arguments and the public disputations were often highly dramatic. Moreover the men taking part in these disputes were often indelicate, petulant, brutal and unscrupulous."

If these disputations suggest a quarrelsome rowdy world far removed from quiet scholarship, it should be remembered that medieval students had only gambling, drinking, wenching, disputing and rioting as diversions. During his course a student had to engage in a disputation; this could be a training exercise (*pro exercitu*) or a final one (*pro gradu doctoris*). After the invention of printing the thesis to be disputed was issued in advance, apparently after the university sermon on Sunday, and was spiked on the church door; the defendant paid the cost of printing. The president of the debate (the *praeses*) occupied the upper part of the double pulpit, the defendant or respondent the lower part, and the opponents confronted them, with an audience around to enjoy the battle of wits. Its primary object was to test the respondent's proficiency in spoken Latin, using the syllogism as the form of argument. When the opponents pressed the respondent into a difficult position, the president came to his aid, hence president and respondent had to be in agreement; this could be simply achieved by the president's drafting the thesis and the respondent's paying for it. One can imagine Linnaeus having a drawer full of notes ready for dissertations which he pulled out on demand. The contribution of the student to the thesis obviously depended on his ability. A few Uppsala students such as Loeffling, Söderberg and Sparrman probably themselves composed most of the theses they defended; but more usually the student acted as a secretary or assistant, Linnaeus himself writing the whole thesis in Swedish or dictating its subject matter partly in Swedish, partly in Latin, and the student then putting it completely into Latin. Linnaeus probably drafted diagnoses of new species directly into Latin as he worked at his collections and the student's task then was simply to provide the preliminary matter. The general and final responsibility for the content of the theses was certainly Linnaeus's; he himself regarded them as his own work and they are to be accepted as such (see *Stearn*, 1957, 51-55; *Stearn*, 1959, 10, 11, figs. 1-4). In the section on dissertations in his *Bibliotheca botanica* (1736) Linnaeus refers to the compilation of theses by the president as being the custom in Germany. This was true of the German universities of Wittenberg (*Wittenberga*), Halle (*Hala*), Helmstädt (*Helmstadium*), Jena (*Jena*), Munich (*Monachium*) and Tübingen (*Tuebinga*) as well as the Swedish universities of Uppsala (*Upsala*) and Lund (*Londinum Gothorum, Lunda*), so that theses from these universities having Afzelius, Agardh, Boehmer, Camerarius, Fries, Gmelin, Heister, Linnaeus, Mohl,

Schübler, Thunberg and Wedel as *praeses* should be attributed to those botanists. It was not, however, the custom at Basel (*Basilea*), Giessen (*Gissa*), Harderwijk (*Harderovicum*), Leipzig (*Lipsia*), Marburg (*Marburgum*) and Strasbourg (*Argentoratum*), and the student named on the titlepage of a thesis defended at these universities must be accepted as its author. Thus Linnaeus both wrote and defended the *Dissertatio medica in qua exhibetur Hypothesis nova de Febrium intermittentium Causa . . . Academia quae est Harderovici . . . submittit Carolus Linnaeus Smol.-Svecus* wherewith on 23 June 1735 he gained his doctor's degree at the little Dutch University of Harderwijk. The procedure before 1850 evidently varied from university to university (see *Horn*, 1893). Difficulty over the attribution of new names arises in such a thesis as *Primitiae Florae Holsaticae quas Praeside D. Joh. Christiano Kerstens . . . publice defendet Auctor Fridericus Henricus Wiggers* (Kiel, 1780) of which the main author was apparently neither the president or the respondent but the latter's professor, Georg Heinrich Weber (see E. H. Nolte, *Novitiae Florae Holsaticae, sive Supplementum alterum Primitiarum Florae Holsaticae G. H. Weberi*, 1826), although this has been disputed (see *Grumman*, 1962, for references).

The Linnaean theses as used in public disputation were pamphlets of small extent, convenient for the occasion and for sending to scholars elsewhere as a form of publication, scientific journals being then few, but they were easily lost or destroyed. Hence Linnaeus produced a collected edition with the title *Amoenitates academicae* (see *Stearn*, 1957, 51-64). It has often been assumed that the *Amoenitates* constitute an exact reprint of the original dissertations. This is a dangerous assumption, since Linnaeus often took the opportunity, when republishing a dissertation in the *Amoenitates*, to alter names and to add or delete material, as *Rickett* (1955), *Stearn* (1957), *Nordenstam* (1961) and others have pointed out. Hence the *Amoenitates* versions should be treated, not as reprints, but as second editions of the original pamphlets, and both should be consulted, particularly in matters of nomenclature. Thus *Svenson* assumed that the binomials in the thesis *Radix Senega* as printed in *Amoen. acad.* 2:112-126 (1762) also occurred in the original pamphlet of April 1749, which in fact has none of them and which uses diagnostic polynomial names. When republishing the thesis *Centuria I Plantarum*, which has been studied by *Rickett* (1955) and by *Nordenstam* (1961), Linnaeus replaced the species *Dianthus hyssopifolius* of the original 1755 thesis by another species *D. superbus* in the 1759 *Amoenitates* version, substituted for the name *Potentilla heptaphylla* the new name *P. opaca*, deleted *Cistus hirta*, *Iberis badensis* and *Lupinus stoloniferus*, added *Geranium*

scabrum, replaced the preempted name *Antirrhinum molle* by *A. glaucum* and the preempted *A. spartum* by *A. junceum*, substituted the new name *G. striatum* for the name *Geranium versicolor*, and transferred *Hieracium tomentosum* to *Andryala lanata*.

The thesis *Flora Monspeliensis* provides another example of the need to consult both versions. In this list of plants found at and near Montpellier a number follows a binomial:

Bromus secalinus 535
Seseli tortuosum 1081
 longifolium 1285
 glaucum 344
Thapsia villosa 1132
Pastinaca sativa 385

The original thesis of June 1756 gives no explanation of these numbers and the hitherto unpublished names listed are accordingly *nomina nuda*. To the *Amoenitates* version (4:475) of 1759 Linnaeus added the important sentence apparently omitted from the original owing to lack of space: "Numeri speciebus adpositi indicant eandem plantam in Magnolii Botanico Monspeliensi, si numerus libro adscribantur" (The numbers added to the species indicate the same plant in Magnol's Botanicum Monspeliense, if the number is inserted by writing in the book). Linnaeus's annotated 1688 copy of Magnol's *Botanicum Monspeliense* (first published 1686), now at the Linnean Society of London, has serial numbers inserted in the margin against Magnol's entries as well as many binomials. Thus the entry *Seseli tortuosum 1081* of the thesis refers to the entry *Seseli Massiliense folio foeniculi crassiore* of Magnol (p. 239) which is numbered 1081 by Linnaeus; the entry *Seseli longifolium 1285* of the thesis refers to the entry *Daucus montanus folio foeniculi longiore* of Magnol (p. 294) which is numbered 1285 by Linnaeus.

Since the original theses are comparatively rare but the *Amoenitates* versions generally available, critical comparisons of the two listing the differences between them for the whole series would be a service by bibliographers to both systematic botanists and zoologists.

Typographical Variation in the Species Plantarum

Linnaeus first used Latin binomials for plants in the index to his *Ölandskå och Gothlandskå Resa* (1745; reproduced in *Stearn*, 1957, between p. 50 and p. 51) and the dissertations *Gemmae Arborum* (1749), *Pan Suecicus* (1749) and *Splachnum* (1750). He first used Latin binomials for animals in the dissertation *Hospita Insectorum Flora* (1752). Here he introduced into

biological nomenclature the binomial method which he had earlier used in citing books, a matter discussed at length by Heller (1964); see above. These works dealt with a limited number of species. In 1753 Linnaeus gave binomials to all the species of plants then known, classifying and listing them in his *Species Plantarum*, and this work has accordingly been internationally accepted as the starting point for modern botanical nomenclature. An original copy now fetches, I am told, about \$400. It is, however, an indispensable working tool for plant taxonomists and has fortunately been three times reproduced in photographic facsimile, by W. Junk in Berlin in 1907, by Shokubutsu Bunken Kankokwa in Tokyo in 1934 and by the Ray Society in London in 1957-59. Comparison of a number of original copies has revealed a surprising number of irregularities and variations from copy to copy. As I have stated elsewhere (Stearn 1959, xi), "the first edition of the *Species Plantarum* is a badly printed work . . . Apparently Salvius's workmen lacked the skill to ink their type evenly. No two copies of the original issue seem to be identical typographically when whole volumes are compared. Thus some letters or words may be lacking from one copy, faint in another, smudged in yet another, but clean and clear in others. There are also many misprints. Some corrections were made to the type after a number of copies had been printed without these early sheets being destroyed. Thus on p. 444 the epithet *tapia* of some copies is replaced in others by *Tapia*; *pirosa* appears on p. 255 of at least one copy but *virosa* in others; the epithet *Hepatica* on p. 538 is represented by a blank space in many copies. Moreover a few copies possess cancelled leaves." The explanation of this state of affairs is probably to be found in the limited quantity of type available and the frequent shortage of paper as well as of skilled printers in poverty-stricken eighteenth-century Sweden; a printer could not afford to keep type standing very long; he had to print off the early sheets, then disperse the type and use it to print the later sheets of a big book; moreover he probably disliked wasting proof sheets. Presumably Salvius, Linnaeus's printer in Stockholm, printed a few sheets, dispatched them to Uppsala for Linnaeus to check, then corrected the type and printed the bulk of the book but did not always destroy the first uncorrected sheets.

In dealing with Linnaean works therefore it may be advisable to consult more than one copy and to check carefully before considering one to be an absolute duplication of another. Compilation of the index to the Ray Society facsimile of the *Species Plantarum* necessitated reference to six copies in order to make good the typographical deficiencies of one.

Priority of Publication

Acceptance by naturalists of the Linnaean binomial nomenclature for plants and animals rendered obsolete the names used in botanical works before 1753 and in zoological works before 1758, although many of these earlier works, notably those with illustrations, remained important and are still essential for the interpretation of Linnaean species and the correct application of Linnaean names for organisms already known. Many of Linnaeus's contemporaries disliked and rejected his nomenclatural innovations, as did Haller, or accepted them reluctantly, as did Miller, but nevertheless such convenient and mostly apt two-word names in some 25 years ousted completely as designations the earlier several-word diagnostic names. This was a gain as regards present and future use, a loss as regards access to literature of the past. Linnaeus's own works provide almost the only bridge between present and pre-Linnaean nomenclature and the information recorded under the earlier forms. Hence the value to taxonomists and biological historians of facsimiles of Linnaean works. Meanwhile the practical encyclopaedic nature of Linnaeus's major publications led to the recognition of more and more genera and species not recorded in these works and hence needing names. In Denmark, England, France, Germany, Italy, Sweden and elsewhere naturalists described and named them. Inevitably the same organism sometimes got named more than once. Which of two or more competing names should be adopted?

Gradually priority of publication, being independent of considerations of aptness and of personality of authors, came to be accepted as decisive. A. P. de Candolle stated in his *Théorie élémentaire de la Botanique*, 250 (1813): 'L'auteur même qui a le premier établi un nom, n'a pas plus qu'un autre le droit de le changer pour simple cause d'impropriété. La priorité, au contraire, est un terme fixe, positif, qui n'admet rien d'arbitraire, ni de partial'. Consequently it has become the basis of modern international scientific nomenclature. Its acceptance has imposed upon taxonomists the necessity of consulting the works wherein names and descriptions were first published, upon librarians the duty of acquiring and preserving such works and upon bibliographers the duty of ascertaining as precisely as possible the dates of publication.

Dates of Publication

By 'date of publication' is meant the date on which a given printed work was made available to the botanical or zoological public by sale or distribution.

To provide detailed and accurate information about dates of publication is the major contribution which bibliography can make to the stabilization of biological nomenclature.

At first this looks simple and easy; surely the titlepage provides the date of publication. Every bibliographer knows, however, the titlepages may tell lies or half-truths which can be equally misleading. In the absence of evidence to the contrary the date on a titlepage is to be accepted. It may not, however, be sufficiently precise. Many books on natural history, particularly those with plates, were issued in parts over a period of years. If the titlepage was issued with the first part, it tells when the work began but gives no information on when this was completed. Thus the titlepage of Smith, *Florae Graecae Prodromus*, vol. 1. is dated '1806', in which year the first part (pp. i-xvi, 1-218) appeared, but the second part (pp. 219-442) was published in 1809. On the other hand the titlepage may merely indicate when the work was completed. The titlepages of vols 1 and 2 of Hooker's *Flora Boreali-Americana* are dated '1840', but vol. 1 was published in parts between 1829 and 1834, vol. 2 in parts between 1834 and 1840, only vol. 2 pp. 241-328 first appeared in 1840. Again the titlepage may correctly state when the years when the work began and ended, but information may be lacking as to when the individual parts appeared. A notorious example is the *Phytographia Canariensis* of Webb and Berthelot, dated '1836-1850' (see Stearn, 1937). Sometimes, however, the titlepage date may be too early. For example, L'Héritier's *Sertum Anglicum* is dated '1788' but the first part was issued in January 1789, the fourth and last in 1792. Blatter and Millard's *Some beautiful Indian Trees*, second ed., revised by Stearn, is dated '1954' but owing to binding difficulties did not appear until March 1955. The need for bibliographical investigation usually becomes evident when a choice has to be made between two names or epithets for the same organism seemingly published about the same time, e.g. in 1788 the names *Ochroma lagopus* Swartz (actually June-July 1788) and *Bombax pyramidale* Cav. (actually April 1788) were published for the West Indian balsa tree, now to be called *Ochroma pyramidale* (Cav.) Urban.

Such enquiry usually involves much tedious detective work. It is necessary to ascertain both the contents of parts and the dates when they were published. For example, the contents of the 72 parts of Curtis's *Flora Londinensis* (1775-98; see *Cat. Bot. Books Coll. R. M. M. Hunt* 2.ii, 389-412; 1961) are now known, but the precise dates of publication of most of them still remain to be ascertained, despite the keen interest of British botanists in this matter for some eighty years. On the other hand the approximate dates of publication

of the fifteen parts of Roscoe's *Monandrian Plants* (1842-29) are known but not their contents. If a copy of the work in original wrappers as issued became available the problem would be solved; even a few parts as issued would help. If a work issued in parts is to be bound and it contains no statement regarding the course of publication, then the wrappers should be bound in place or, if this is inconvenient, then the contents of the parts should be recorded and the wrappers bound at the end of the book. Don't let the binder throw them away. Sometimes the advertisements in one book provide information about the publication of others.

If no such copy is available, then the bibliographer has to search contemporary literature for reviews and advertisements, as well as notices of receipt by libraries, library invoices and accession records, correspondence and diaries of botanists etc. A book-trade journal may state that a given part contains so many sheets while a review may state that this part deals with certain subjects. The two together may indicate the pages on which it began and ended.

Rarely can a single piece of evidence be regarded as conclusive. Book-trade advertisements may announce a book well ahead of actual publication; a library may not acquire a book until several months after publication; reviews may be delayed. Hence evidence from several independent sources should be sought in order to eliminate the possible abnormality of one. Personally I like to have three pieces of evidence leading to the same conclusion. Thus, if the review of Bentham and Hooker's *Genera Plantarum* vol. 2 part 1 in the *Gardener's Chronicle* of 9 August 1873 provided the only evidence available, one might conclude that this part was published not long before then. A notice in the *Journal of Botany* of 1 May 1873 indicates that it was published in April 1873 or earlier. The Linnean Society received a copy on 10 April 1873, which points to April 1873 or earlier. Bentham's unpublished diary (at Kew) for 7-9 April 1873 records 'our new part of the *Genera Plantarum* at last out.' Thus from the agreement of these three lines of evidence it is clear that the part appeared in early April 1873 (see *Stearn*, 1956).

Such investigations are very time-consuming. They call both for a knowledge of how books are printed and published and of what periodicals, accession lists, etc. are likely to yield information. These sources of information have to be searched page by page, entry by entry, and often they are searched in vain. The only economical way of doing this kind of work is to take a periodical or other record which reviews or lists books and parts of periodicals and to note every item likely to be of use, then take other such periodicals and do the same, afterwards listing and correlating the information thus acquired

under the headings of the various books and matters which have come to notice. Over the years enough information may become available to elucidate the dates of publication of these works. Almost always, however, a special effort has to be made to fill in gaps. Such contributions by bibliographers to stability of nomenclature are extensive but comparatively little-known. In the field of zoological bibliography Charles Davies Sherborn (1861-1944) did much valuable work as a by-product of his forty-year task of compiling the monumental *Index Animalium* (1902-33), all of its 440,000 or so references being dated. Sherborn was a founder-member of the Society for the Bibliography of Natural History, London, which publishes in its *Journal* not only many original papers on the dates of publication of natural history works but lists of such papers published in other journals. For botanists the *Flora Malesiana Bulletin* (Leiden) renders a like service. Even so, those who most need such information rarely know where to find it. Librarians can save themselves much loss of time and earn the gratitude of their colleagues by inserting references to papers about dates of publication on the front end-papers of the works concerned; they will do even better if they also summarize there the bibliographical conclusions of such a paper. Between 400 and 500 books of consequence to systematic botanists have now been investigated, thereby making it possible to cite with precision the dates of publication of thousands of scientific names (*cf. Rickett & Stafleu, 1961; Sayre, 1959; Stafleu, 1963; Steenis-Kruseman & Stearn, 1954*).

Detection of Faking

In a very helpful introduction to bibliography for botanists, Ian MacPhail (1964) has dealt with techniques of descriptive bibliography relevant to botany, including matters of collation and paper, the latter being a subject to which Allan Stevenson (1961) has given special attention. The original issue and the later Bohn issue of Sibthorp and Smith's *Flora Graeca* can be easily distinguished by the watermark of the paper. In general, however, there has been no need to apply to most natural history books the finer techniques of bibliography.

The history of science abounds in examples of people independently making the same discovery about the same time and in examples of a discovery credited to one person having been made earlier by someone else, leading to arguments over priority and sometimes indeed to accusations of plagiarism. Such independent discovery is indeed to be expected and results largely from assimilation of work of the previous period. If the first of the discoverers gives his own work effective publicity, so that it can be readily incorporated

into or correlated with existing knowledge, others working on the same lines usually acknowledge his anticipation of their own results and leave it at that. The best-known example of such independent discovery is probably Darwin and Wallace's theory of evolution by means of natural selection. Charles Darwin worked from 1837 to 1858 on this, then in the summer of 1858 received an essay from a much younger naturalist, Alfred Russel Wallace, at Ternate in the Malay Archipelago, outlining essentially the same ideas and basing them on the same kind of evidence. The result was their joint communication to the Linnean Society of London in July 1858 'On the tendency of species to form varieties; and on the perpetuation of varieties and species by natural means of selection', followed in 1859 by Darwin's *Origin of Species*.

Since then it has become evident how many of their predecessors had come to much the same conclusions or had handled much the same evidence but failed to realize the full implications, to give them effective publicity, or to support them with a vast body of convincing evidence from observation and experiment which would compel attention (see *Eiseley*, 1958). What Darwin and Wallace did was to present the conclusions in such a way that they could not be ignored.

In 1913 Wallace received a pamphlet from Boston, Mass., entitled *Shall We have Common Sense* and dated '1849', the author being one George Washington Sleeper (1826-1903) among whose papers it had been found after his death. In this hitherto unknown work he put forward ideas on the origin of life and the advance of civilization well ahead of those current in 1849. Wallace communicated it to the Linnean Society of London and Professor E. B. Poulton made it the subject of his presidential addresses to the Society in 1913 and 1914. Opinions were naturally divided about the nature of this work, some considering it the outcome of remarkable genius, others a remarkable fraud. Application of bibliographical methods essentially the same as those used twenty years later by Carter and Pollard in their famous *Enquiry* led to a similar conclusion of fabrication. There was, for example, a suspicious absence of any advertisement or contemporary record. The type used was not available before 1870. The author's contract of 1849 with the printer came to light but proved to be a forgery, made to look old by means of an artificial brown stain. The text implied some knowledge which did not exist in 1849. Thus it became certain that the pamphlet had likewise not existed in 1849. All one can assume is that it contains ideas the author wished he had had in 1849. One supposition is that he printed it himself about 1890 and left it with circumstantial evidence to be discovered

among his effects after death so that people with whom he had got on none too well could then give him the honour they had failed to bestow upon him in life. Alas, however, bibliographical method has revealed the sad truth: George Washington Sleeper, despite his Christian names, was something of a liar.

Misleading Titlepages and False Attributions of Authorship

Half-truths if not downright lies occur indeed on many titlepages, even on those of books by such usually virtuous people as botanists and zoologists. A titlepage may be erroneously dated, as already mentioned. Also it may fail to give proper statement of the book's content and authorship. There is, for example, a gardening book by a lady now dead, Marion Cran, called *The Story of my Ruin*. She was no Fanny Hill or Moll Flanders: her book refers to a tumbledown edifice in her garden. An appropriate companion for it on the bookshelf is William Robinson's *The Virgin's Bower*, devoted to the genus *Clematis* which can be used to climb over ruins. The real author of a botanical book, i.e. the person who supplied the essential botanical text, is not always the person named on the titlepage. This can be a matter of importance. Thus, if Carl Peter Thunberg wrote some of the descriptions of South African plants in the younger Linnaeus's *Supplementum Plantarum* (1781), then the type-specimens of these descriptions are more likely to be in Thunberg's herbarium at Uppsala than in the Linnaean or Smithian herbaria at the Linnean Society of London. Actually the name of the younger Linnaeus (1741-83) alone occurs on the titlepage of the *Supplementum Plantarum* (1781), but this book also contains the work of the elder Linnaeus (1707-78), Thunberg, and Friedrich Ehrhart (1742-95), as noted by Stearn (1961:civ). Some other examples are W. Aiton's *Hortus Kewensis* (1789; 2nd ed., 1810-13) for which Daniel Solander and Jonas Dryander and later Robert Brown were responsible (see *Britten*, 1912); H. C. Andrews, *Botanists' Repository* (1797-1815), the first five volumes of which were probably written by John Kennedy, the sixth certainly by Adrian Hardy Haworth, the last four supervised by George Jackson (see *Britten*, 1916); L.T.F. Colladon, *Histoire naturelle et médicale des Casses* (1816), the botanical descriptions being by Aug. P. de Candolle (see Alphonse P. de Candolle, *Phytographie* 404; 1880); S. F. Gray, *Natural Arrangement of British Plants* (1821), mainly by his son John Edward Gray; Joseph Knight, *On the Cultivation of Plants belonging to the Natural Order of Proteaceae* (1809), the descriptions by R. A. Salisbury, who thereby notoriously anticipated the work of Robert

Brown on this family; A. Michaux, *Flora Boreali-Americana* (1803), much of which was the work of Louis Claude Richard (see Stearn, 1961:xcix); W. B. Page, *Prodromus of the Plants cultivated in the Southampton Botanic Gardens* (1817-18), written by John Kennedy; P. J. Redouté, *Les Liliacées* (1802-16), the text of vols 1-4 by A. P. de Candolle, of 6-7 by F. Delaroché, of 7-8 by A. Raffeneau-Delile; H. B. D. Woodcock & J. Coutts, *Lilies, their Culture and Management* (1935), most of which was written by W. T. Stearn (see Royal Horticultural Society, *Lily Year Book* 21:89;1957).

These works exist. Far otherwise are some 69 apparently important works on Latin America listed in *Appleton's Cyclopaedia of American Biography* (1887-1900), which includes plausible but wholly fictitious biographies of their equally fictitious authors, imaginary botanists such as Stanislas Henri de la Ramée, Édouard Sylvie, Gaston Louis Thibaudin and Jacques du Vivier. The author of these entries is unknown but he was clearly a scholar with a good knowledge of French, Latin and Spanish and of the lives and works of botanists who did exist; he was also one feels either impecunious and unscrupulous or endowed with a wry sense of humor (see Barnhart, 1919; Jervis, 1953).

Rarity

Acquaintance with booksellers' catalogues over the years reveals increasing application of the words 'scarce' and 'rare' to natural history books and a corresponding rise in prices affecting many books used by systematic biologists as indispensable tools of their research (*cf. Swann, 1956*). A rare book from the bookseller's viewpoint is a book which rarely or never comes into his hands for sale and is usually unprocurable when wanted. A rare book from the user's viewpoint is one which he cannot find in a number of specialist or well-stocked general libraries which ought to possess it. A book which is rare according to the one standpoint is not necessarily so according to the other. Both depend, however, on the number of copies printed and the circumstances making for their survival or destruction; obviously the longer a work has been exposed to hazards of wear, damp, insect damage and fire the fewer will be the copies remaining.

A work printed in a very limited edition can never be other than rare. There are many natural history books of absolute rarity, as so defined by John Carter (1961). Thus of the Earl of Bute's *Botanical Tables* (1785), with illustrations by J. S. Miller, only 12 copies were printed, the cost of this futile undertaking being £12,000; fortunately the work has no scientific value. Of Jacquin's *Selectarum Stirpium Americanarum Historia . . . adjectis*

Iconibus . . . pictis (1780), which is an important work for students of the Caribbean flora, there were only 18 copies, of which five are now in libraries in the London area; the coloured illustrations of this work are direct copies by an artist from Jacquin's original drawings, not hand-coloured engravings as in Jacquin's other works. Only 25 sets were completed of Sibthorp and Smith's magnificent *Flora Graeca* (1806-40), which cost £15,572 to produce, and the reissue by Bohn in 1845-46 was limited to 40 sets. Of Rudge's *Plantarum Guianae rariorum Icones* (1805-06) apparently only 150 copies were printed. Haworth's publications on succulent plants probably did not exceed this. The Emperor Pedro I of Brazil had 3,000 copies printed of Velloso's *Florae Fluminensis Icones* (1835) but owing to the Emperor's abdication the edition was limited to 100 copies, all the others being treated as wastepaper and used for making cartridges for the French conquest of Algeria. Of Lindley's *Victoria regia* (1837) there were only 25 copies.

These works can now rarely come into the market because most of the copies available have passed into the keeping of institutional libraries. Their survival rate has been high because such works on account of their size and their plates immediately give an impression of value. Fires and wars destroying whole libraries are their main risk, fortunately seldom but a serious one nevertheless, as witness the destruction by fire in 1948 of the Nymans Garden Library with its holding of many rare books (partly described by Rohde, 1933). Much rarer than these celebrities are many small unpretentious works with few or no illustrations which offer no such inducements for preservation by collectors of fine books but which may nevertheless be scientifically important. An example is H. A. Duval's *Plantae succulentae in Horto Alenconio* (Paris, 1809) containing the original descriptions of the genera *Haworthia* and *Gasteria*. The late Mr. A. J. A. Uitewaal searched continental libraries for years without ever locating a copy. The only one known to have survived was preserved by Sir Joseph Banks and is now in the British Museum, Bloomsbury; fortunately the Cactus and Succulent Society of Great Britain published a photographic facsimile in 1939 (in *Cactus* J. 7 no. 4). I have so far traced only one copy, likewise in the British Museum, of Turner's *Libellus de Re herbaria* (1537), the first printed work relating to British plants with any claim to originality. It is a little book without illustrations, written in Latin and liable to be thrown away in the past by executors and others who understand neither its interest nor its importance; moreover copies may have been deliberately destroyed during Turner's periods of exile from England, when his theological works were banned. B. D. Jackson published a facsimile of this rare book in 1877; a new facsimile is being published by the

Ray Society.* F. Alefeld's *Landwirthschaftliche Flora* (1866) is an important contribution to the systematics of cultivated plants. During some thirty years I have never once seen it offered for sale in a bookseller's catalogue and it seems to be scarce even in German libraries.

'Rarity is the salt in book-collecting', as Carter has remarked. To the antiquarian bookseller it is an asset when he has a copy of a rare book for sale. To the bibliographer and above all the user of natural history books it is a matter for regret. Fortunately for both bookseller and user the issue of facsimiles has become a thriving enterprise in modern publishing. Between 1934 and 1936 the Shokubutsu Bunken Kano-Kai at Tokyo published facsimiles of Linnaeus's *Species Plantarum*, the younger Linnaeus's *Supplementum* and Thunberg's papers on the Japanese flora. Later (1942-46) E. D. Merrill sponsored facsimiles of Gronovius's *Flora Virginica*, Walter's *Flora Caroliniana* and Rafinesque's publications. These have proved of great value to professional taxonomic botanists. Thus, before the issue in 1946 of the facsimile of Rafinesque's *Flora Telluriana* (Philadelphia, 1837-38), there seems to have been only two complete copies in Europe of this nomenclatorially important if eccentric work and Merrill estimated that there were less than 15 in American libraries; the original edition consisted of only 160 copies. Merrill thought that it sufficed to issue facsimiles of old and rare works by themselves without accompanying matter. My experience as a librarian and as a botanist called upon to explain procedure etc. in such works led me to the opposite opinion, namely that whenever possible a facsimile should be accompanied by an introduction making readily available the results of scholarship scattered through periodicals, giving its history, explaining its methods, elucidating its cryptic abbreviations and generally rendering it usable again. In 1929 I sponsored a facsimile of Duval's *Plantae succulentae* with a short introduction; not until 1957, however, did I have an opportunity of exemplifying this kind of introduction to a large and important botanical work. The publication of the Ray Society facsimile of Linnaeus's *Species Plantarum* (1753) in 1957 and 1959 and the *Historiae Naturalis Classica* facsimile of Brown's *Prodromus Florae Novae Hollandiae* (1810) in 1960 provided the opportunity of demonstrating the utility of such introductions which are now becoming usual, to the great gain of natural history. Thus equipped, a modern photographic facsimile has a higher working value

* This was published in December 1965 by the Ray Society, London, in a volume entitled *William Turner, Libellus de Re herbaria 1538, the Names of Herbes 1548, Facsimiles with introductory Matter by James Britten, B. Daydon Jackson and W. T. Stearn*. Mr. Albert E. Lownes has called my attention to the existence of a second copy, this one in the United States. The work is of linguistic as well as botanical interest: it mentions in print for the first time a number of English vernacular names now used in the United States and Canada as well as Britain.

then an original copy; moreover it is often printed on better paper, making it easier to consult.

Conclusion

From this by no means exhaustive survey, which has not covered the important enumerative works of Haller, Agassiz, Pritzel, Jackson and others, and the special bibliographies of Keynes, Linsley and others, it should nevertheless be evident that the services which bibliography provides to natural history are many and various. The qualities of mind and temperament needed for bibliographical enquiry are indeed similar to or identical with those required in taxonomic research. In any field much research is sheer drudgery, requiring tenacity and patience to keep the task going until enough evidence becomes available to produce a coherent pattern. It also requires enough basic knowledge to appreciate where and how evidence can be found, judgment to assess its reliability, imagination to perceive correlations. Thus it is not surprising that Artedi, Linnaeus and Haller, who did such useful bibliographical work in the eighteenth century, were the best systematists of their age and that the great botanical bibliographer of the nineteenth century Georg Pritzel began by monographing the genus *Anemone*. Those who have as it were one foot in bibliography and the other in natural history thus share a breadth of interest with these leaders of the past.

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The present address is essentially an abridged version of the Sandars Lectures later (1965) delivered by the speaker as Sandars Reader in Bibliography in the University of Cambridge under the title "Bibliography in the Service of Biology."

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Two Centuries of Linnaean Studies

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A great deal has been written about Carl von Linné—or Linnaeus, as he is called by the English-speaking world, and as I shall call him here. He is one of the great figures in the history of natural science. In his own field of botany he acquired, in the later part of his life, a position of almost unparalleled pre-eminence, and in his native Sweden he has become something of a national figure whose works are still read and beloved. There are Linnaean societies throughout the world, the most famous being in London. Linnaeus himself still stands today as a kind of incarnation of botanical science.

This is all very well, and of course far from displeasing to a Swede. Linnaeus's greatness is undeniable; botany would somehow be unthinkable without him. One has only to compare a work in systematical botany written at the end of the eighteenth century with one from the beginning to understand his importance. But at the same time his greatness did entail certain disadvantages. The very scope of Linnaeus's work has proved somewhat forbidding. Since he wanted to refashion the whole study of natural history, the demands made on any scholar who attempts to follow him through the three kingdoms of nature are proportionately great. In addition, the aura of glory which surrounds his name, and the affection and respect given to him act as a hindrance to free and unbiased enquiry. This factor has had definitely discernible results. It has been particularly strong in Sweden and in Swedish works on Linnaeus. While Linnaeus was not by any means regarded with unqualified affection by his fellow-countrymen during his lifetime—at least not as a living, human personality—after his death he gradually came to be regarded with an uncritical admiration which was given ever more flowery expression. Linnaeus was canonized and his life became an edifying piece of hagiology which was the property of the whole nation. In the face both of his scientific work and his personality, criticism was struck dumb. The traditional view was accepted without reservation and research was instead devoted to details and anecdotes; it was as if one were dealing with the founder of a religion, not with a scientist.

The consequence of all this is that the extensive literature on Linnaeus is not always as rewarding and valuable as one could wish. Having made this assertion, which I hope will be substantiated in what follows, it is now time to begin from the beginning. I can of course do no more than point out a few milestones in the development of Linnaean scholarship.

The story begins with the commemorative addresses, delivered after Linnaeus's death in January, 1778. There were three such addresses printed, one Swedish and two French. The Swedish one was in a class of its own. This was inevitable, for the speaker was Abraham Bäck, the well-known doctor, Linnaeus's closest friend throughout his lifetime, and the place of delivery was the Swedish Academy of Science in Stockholm, whose pride Linnaeus had been from the beginning. Bäck was exceptionally well-informed, he knew Linnaeus through and through, and he had access to some of his unpublished manuscripts. His speech is in fact an excellent biographical account, both informative and inspiring. Bäck also deals with Linnaeus's achievement as a botanist, commenting on his published works one by one.¹ In the Paris Academy of Science, where Linnaeus had been one of the eight foreign members, the speaker was no less a person than the great Condorcet. He was able to base his speech on a good or at least first-hand source, Linnaeus's own manuscript autobiography which had been sent to him for the purpose. The picture Condorcet gives of the life of the Swedish botanist is in the main correct; he admires him and gives an excellent description of Linnaeus's sexual system and his reform of botanical taxonomy.² The second of the French memorial addresses, on the other hand, caused some trouble. It was delivered by Félix Vicq d'Azyr, the famous anatomist, in the Société Royale de Médecine in February, 1779.³ Vicq d'Azyr was also among the well-informed and he had much to say in praise of Linnaeus, but now and then a different note creeps in; for this reason his address is rather interesting. Linnaeus had never won complete acceptance in France. A good many people, such as the great Buffon, Adanson and others, had criticized him and resisted his claim as omnipotent lawgiver for all natural historians. This Vicq d'Azyr also does, in spite of all his French politeness. He complains of Linnaeus's lack of tolerance, of flaws in his botanical system and above all of his medical writings, which he subjects to savage criticism. In Sweden people were deeply shocked by the Frenchman's abuse. Carl Magnus Blom, a country doctor, seized his pen to reply to Vicq d'Azyr in 1781, and in Uppsala a little later, Sven A. Hedin, another doctor, began his career as an enthusiastic Linnaean with an academic dissertation in which he reproached the French anatomist and defended Linnaeus's reputation as a medical writer.⁴

However, the time had not yet come for the canonization of Linnaeus. He was not yet at a sufficient distance; Bäck himself was matter-of-fact and balanced, even indicating certain less attractive sides of the great man. The Linnaean literature which immediately followed at the end of the eighteenth

century also gives appraisals characterized by rather qualified admiration. Two of these works are particularly detailed and important. The first is English, Richard Pulteney's *A General View of the Writings of Linnaeus* (1781). In England, as opposed to France, Linnaeus and his reform of the most charming of the sciences had always met with sympathetic appreciation. Even during his lifetime Linnaeus had achieved undisputed pre-eminence in English botany. His books had been read everywhere and his sexual system had been made available to the general public in attractive expositions.⁵ It was, significantly enough, an Englishman, James Edward Smith, who acquired Linnaeus's scientific possessions and manuscripts, and the Linnean Society of London, which he founded, was thus made a permanent stronghold for Linnaean studies. Richard Pulteney, a doctor by profession, shared the general English enthusiasm for Linnaeus and his work. His book is the first large-scale Linnaean monograph and runs to more than four hundred twenty-five pages.⁶ It is a kind of bibliographical reference book interspersed with facts about Linnaeus's life, the latter taken in part from Bäck's memorial address which was already available in a German translation.⁷ Pulteney gives a detailed account of the contents of Linnaeus's immortal works, the *Systema Naturae*, *Species Plantarum*, *Amoenitates Academicæ* and the others; he admires them immensely, but is first and foremost factually informative.

The same is also true of the well-known *Leben des Ritters Carl von Linné* by Dietrich Heinrich Stöver, a doctor from northern Germany.⁸ This work, which appeared in two parts in 1792, is one of the classics of Linnaean literature and in many ways admirable. Stöver gathered a great deal of material, including unpublished letters and accounts; he turned among others to James Edward Smith and to Carl Peter Thunberg of Uppsala, the famous disciple of Linnaeus.⁹ Step by step he follows Linnaeus's remarkable progress towards power and glory on the botanical throne; he goes into detail, providing a large mass of biographical information which was to be used for generations to come by all Linnaean scholars. Linnaeus was, in Stöver's opinion, a man of the same order of importance as a Luther or a Voltaire, and his life becomes in this biography something of a heroic legend, a triumphant struggle against fate filled with dramatic episodes—just as Linnaeus himself had presented it. But at the same time Stöver is as objective as one could desire; he sticks close to his sources and also recognizes that Linnaeus had his trying and difficult sides. The biography is carefully documented, well written and still very readable today, not for its judgment on Linnaeus's scientific achievement, but for all that it tells us about his life. More than a hundred years were to pass before it was superseded.

Very soon the publication of original material began. The issuing of the correspondence of learned men was a regular feature of literary life in the eighteenth century, and it was thus natural that the greatest interest should be taken in Linnaeus's immense correspondence with botanists throughout the world. The pioneer in this field was Stöver. In 1792, the same year in which his biography appeared, he published a comprehensive collection of letters from Linnaeus to Haller, Giseke and others, entitled *Collectio Epistolarum*.¹⁰ But the key figure in this connection is the James Edward Smith already mentioned. He had in his possession all the letters, papers and manuscripts left by Linnaeus and he considered it his privilege and his duty to make this invaluable material available to botanists and scholars. It was not until 1821, however, that Smith's large collection of letters was available in two volumes called *A Selection of the Correspondence of Linnaeus and Other Naturalists*; it evidently consists primarily of letters to Linnaeus taken from the Linnaean collections in London.¹¹ By then Smith had already published what was perhaps the most remarkable of the previously unpublished manuscripts of Linnaeus, the youthful, refreshing and astonishing *Journey to Lapland* (1811).¹² One cannot blame him for translating it into English; it was not until towards the end of the nineteenth century that the original Swedish text was generally available, read and admired.

While this was taking place in the world at large, Linnaeus's own countrymen remained noticeably silent. The situation was paradoxical in the early nineteenth century a Swede who wished to increase his knowledge of Linnaeus's life and writings had to go to foreign works such as Pulteney and above all Stöver. However, the situation quickly changed. There was what might be called a "Linnaean renaissance" in Sweden and it had incalculable consequences. The national Linnaeus legend was now created, the incense was lit and with the advent of romanticism and its feeling for nature Linnaeus became the divine guide to the mysteries of creation.

The trail-blazer for the new attitude to Linnaeus and his work was, however, not one of the new romantics but a member of an older generation, indeed one of the last pupils of the aged Linnaeus. This was the influential Sven A. Hedin whom we have just mentioned; he was at this time physician-in-ordinary at Stockholm. In 1807, when he took part in the celebrations held here and there to commemorate the centenary of Linnaeus's birth, he delivered a speech which was afterwards printed in a somewhat expanded form.¹³ Straightforward biography provides its framework, but it is the tone and the general estimation of Linnaeus which give the work its individuality. Hedin is very high-flown: we have here the first canonization of Linnaeus;

he is presented as a sun without spots. Linnaeus was, Hedin asserts, "one of the greatest luminaries the world has ever seen," in amazement he even wonders whether Linnaeus was "an ordinary man". Hedin is sentimental, almost moving the reader to tears. Placed next to Linnaeus all earlier botanists pale like the stars of night at dawn, Linnaeus was the personal high-priest of Flora, the goddess of flowers, nursed at her bosom; small flowers waved to him "in friendship" when he climbed about the Lapland mountains.

Hedin's sermon fell on fertile ground. With the triumph of German romantic philosophy in Sweden a little later, the picture of Linnaeus which was to dominate literature for a century became largely fixed and finished. Botanists could indeed criticize isolated details of Linnaeus's achievement but the master himself was inviolable. He was one of nature's chosen interpreters, guided by an infallible intuition; his bust was hung with garlands, and accounts of his personality and greatness tended to become sweet and sugary in the romantic and post-romantic fashion.

There are two Swedish writings from the romantic age which are particularly illuminating in this connection, though they are not completely lacking in problems. The authors, the algologist Carl Adolph Agardh and the phytogeographer Göran Wahlenberg, were two of the foremost botanists of the period, with international reputations. Agardh's address in commemoration of Linnaeus, which was awarded a prize by the Swedish Academy in 1821, is in itself rather restrained and balanced.¹⁴ Far from being an advocate of the Linnaean sexual system, Agardh sees Linnaeus's greatness primarily in the fact that he was constantly searching for a natural plant system which would be an expression of nature's own, inner order. But it is precisely this romantic evaluation which gives to botany, and therefore to Linnaeus, the claim to be something divine and sacred. Nature, says Agardh, is the manifestation and incarnation of God and the aim of natural history accordingly to learn to know the Infinite; it was through Linnaeus that Nature first made "its Aeolian notes" heard. Göran Wahlenberg was far less restrained. This stern and headstrong man was in fact the most fanatical of all the Linnaeans of the period, his admiration for the master being as boundless as ever Sven Hedin's had been. His fascinating, original and even penetrating study of Linnaeus and his work was published in 1822. In true romantic fashion Wahlenberg sees Linnaeus as communing mystically with living Nature.¹⁵ Nature had "taken Linnaeus to herself," and his immortal, eternally valid sexual system was a "Nordic system of nature". Wahlenberg expounds the idea that when Linnaeus with infallible art united the natural and the artificial in his botanical system, he did so as a child of

Scandinavian nature; he was influenced by its dualities, by the opposition between summer and winter, between the bright south and the frosty Uppsala. And so Linnaeus, "the greatest natural Historian in the world", became the object of poetic interpretation; he was infallible because Nature herself spoke through him.

While the botanists of the romantic period were completing their picture of Linnaeus, very little was happening within Linnaean scholarship proper, either in Sweden or abroad. Some new firsthand material was however gradually made available, especially Linnaeus's remarkable autobiography, or rather one of his autobiographies, which was published in 1823 by Adam Afzelius, one of the last surviving of Linnaeus's pupils.¹⁶ The public was now given the opportunity, like Condorcet earlier, of knowing Linnaeus's own appraisal of his life's work—by no means the most modest one. A few books containing source-material were published around the middle of the century.¹⁷ There were of course occasional writings on Linnaeus and his achievement, some of these being quite exhaustive (for example J. Fr. X. Gistel's *Carolus Linnaeus, ein Lebensbild*, published in 1873). But in general real Linnaean scholarship lay fallow. People continued to read good old Stöver, and it was only towards the end of the century that serious research began again.

With one notable and isolated exception in Germany, to which I will return later, this revival of Linnaean scholarship was first and foremost concerned with source material and the life of Linnaeus, the aim being mainly biographical. Its pioneer was a humble Swedish school teacher, Ewald Ährling, who worked in a country town and who died young.¹⁸ He conceived the bold plan of examining and describing all the manuscripts Linnaeus had left behind him. A few of them remained in Sweden, but as we have seen most of them were preserved at the Linnean Society in London, and at the beginning of the 1880's Ährling went there as the first man since Smith's day to investigate the treasures left by Linnaeus. He returned with a rich harvest and soon began to publish parts of the material he had gathered in England and elsewhere. He first published, in 1885, a catalogue of Linnaeus's extant correspondence, which is still invaluable. This was followed in 1888-89 by a pioneering edition of Linnaeus's early works in two volumes; by then Ährling had already published a selection of Linnaeus's Swedish correspondence.¹⁹ Linnaean scholarship was thus, in one stride, advanced to a much more favorable position. Previously unknown material of the greatest interest was now made generally accessible; above all more light was shed upon Linnaeus's intellectual development as a young man.

Ährling's beginning was pursued on a grand scale by Thore M. Fries. Fries, an influential man and professor of botany at Uppsala, had rather late in life begun to prepare himself for the enticing but hazardous task of writing the great, definitive biography of Linnaeus. This was finally completed, after several preparatory studies, a few years after the turn of the century. Fries's *Linné* (1903) is a monumental work.²⁰ The two bulky volumes contain a vast amount of information, a prodigious mass of material, both published and unpublished, having been worked into them. Step by step, year by year, Linnaeus is followed from the cradle to the grave, his various activities as an illustrious professor at Uppsala are described in detail, we learn to know his pupils and the world he moved in. This imposing biography has, however, one limitation; it is, and was only intended to be, an account of Linnaeus's life. Fries does not give a detailed analysis of Linnaeus's scientific achievement or of his struggle for the reform of botany. All in all, however, Fries's work marks an epoch in Linnaean scholarship; it has not yet been and may indeed never be superseded, for any attempt to improve on it would mean the reinvestigation of the whole mass of biographical material. Unfortunately Fries wrote in Swedish; the world of international scholarship was only able to make use of his results after 1923 when Benjamin Daydon Jackson published an abridged and revised version in English.²¹

From his early childhood Fries had grown up in the romantic Swedish Linnaean tradition, and his admiration for the master was in consequence deep, almost boundless. The dark sides of Linnaeus's character, which had been readily recognized by contemporaries and the immediately succeeding generations, have completely disappeared under his hand. Though in many respects critical and balanced, Fries has painted a full-length portrait of a Swedish national hero. Others soon joined him in the same spirit; the beginning of this century was a time of general revival for Linnaeus and all things Linnaean in Sweden, the trend reaching its extreme manifestation in the great Linnaeus jubilee in 1907. Serious scholarship undoubtedly benefited from this situation—the jubilee occasioned the publishing of several important works on Linnaeus as well as a long series of text-editions. Among them we have the well-known volume on Carl von Linné's importance as a natural scientist and physician, published in German and Swedish editions by the Swedish Academy of Science.²² Its intention was to fill the void left by Fries by supplying a coordinated general account of Linnaeus's achievements as a naturalist and a medical writer. The work, the first of its kind, has its virtues; five specialists give detailed accounts of Linnaeus's discoveries in

medicine, zoology, botany, geology and mineralogy. Much useful material is gathered, and there are good descriptions and analyses of Linnaeus's innumerable writings; what is lacking is critical distance and an adequate historical background. Linnaeus's brilliance is taken for granted, his most trifling thoughts are commented on reverently. With editions and bibliographies the situation is different; they are written for eternity. Two such undertakings deserve mention; both of them are well known and both are the result of the jubilee year of 1907. At last there appeared a modern, critical and complete bibliography of all Linnaeus's printed works. The man responsible for this indispensable aid to all Linnaean scholars was Markus Hulth, Librarian at Uppsala.²³ The second of the two publications was even more ambitious and even more eagerly awaited. In his extreme old age Thore M. Fries set about the daunting task of publishing the whole of Linnaeus's correspondence. What Stöver, Smith and Ährling had accomplished in this domain was merely fragmentary preparatory work. Where letters to Linnaeus were concerned the matter was, as we have seen, technically simple; they were all preserved by the Linnaean Society. The difficult task which required all Fries's devotion was that of tracking down the numerous letters *from* Linnaeus to be found in libraries and archives in Sweden and abroad. The publication of the Linnaean correspondence was considered a Swedish national duty and was financed by the state, the volumes following one another fairly quickly even after Fries died in 1913. Gradually, however, interest cooled and resources ran out; in 1943 there appeared the last volume to date of Linnaeus's correspondence. The work, being of fundamental importance for our understanding of Linnaeus and eighteenth century natural history in general, had not by that time been even half finished; the foreign correspondence had only reached B (Burmans).²⁴ There is no more important task facing Linnaean scholarship at the present moment than the completing of this monumental correspondence; we have only to find the right man for the job.

Swedish Linnaean scholarship has mostly followed the lines laid down at the beginning of the century. Interest has been centred on Linnaeus's life, his personality and environment, on Linnaeus as a national cultural figure, if you like. The Swedish Linnaean Society, founded in 1917, has been very active along these lines, striving hard to preserve the memory of Linnaeus; the many year books of the Society contain numerous essays and editions of texts, intended to provide a more detailed knowledge of Linnaeus, his work and his world. The best known of the remarkably few modern biographies of Linnaeus has come into existence in this atmosphere. This is Knut Hag-

berg's *Carl Linnaeus*, originally published in 1939 and thereafter translated into several languages, English among them. Hagberg's rather popular book is presumably the main source from which the international reading public acquires its knowledge of Linnaeus. It has many virtues, and is extremely well written and persuasive. Dealing with the fundamental concepts in Linnaeus's scientific work, it gives a balanced picture of Linnaeus the man, his happiness and his secret sorrows.²⁵

The latter call for some consideration here. The picture of Linnaeus which Hagberg presents is not in all respects the old and traditional one. This brings us on to new questions, new attitudes and methods of approach in serious Linnaean scholarship today. There are in particular two essential problems which we are nearer to understanding now than before. One is concerned with Linnaeus's personality and character, his private life and his way of apprehending God and the world; the second with his scientific achievement.

The first problem raises questions of a somewhat limited and local interest, since they concern the picture and myth of Linnaeus which has been cherished by generations of Swedes, and I shall therefore limit my comments to a few points fundamental to the history of Linnaean scholarship. The romantic conception of Linnaeus, as it has grown up ever since Sven Hedin's memorial address, was simple and truehearted. Everything in it breathed harmonious idyll in the age of Rococo. Linnaeus was the prince of flowers, as innocent as the wild flowers of the field, beloved by all. No attempt was made to penetrate beneath the exterior appearance; Fries in his great biography, and many others after him, still accept without reservation the rather sugary picture of Linnaeus which had become accepted by the Swedish people during the nineteenth century. The first who began to question this picture, or at least to approach Linnaeus the man with something of the sensibility of modern psychology and aesthetics, was the distinguished Swedish essayist and poet, Oscar Levertin. In a posthumously published book, *Carl von Linné*, which appeared in 1906, unfortunately unfinished, he shows a fine, sympathetic understanding in his portrait of Linnaeus as author and moral thinker.²⁶ Levertin gives a sensitive analysis of Linnaeus's inimitable qualities as writer of Swedish prose, of his graceful mythological fancies and of the biblical nature poetry which breaks out in his moments of exultation. And he deepens our understanding of Linnaeus's still incompletely published notes on *Nemesis Divina*, the avenging, divine justice which implacably punishes all human misdeeds. These primitive and gloomy ideas were also part of Linnaeus's nature; he also knew the misery of existence. Twenty years later

another scholar, Elis Malmeström, began more or less where Levertin had left off. In a study called *Carl von Linnés religiösa åskådning* (Carl von Linné's religious outlook) he gave a well-rounded account of the decisive influence of Linnaeus's deep biblical piety on his attitude towards nature and human life.²⁷ Malmeström of course confirmed what had always been known: Linnaeus's God was God the Creator; the Bible, supplemented by Wolff, Derham and other physico-theologists of the eighteenth century, had taught him to consider nature as an unfathomable system of harmony, the minutest part of which held a hint of God's wisdom. But at the same time Malmeström showed how difficult it became, with the passing of years, for Linnaeus to take comfort from his religious convictions. He was seized by sombre feelings of vanity, he felt bitter and persecuted, the world and humanity caused him suffering. In these ways Swedish scholarship has continued to deepen and change our understanding of Linnaeus. Several writings (later studies by Malmeström and Erland Ehnmark) have been devoted to Linnaeus's moral and religious thought: with their help we have entered more and more deeply into the life of this very singular man.²⁸ Naive he certainly was, but neither uncomplex nor particularly happy.

When it comes to Linnaeus's scientific achievements, and the works upon which his world-wide reputation is based, the present situation is different and far more complicated. There is no clear tendency towards a general re-evaluation. What we find instead is a few isolated essays which have hardly won general acceptance. These have, significantly enough, not come from Sweden, where the glory surrounding Linnaeus's name is still to some extent a hindrance to an unprejudiced investigation of his qualities as a botanist and taxonomist. It is as if Linnaeus's own glorification of his scientific greatness had prevented posterity from seeing him clearly.

The first and most important of the investigations to which I have here alluded is by now quite old. It is included in the well-known *Geschichte der Botanik*, published in 1875 by the famous German plant-physiologist Julius Sachs.²⁹ What Sachs has to say introduces new and inspiring views of undeniable interest. Naturally he does not deny Linnaeus's historical importance, nor his genius, but he considers both of them in an unusual light. According to Sachs, Linnaeus is by no means the reformer of botany he is generally considered to be. It is true that he prescribed laws accepted by most botanists throughout the world and that he demonstrated in his voluminous works how plants should be classified, described and given Latin names; all this he did with masterly clarity. But he did not thereby inaugurate a new epoch in the history of botany. On the contrary, botanists had been doing

this kind of thing for centuries and Linnaeus continued to do it in the ancient, traditional spirit. The basic concepts to be found in Linnaeus's works are, Sachs emphasizes, in fact medieval and scholastic. Botany's only worthwhile task was for Linnaeus something purely formal and verbal; *divisio* and *denominatio*, the knowing of plants by name and the placing of them in a system, was the final aim to which everything tended. He "classified, and that was the end of the matter." Linnaean botany was thus merely a game with abstract concepts, with the correct terms and names prescribed by Linnaeus himself. He applies these to the empirical reality of botany and so forces this reality into the strait jacket of a closed intellectual system, exactly in the scholastic manner. Experimental science in the modern sense of the term was not Linnaeus's business; he had, according to Sachs, no inkling of how a hypothesis could be established as fact by means of induction. And Sachs poses the crucial, we might perhaps say the astounding question: did Linnaeus make one single important botanical discovery? The answer is negative; Linnaeus did not.

Though Sachs undoubtedly overshot the mark now and then, this does not essentially lessen the value of his shrewd and unprejudiced interpretation. It won no real following and in Sweden, with a few exceptions, it was killed by neglect, and dead it has remained to this day. It was incompatible with the Linnaean cult, no one even bothered to define his views on the German botanist's argument. Only very recently has scholarship in the rest of the world taken up for renewed consideration the views which Sachs put forward with such rigour. This new turn should be associated with the highly increased interest in Linnaean systematics, and its method and practice, within modern botanical and zoological taxonomy. In this field Linnaeus has shown himself to be more and more important, biologists having felt the urgent need of illuminating his concept of species, of analyzing the extant Linnaean type specimens and of investigating his rules of nomenclature and his working methods in general. In this connection, the crucial problems within Linnaeus's reformation of botany are all being revived, as eventually will be the general historical and philosophical foundation upon which he built. In particular, the Linnaean concept of species and his principles of naming species have been the subject of penetrating studies, by Ramsbottom, Svenson and others.³⁰ The English botanist W. T. Stearn has investigated the gradual development of binomial nomenclature in Linnaeus's writings.³¹ By these efforts we have gained a deeper insight into his originality as a scientist and his attitude to the empirical reality he wanted to describe. It is nowadays obvious that this attitude concealed problems of a rather complicated kind. And here new

credit has been bestowed upon the almost forgotten opinions of Sachs. The work of Linnaeus—says Bremekamp in a paper on the hierarchical structure of his botanical system (1953)—must be considered against the background of the theological debates of his time; even when discussing quite other questions he liked to dress his arguments in a theological garb.³²

Following this direction, modern research has approached what may be called the very core of Linnaean thought. Particularly noteworthy is a penetrating analysis published by the British zoologist A. J. Cain: *Logic and Memory in Linnaeus's System of Taxonomy*.³³ Cain in this article investigates the logical structure of Linnaean systematics. Not confining himself to its smallest unit, the species, which has already been treated by others, he deals with the theoretical basis of Linnaeus's entire activity as a taxonomist and classifier of the three realms of nature. In all fundamentals he confirms Sachs's findings. Linnaeus set to work as an accomplished Aristotelian; his innate passion for order had been trained by scholastic logic. Aristotle's logical terms "definition," "genus," "differentia" and "species," were his primary tools. A scientific definition—of a plant, or any object whatsoever—must, according to this method of thought, be constituted "per genus et differentiam", by genus and specific character, and this was the method employed by Linnaeus. The undertaking was attended by certain fundamental difficulties, since it was concerned with empirical phenomena and one could not therefore rationally know *a priori* which properties of the object should provide the basis for classification ("taxonomy of unanalyzed entities"). But it is very significant that Linnaeus, like Ray and others before him, was striving with all his might to build up a botanical system on a foundation of logic, as if he were dealing with "analyzed entities". "Logical division" in the Aristotelian sense thus became sovereign; it followed its own fixed rules. The same dividing principle (*fundamentum divisionis*) had to be used at each stage within the system, and Linnaeus adhered to this method strictly—finding the principle of botanical division, as we all know, in the sexual organs of flowers.

Neither Julius Sachs nor Cain gives us the whole truth about Linnaeus, but they have pointed to something of fundamental importance, perhaps the most important in Linnaeus's whole achievement. I am personally convinced that Linnaean scholarship will have to develop these or similar ideas further. However, the problem is a complex one simply because Linnaeus was a far more complicated man than has been commonly thought. And here I come finally to my own attitude toward Linnaeus, the scientist and the man. What are the most urgent problems facing Linnaean scholarship today?

What points of view should we advocate, what do the available sources tell us about Linnaeus and his celebrated reform of botany?

We can properly start with some rather secondary aims. One of them has already been mentioned; of all the tasks concerned with the texts, none is more urgent than the completion of the great edition of Linnaeus's correspondence. Not the least important reason for this is that it is a prerequisite for a successful treatment of one of the great problems in Linnaean scholarship. This concerns the spreading, one might almost say the triumphal progress across the globe, of the sexual system and of Linnaean botany in general. The subject, being of fundamental importance, must be tackled on a massive scale, for only thereby can we arrive at a clear picture of Linnaeus's actual position as *princeps botanicorum*, the prince of flowers, in his own age. But the subject has, oddly enough, hardly been touched. At least in Sweden, more interest has been shown in the incidents and details of Linnaeus's life than in the great historical problems. Of course certain particulars concerning Linnaeus's struggle for the recognition of the sexual system have long been common knowledge. A good deal has been written, ever since Stöver's day, about the opposition to Linnaeus's new botany by men like Heister, Siegesbeck and the great von Haller. But this has happened, significantly enough, because their sometimes bitter attacks are part of Linnaeus's biography, they affected him personally. The fundamental question of how his ideas were received in Europe is another and a more important one. The answering of it will require hard work with an immense amount of source material, but soon or later it must be carried out.

However, I wish to concern myself here above all with evaluation—with historical and psychological analysis of Linnaeus's scientific work. The task is both inevitable and fascinating, because the sacred halo surrounding Linnaeus has for generations prevented scholars from looking at him closely. We must at all costs encourage a more rounded and unbiased picture of Linnaeus; Sachs has shown the way. It is not a question of reducing the stature of Linnaeus, but only of seeing him as he was.

There is perhaps no better way of coming to grips with Linnaeus than by taking up the subject of what might be called: Linnaeus and the external world, the world around him. Here he is in truth no scholastic, here we meet him in the fields and meadows, blessed with happiness at the manifold riches of creation. We are here concerned with something fundamental to him as a man and a scientist, with "Linnaeus's eye," with Linnaeus the visual genius. He experienced the diversity of the empirical world, separate natural objects, with an incredible intensity. With his characteristic lack of modesty,

he himself speaks of his "lively, brown, fiery eyes"; portraits and contemporary judgments confirm this: his eyes were very beautiful indeed. Linnaeus had a kind of genius in things sensuous. He is transported, astonished, in a whirl before the incomprehensible abundance of nature, like a wide-eyed child among new toys; naive as he is fundamentally, he gives his enchantment unfettered expression. It is this Linnaeus, Linnaeus the virtuoso observer, that we meet in the Swedish travel diaries and speeches. They are packed with information, with concrete facts that follow one another on the pages with a dizzying rapidity. It is as if nature itself were flooding in on the page. All this is brilliantly reflected in Linnaeus's style, which shares the quickness of his glance. It is laconic and muscular, incredibly rapid in movement. Condorcet spoke, half complainingly, of "the extreme laconicism of Mr. Linnaeus's style". Sometimes the tone rises to the level of the poetical arias of a cataloger of nature. Swans float upon the water, larks hover trilling above the cornfields, frogs croak and bellow from the pools. It is descriptions of this kind which make Linnaeus one of the great, classical Swedish writers.

Thus, there is always an intense emotional involvement in Linnaeus. However factual he is, he is in the last analysis a liturgist singing in praise of the inexhaustible splendour of nature. He gives to facts a new dimension of poetry and mystery; in moments of inspiration the lofty phrasing of the Old Testament may lend his style elevation and magnificence. In this way we approach Linnaeus's attitude to nature, his interpretation of its innermost essence. It is the omnipotence of God the Creator that he sings, the miracle of God in nature. "I saw," he says in one famous passage, "the other side of the infinite, omniscient and almighty God . . . and I grew dizzy." There is nothing original in this, as a general philosophical outlook. As Malmeström in particular has shown, Linnaeus was inspired by the physico-theology in vogue during the eighteenth century; the notion of God's miracles in nature was among the most commonplace of ideas. But Linnaeus has his own tone. His inimitable freshness and enthusiasm shine through his writing. And then there is something peculiar to him, his violent, almost megalomaniacal sense of vocation. He considered himself to be literally an interpreter of nature chosen by the Lord, whose work it was to reveal the mysteries of nature to mankind. Consequently it became a kind of blasphemy to contradict him: he had delved more deeply in nature than any other.

Had he, really? Though the question is essential, it has been put far too seldom. To begin with, it is obvious that Linnaeus's religious feeling was an important driving force towards an intense scientific study of nature. Everywhere he found evidences of God's plan, an inner purpose and harmony.

With this as his starting point, Linnaeus was sometimes able to achieve excellent results when he went out into the fields, studying the miracles of plants and animals. In a few captivating short works he built up what may be called an "ecological theory" of an amazingly modern type. This is the case with the two Latin dissertations *Oeconomia Naturae* (1749) and *Politia Naturae* (1760); it is with good reason that they have proved highly interesting to modern Linnaean scholars. Here Linnaeus tries to show precisely how God has ordered nature. For a casual observer chaos reigns and all things, animals and plants, war on each other; nature's law is eat or be eaten. But this is only appearance. In reality nature is controlled by the most delicate inner equilibrium, an intricate interplay between the innumerable species which ensures that none of them can gain control and dominate; everything is part of one whole. Linnaeus, influenced by the physico-theological optimism of his time, principally by the Englishman Derham,³⁴ has here achieved an admirable insight into the interaction of nature's hidden forces and it was not without consequences. The famous Darwin family continued Linnaeus's line of thought. Old Erasmus Darwin seems to have gained inspiration from Linnaeus when in his *The Temple of Nature* he speculates on the struggle for existence in a nature crammed to overflowing; he even uses the same expression as Linnaeus: the world is "one great slaughter-house" —"horrenda laniena" is the expression used by the great Swede.³⁵ And recently it had been established, by Professor Stauffer, that his grandson Charles Darwin immersed himself in both these Linnaean treatises with great profit when he was struggling with his theory of natural selection.³⁶ Thus Linnaeus is part of the history of the creation of *The Origin of Species*, although in a different way than had generally been thought.

But our main concern is Linnaeus's real life's work: the botanical system. How does this fit in with the picture of Linnaeus as the great empiricist and the religiously inspired interpreter of nature's secrets? The answer to this question involves us in something of a paradox; at the same time it brings us near to the heart of Linnaeus's scientific thought. Here I can only point to essentials.

As an empirical genius, Linnaeus ought, one may guess, to have had enough to deal with. Still, nothing could have suited him better than the working out of what was already at that time called a *natural* plant system; only such a system could adequately express God's plan of creation. It is well known that Linnaeus drew up a rough outline of such a "natural" system, but he never completed it; the system which won him world-wide fame was of a fundamentally different kind. It was artificial, drawn up at

his working-desk. And here lies the paradox, which was at the same time something of a tragedy. It was precisely because of his visual genius that Linnaeus stood fast by separate concrete things and this in turn strangely enough forced him to abandon empiricism, at least as a taxonomist. The incredible intensity with which Linnaeus reacted to the multitude of forms threatened to overwhelm him. The only way out was to order and organize immediately, to find a system or pattern which would give the unordered mass a structure. Linnaeus was a hasty and temperamental man; the system could well be superficial, if it could only provide a practical classifying principle. It was thus that he created his artificial sexual system. He was peculiarly well fitted for an undertaking of this kind. He was a born systematizer, with an almost daemonic passion for ordering everything in groups and sub-groups like soldiers on a barrack square. This intense need for clarity is typical of Linnaeus; he had at all costs to find an order in nature. If none was to be found, then he had to invent one. And at this point he abandoned empiricism and became a botanical legislator and scholastic. The system itself, the ordering of natural objects according to certain prescribed norms, became, as Sachs has emphasized, the only worthy purpose of natural history. The botanist is one "qui nominibus noscit nominare," who can give names, who can set the right labels on the specimens in nature's colossal cabinet of curiosities. And this must be done according to certain general rules worked out by Linnaeus himself. Woe to the botanist who turned aside from them; he was a heretic and Linnaeus spewed him out of his mouth. None of Linnaeus's works is more instructive in this connection than the famous *Philosophia Botanica*. There Linnaeus provides the "philosophy," a handbook on the principles of botany. Everything aims at systematics—Linnaeus communicates the correct terms for the parts of plants, explains how they are to be valued from the systematic point of view, and gives rules for the assigning of Latin names. The *Philosophia Botanica* is a law book in the most literal sense of the term. Botany becomes a game with abstractions, with terms and concepts whose validity Linnaeus has established once and for all.

It can hardly be denied that we are here very near to the world of medieval scholasticism. Julius Sachs's evaluation of Linnaeus seems to be in the main correct; Cain's analysis of his taxonomical method tells us something essential about him. Linnaeus the empirical genius never made any major biological discovery, quite simply because as a taxonomist and a reformer of botany he was concerned with problems of quite another sort; they were rather of a logical nature. In this he was a follower and a culminator, an age in the history

of botany reached its peak and its end in Linnaeus. Linnaeus had little in common with the really fruitful biological research coming to the fore in the eighteenth century. Such research was experimental, dealing with physiological, anatomical and embryological problems; I am thinking of men such as Hales, Spallanzani, Trembley, Bonnet and Ingenhousz. As a natural historian Linnaeus seems to some extent a stranger in his own age, even old-fashioned and primitive, and his immense influence must have delayed the breakthrough of modern, experimental biology, not only in the Scandinavian countries.

Thus Linnaeus the man and Linnaeus the scientist were, I believe, far more complicated than has generally been thought. There was in him a duality, a tension between conflicting tendencies, which gives his life's work a character of its own. This brilliant observer and recorder of natural phenomena belonged in some measure to a past age and thus never, or very seldom, put the really fruitful questions to nature. This is not merely a matter of what we might call a fundamentally scholastic attitude. In other ways, too, he seems primitive, old-fashioned and thereby isolated in his age: there is his fervent Old Testament kind of religion and his credulous acceptance of many superstitions and unfounded fancies. The modern observer often stands as a stranger before Linnaeus. But perhaps, in the end, such an attitude will prove more rewarding for the study of the man and his work than the blind devotion which has, ever since the beginning of the nineteenth century, given the figure of Linnaeus something of the unreal appearance of a legend.

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30. J. Ramsbottom, "Linnaeus and the species concept," *Proceedings of the Linnean Society of London*, 150 (1938), pp. 192-219; H. K. Svenson, "On the descriptive method of Linnaeus," *Rhodora*, 47 (1945), pp. 273-302, 363-388.
31. W. T. Stearn, "The background of Linnaeus's contributions to the nomenclature and methods of systematic biology," *Systematic Zoology*, 8:1 (1959).
32. C.E.B. Bremekamp, "Linné's views on the hierarchy of the taxonomic groups," *Acta Botanica Neerlandica*, 2 (1953), p. 244.
33. A. J. Cain, "Logic and memory in Linnaeus's system of taxonomy," *Proceedings of the Linnean Society of London*, 169 (1958), pp. 144-163. See also Stearn, pp. 16 ff.
34. See Malmeström (1926), p. 150 n. 1. Concerning Linnaeus's ecological view on nature cf., especially Malmeström (1926), pp. 137-153, also N. von Hofsten, "Linnaeus's conception of nature," *Kungl. Vetenskaps societetens årsbok*, 1957, pp. 90 ff.
35. "And one great slaughter-house the warring world"; cf. D. King-Hele, *Erasmus Darwin*, London 1963, p. 74. Linnaeus (in his lectures on the animal kingdom): "bellum omnium perpetuum in omnes et horrenda laniena"; Malmeström (1926), p. 145 n. 3.
36. R. C. Stauffer, "Ecology in the long manuscript version of Darwin's Origin of species and Linnaeus' Oeconomy of nature," *Proceedings of the American Philosophical Society*, Vol. 104:2 (1960).

Redouté and His Circle

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The life of Redouté, one of the greatest flower painters of all times, spans the last phase of the *ancien régime* in France, the French revolution, the Consulate, the Napoleonic era, and the Restoration. A fascinating time in history in which the western world was shaken and reformed, but, in addition, a time in which the sciences flourished, and in which new methods, ideas, and people came forward. Along with this cultural revival came the publication of an unexpectedly high number of important botanical books; important not merely within the period, but even for science to-day. One might perhaps ask why these books still have actual importance and why old illustrated botanical books may have merits to-day that go beyond their artistic interest: scientific merits which are closely linked with exactly these artistic qualities.

Plant taxonomy is not only a purely descriptive branch of science, it has also, besides other aspects, an important historical function. We might even say that plant taxonomy, like social history, is in several respects an archival science, the archives being in the first place the books published by previous botanists describing and naming the plants of the world, and in the second place the herbarium specimens which document these descriptions and names. I mention the names in addition to the descriptions, discussions and systems, because it is through the names that we are able to create order in the vast amount of data provided by nature. In biological systematics we are dealing with an immense heritage of knowledge assembled in previous centuries, a heritage to which the names provide the keys. It is therefore essential to have international agreement among scientists on how to use the names of the past. In botany and zoology it has been agreed to accept and use the Latin names given to organisms by and since Linnaeus. For botany this starting point of nomenclature is Linnaeus' *Species plantarum* of 1753. It is furthermore agreed that when an organism has been named several times, it is in general the oldest name that will have to be used. Leaving out of account a number of exceptions, we can say that the principle of priority governs the use of botanical names with the one important restriction that this holds from Linnaeus onward. It will therefore be clear that all taxonomic publications by and since Linnaeus are of actual and not just historical importance for biology. The old publications are used almost daily by biologists

in order to determine for what concept a well-established name stands, and how this name has to be used: the interpretation of our names is based on these original publications and on the original specimens, if the latter happen to have been preserved.

The interest in Redouté and in the books illustrated by him is therefore shared by to-day's plant taxonomists, 'biohistorians', bibliographers, and students of his artistic performance.

Bibliographically and historically, Redouté and his patrons and botanists are important because they have enriched human culture with an exquisite series of beautifully produced books of high intrinsic value which are valuable documents for their age.

Taxonomically these books are important because they describe many plant species which are often still of great importance; a documentation usually made almost perfect by the highly skilled illustrations provided by Redouté.

Artistically Redouté is important in the first instance because of the sheer beauty of many of his productions, but certainly also because of his technical innovations in color-printing which succeeded in diffusing more widely the products of his artistic creativeness.

Let us now turn to this small group of artists, botanists, and wealthy, often royal, patrons, from 1780 to 1830 in which Pierre-Joseph Redouté played such an important part. Redouté is described by people who knew him as short thick-set, ugly and stumpy-fingered, more the type of a mason than of an artist. Still, he cannot have been so singularly unattractive if we take into account his great social success, especially with the female part of early 19th century French society. After all, what other man could boast of having been the successful teacher of two queens, two empresses, one other very attractive female pretender to the throne of France, and a host of mostly charming young ladies from the French upper classes? All these women were of course primarily attracted by the beauty of his art, but still . . .

Redouté was born in Belgium on 10 July 1759 in the little town of Saint-Hubert² in the Ardennes near Liège. His father (Charles-Joseph Redouté, 1715-1776) was an interior decorator in the old style who painted walls, but occasionally also altar pieces and religious scenes. Redouté, however, escaped from this narrow provincial background by moving to Paris in 1782, then as now a world center of culture and creative art. In his early years in Paris, Redouté earned a living with stage decoration, but he learned also the first principles of copper-engraving and perhaps even color-printing. In his spare time he was a frequent visitor to the Royal Botanic Garden in Paris where

he started drawing flowers from nature. This garden belonged to the institution then called Jardin du Roi and now known as the Paris Museum of Natural History. This Jardin du Roi was indeed much more than a simple botanical garden: it was in many ways a biological university of its own, with a separate scientific staff and a group of museums dedicated to scientific research and teaching in the fields of botany, zoology and mineralogy. The professors at the Jardin du Roi gave annual courses independent of the regular university courses of the Sorbonne. One of the professors had the special charge to teach flower-painting: at the time of Redouté's first visit to the garden this chair was occupied by the Dutchman Gerard van Spaendonck (1746-1822), a man with whom Redouté would soon become intimately acquainted (*cf. Blunt 1957*). Before that, however, Redouté—while painting in the garden in 1783 and 1784—attracted the notice of the wealthy amateur botanist Charles-Louis L'Héritier de Brutelle (1746-1800), who recognized his talents and who engaged him to make drawings for his publications. The association with this rather eccentric Parisian magistrate was to become one of the determining factors in Redouté's further career. L'Héritier was a judge in one of the highest courts in France, the Cour des Aides, the supreme fiscal court dealing with tax offenses, including the abuses of power by tax officers (*cf. Stafleu 1963c*). He was highly respected socially as well as intellectually and moved among the group of enlightened and influential Frenchmen who paved the way for far-reaching social and administrative reforms—and therefore in fact for the French revolution—but who were still closely associated with the court and with other governmental and aristocratic groups. L'Héritier was a highly skilled and intelligent amateur botanist whose knowledge in this field was recognized by his election as a member of the Académie des Sciences in the year 1790. His ample means allowed him to build up one of the best botanical libraries of his time (*cf. Debure 1802*), to grow numerous rare and interesting plants in his own garden, and to maintain contacts with travellers who collected material for him.

Wealthy amateur botanists and horticulturists, such as L'Héritier, have played an important rôle in the history of plant taxonomy and of plant introduction: the Dutch merchant George Clifford (1685-1760) may be mentioned in this respect. Clifford engaged the botanist Linnaeus and the artist Ehret to describe and picture his great collections at De Hartecamp near Haarlem, a collaboration that resulted in the publication in 1737 of Linnaeus' *Hortus Cliffortianus*. Unlike Clifford, however, L'Héritier was a patron who turned botanist himself and who, in 1784, was just planning to start his first book, to be called *Stirpes novae*, 'new kinds of plants'.³ This was to be

a huge folio production issued in parts and produced entirely at his own expense. Every description of a new plant was to be accompanied by an illustration. L'Héritier recognized in Redouté a coming flower-painter and started training him to make botanically as well as artistically acceptable drawings for his book. It was L'Héritier who taught Redouté botany, how to dissect flowers, how to make detailed drawings of essential characteristics, and, therefore, in general how to draw plants for botanical publications. Redouté thereby entered the first phase of his development as a botanical artist: that of the more or less academic, naturalistic flower painting. Botanically speaking these drawings or paintings are very valuable. From an artistic point of view they are often still rather stiff and formal, although it must be said that some of Redouté's drawings as reproduced in the *Stirpes novae* are already of great beauty, especially in the colored copies. His earliest plates (e.g. nos. 15 and 17) are artistically somewhat dull, although technically sound, but later plates (e.g. nos. 73 and 74) are in all respects excellent. Redouté, therefore, had L'Héritier to thank for setting him on the road to success: without the thorough botanical training of his early days with L'Héritier, Redouté would never have become a flower-painter eminent both from the botanical and the artistic points of view. At the height of his career, Redouté publicly acknowledged his indebtedness to L'Héritier in the foreword to his *Roses* in 1817, saying that it was L'Héritier who had led him to a new career and who had made it possible for him to develop his talents. At a much earlier date, however, around 1799, L'Héritier had already dedicated a paper⁴ to Redouté saying "Dear Redouté, the truth of your brush even more than its magic will let me share with you the celebrity which our common works will perhaps earn some day." These words have proved to be prophetic: most plates in L'Héritier books were drawn by Redouté and his books certainly owe as much of their fame to the illustrator as to their author. All of them are now collector's items: copies are extremely scarce and rarely appear on the market; of some of the books only two or three copies are known to exist. L'Héritier even described some new plants on separately published plates accompanied by a descriptive text. Some of these so-called "dissertations" were later included in the *Stirpes novae*. Not more than four or five copies were made at the time; they were given to colleagues and friends and not offered for sale. Not more than two or three copies of each of them are known to-day, but they must still be taken into account for botanical nomenclature. The *International Code of Botanical Nomenclature* gives rules for the publication of names of new plants. These rules often have important consequences and present bibliographers with some definite questions. It

is necessary for a publication to have been available at any rate at one or two public or semi-public institutions, and it must be known that at least two copies are in existence. Some of L'Héritier's dissertations fulfill these requirements.

The *Stirpes novae* remained unfinished: of the projected 120 plates only 91 were published, in six instalments. The sixth part appeared after the beginning of the French Revolution, in 1791. L'Héritier, a member of the lower gentry and an ancien régime magistrate, had a hard time during the revolutionary years; he lost most of his fortune and his subsequent career did not allow him to finish the publication of his most sumptuous book.⁵

Most copies of the *Stirpes novae* have plates in black and white, but a number of colored copies are known. The copy at the Library of the University of Kansas, given to that University by Mr. William P. Wreden, has two sets of plates: one in black and white and one in color. A similar copy is at the Bibliothèque nationale in Paris (*Brunet, Stevenson*) and an incomplete one in the library of the Massachusetts Horticultural Society (*Dunthorne*).

The Kansas copy has 91 uncolored and 71 colored plates. In later years Redouté prepared several copies of *Les Liliacées*, *Les Roses*, and his edition of Rousseau's *La Botanique* with two such sets of plates: copies which have become extremely valuable.

The copies with colored plates at the Missouri Botanical Garden and at the Hunt Botanical Library have plates which are line engravings printed in various colored inks, subsequently finished by transparent washes of color applied by hand.⁶ All the colors of the engraving were applied simultaneously, and the plates were re-inked after each impression. The application of the colors was carried out by means of a rag-stump, called *poupée* (resembling a rag-doll), a technique which required considerable skill. It was important to prevent the colors from mixing, and the repeated inking for each impression must have been a time-consuming job. The colors that were printed were only the basic ones: for example, green for the leaves and the stems, or brown for the stems, golden brown for the engraved border, the dominant color for the flowers. The final application of water colors by hand was indispensable: it is precisely this which makes the illustrations so attractive. Redouté was to perfect this method greatly in later years, mainly by using stipple-engravings (see below), but the colored plates of the *Stirpes novae* have a great direct charm notwithstanding the absence of toning or shades. The finishing by hand gives the plates a certain individuality and the final product often closely resembles an original water-color painting.

From the dates of the early parts of the *Stirpes novae* (1785-1786) it is clear that we are faced with an early experiment in color printing, an experiment from which Redouté's own later technique evolved. There is no evidence that the colored copies were published considerably later than the plain ones; the subsequent history of the book and L'Héritier's early death make this improbable. It should be realized that the first plate by Redouté is no. 15, published in January 1786 in the second installment. The plates of part 1, nos. 1-10, published in March 1785, however, are also colored. They were prepared by various engravers after paintings by L. Freret, Prévost and L. Fossier. It is still uncertain who really initiated the color printing in this particular set of plates. The method described above was not unknown outside botanical illustration, and it is quite possible that Redouté gained his knowledge from some of the other artists or engravers employed by L'Héritier.

Plate no. 15, *Arenaria balearica*, was Redouté's first published botanical illustration; the engraver was Francois Hubert (1744-1809) who worked often for L'Héritier but who was certainly not the most inspired artistic technician employed by the latter. In contrast, our frontispiece, *Sida ricinoides* (no. 55), engraved by Milsan, excels in both design and color.

The second plate published by Redouté in L'Héritier's *Stirpes novae* is that of *Dombeya lappacea* (no. 17) and it is of special interest because it combines the names of Dombey, Redouté and L'Héritier; a combination that was soon to become of great importance in Redouté's life. This Peruvian plant had been sent to the Jardin du Roi by the French explorer of Spanish South America, Joseph Dombey (1742-1793).

The association with L'Héritier and Dombey led Redouté into one of the most adventurous botanical undertakings of the eighteenth century. L'Héritier had obtained permission from Buffon, the director of the Jardin du Roi, to publish the new plants from Dombey's collection which had reached France in 1785. Dombey, however, had been in Spanish territories and because of a very involved set of regulations and understandings, not to say misunderstandings, he was not free to have his material used for publication before that of his companions Ruiz and Pavon, two Spanish botanists, had been published (see Stafleu 1963c, Steele 1964). As soon as the news of L'Héritier's intention to publish on the Dombey material reached Madrid, the Spanish government intervened with the French and demanded that the activities of L'Héritier be stopped. The French court was inclined to give in and, strange as it may seem to-day, sent word to L'Héritier to return the collection to the Jardin du Roi. L'Héritier, however, had already

been warned and he packed up the Dombey herbarium in great haste with the help of Redouté and other friends. On 9 September 1786 he took the night coach to Boulogne and crossed the Channel to England where he hoped to finish his work, expecting that in the meantime the governments would lose interest in the Dombey collections. In London L'Héritier worked at the private natural history cabinet of Sir Joseph Banks (1743-1820), a wealthy and influential patron of arts and sciences, and president of the Royal Society, and in the Royal Botanical Gardens at Kew. Banks' herbarium collections in Soho Square and the collections of living plants at Kew and in some other London gardens were so rich that L'Héritier soon stopped work on the Dombey collections and started describing new species encountered in England. In April 1787 he asked Redouté to join him in order to make the necessary drawings. In London, Redouté became acquainted with James Sowerby (1757-1822), another botanical artist discovered by L'Héritier who was to achieve great fame, as well as with the Italian Francesco Bartolozzi (1727-1815), and several more British artists.

The result of this adventurous trip was the publication by L'Héritier, on his return to France, of the *Sertum anglicum*,⁷ 'an English wreath', a tribute to his English hosts and colleagues. Twenty-two of the drawings in this book are by Redouté, ten are by Sowerby. As a product of international co-operation the book was far ahead of its time, foreshadowing an *entente cordiale* which has still not been fully realized. The original drawings were monochrome water-colors with occasional details in a second color. Some of these originals are in the Hunt Botanical Library; one of them is reproduced in the Pittsburgh facsimile of the *Sertum anglicum*. The book contained the first description of the genus *Eucalyptus*. The engravings are simple line engravings; no colored copies are known to exist.

Another man whom Redouté met in these years just before the revolution has already been mentioned: Gerard van Spaendonck, the Dutch painter who was professor of flower painting at the Jardin du Roi. Just as L'Héritier greatly influenced Redouté by his botanical training, van Spaendonck can be said to have been Redouté's great artistic teacher. Van Spaendonck taught Redouté the essentials of two very important techniques. One of his tasks at the Jardin du Roi was to add to the famous collection of flower-paintings on vellum at the Cabinet du Roi, a collection dating from the first half of the seventeenth century (see *Bultingaire, Blunt* 1950). Before van Spaendonck's time these vellum paintings were mainly gouaches, but he reformed the technique by going over to water-colors, a technique which, with his high skill, proved to be far superior for flower painting because of the greater

transparency and flexibility in the shading of the colors. It was this highly skilled technique of water-color painting on vellum that Redouté learned from van Spaendonck. Another important technique developed, although not invented, by van Spaendonck was that of the stipple engraving as opposed to the old line-engraving. Redouté's early work, for L'Héritier, had all been reproduced by line-engraving. Through van Spaendonck, however, Redouté became thoroughly acquainted with stipple engraving, a technique that he had already seen in London. The process consisted of etching or engraving by dots rather than by lines. The engraver worked with a needle or a roulette and this technique was well suited to give delicate gradations of tone and modelling. Usually printing was still in monochrome, but for his next great book, Redouté printed the stipple engravings in full color. He applied several colors simultaneously to the plate—just as with the line engravings for the *Stirpes novae*—took a single impression, and then reinked the plate. The book in which these combined processes were for the first time consistently applied is the *Plantes grasses* or *Historia plantarum succulentarum* by A.-P. de Candolle and Redouté.⁸ As was the case with the *Stirpes novae*, only the main colors were thus printed; the finishing touches were nearly always made by hand with water-color. The final result of this double process of printing and touching up by hand has, especially if done by Redouté himself, a highly pleasing appearance, although the originals are still artistically much more satisfactory. This double process accounts for the wide variety in quality of the prints in books illustrated by Redouté after his association with L'Héritier. The first prints were often the best, and in later years were the only ones made by the master himself. Of some books only a few copies are known that were really delicately finished off by hand with water-color. The rest remained inferior.

The basis of Redouté's artistic career had now been laid. The botanical side was sound, thanks to L'Héritier; the artistic future was bright, thanks to the advanced techniques learned from van Spaendonck and combined with Redouté's own process of color-printing. It was through van Spaendonck's guidance that Redouté found the way for the expression of his individual creativeness. Talent and skill, however, are not the only requirements for success: it was also important to find the right contacts, wealthy patrons, in order to achieve the success that Redouté was to meet; for this, too, he had the right disposition.

A few words more on this remarkable book on succulent plants published jointly in Paris by the young Swiss botanist Auguste-Pyramus de Candolle (1778-1841) and the Belgian artist Redouté, both still on their way to fame.

The idea of the book was again that of L'Héritier, who was troubled by the difficulty of preserving the salient characteristics of succulent plants in the herbarium. The Swiss botanist was found willing to provide the descriptions, Redouté was to paint the plants and their flowers in such a way that these illustrations would amply document the descriptions as no dried specimen ever could. The book has an interesting but troubled history. It shows in the first place that Redouté had some fame already: his name figures on the front page with the same prominence as that of the botanist. Furthermore it is the only book in which the engraving and printing, after his own originals, were done entirely by Redouté, at any rate for the best copies. The work was published in parts over a series of years, 1799-1805, to be reissued and supplemented again as late as 1830-1832. In the beginning Redouté really did all the work; later the plates were reprinted by others. There were several editions, in folio and in quarto, but there were also simple re-issues of old plates and with new title-pages. In fact the book has been called the bibliographer's nightmare. There are practically no identical copies: I have seen more than thirty variants. There are at least ten different title-pages of which there is one carrying the intriguing date 1790: de Candolle was then twelve years old. The many problems surrounding this book have yet to be solved and a precise description of its history is a bibliographical necessity, the more so since it presents botanists with several puzzling problems of priority. Most of the originals, of exquisite beauty, are at the Muséum national d'Histoire Naturelle in Paris.

Redouté's fame increased. In 1793 he had obtained a permanent position as an artist to work at the collection of vellum paintings at the Jardin du Roi when it had been reorganized after the revolution as the Muséum national d'Histoire Naturelle. This activity resulted in the addition to this marvellous collection of several hundred beautiful water colors, most of them never reproduced. Redouté's younger brother, Henri-Joseph (1766-1852) had obtained a similar position at the Muséum. He had followed his brother to Paris and became a successful illustrator of books on natural history. He never reached the same fame as Pierre-Joseph, with whom he collaborated in a number of books. He went to Egypt with the Napoleonic expedition, and in later years specialized in painting reptiles and fishes.

Around the turn of the century Redouté lost his benefactor, protector, and employer L'Héritier. The latter was killed in 1800 by a gang of murderers, hired in all probability (but there is no proof of this) by his eldest son. Redouté, however, had found a new and much more influential patron in Joséphine de Beauharnais, the first wife of Napoleon. Joséphine had married

Napoleon in 1796, and in 1798 they had acquired the charming property of La Malmaison, then still in the open country, now completely engulfed by the greater Parisian agglomeration. Joséphine had a consuming interest in flowers: her *femme de chambre* Mlle Avrillon gives the following illustrative detail (*Mémoires* 1:202): "Her fancy for botany was not only a whim with her; she made it an object of study, of serious study. She soon knew the name of all plants, that of the family in which they were classified by the naturalists, their origin, and their properties."

Joséphine developed the Malmaison gardens regardless of expense—perhaps to outshine some of the other influential families of the consulate in this respect—and brought together an important collection of living plants. When one now visits the uninspired parks-department type of garden at Malmaison, it is difficult to imagine that this small property was once extensive and housed rich collections of exotic plants—many brought back from the famous Napoleonic expedition to Egypt and by Humboldt and Bonpland from South America—plants which provided the material for three of the world's most magnificent flower-books. At her death Joséphine's Malmaison property measured two thousand hectares; now it is only four. The enthusiastic Joséphine wanted her garden described and her plants depicted. Étienne-Pierre Ventenat (1757-1808), the librarian of the Panthéon, an amateur botanist of the L'Héritier type, was engaged to provide the descriptions, Redouté was to be the artist, and Charles-François Brisseau de Mirbel (1776-1854) the co-ordinator of horticultural and botanical research charged with the acquisition of new plants. Thanks to the co-operation of these three men the magnificent *Jardin de la Malmaison*⁹ was completed. The book was published in parts between 1803 and 1805. This series of a hundred and twenty plates together with the sixty-four plates of the *Description des plantes rares cultivées à Malmaison et à Navarre* and the approximately five hundred plantes of *Les Liliacées*—the other great books of this period—constitute the highest peak of Redouté's achievements in the second phase of his development, that of botanical and artistic harmony. Unlike the illustrations for the *Plantes grasses*, those in these books suit the size of the pages. In the folio edition of the *Plantes grasses*, the illustrations are often dwarfed by the sheer size of the pages. In these books, however, the lay-out and relative proportions of paper and drawing are just right, and the execution of the copies that received Redouté's personal attention is superb. The *Jardin de la Malmaison* has become exceedingly rare. As far as I know only one or two copies have come on the market since the war, and the book fetched prices far beyond the means of ordinary botanical institutions.

The botanical and especially the horticultural importance of the *Jardin de la Malmaison* can best be understood from the implications in Ventenat's dedication to Joséphine: "you have brought together the rarest plants of the French soil. There are even several that have barely left the Arabian deserts and the burning sands of Egypt which have been naturalized by your care, and which, now classified and presenting themselves to us as the beautiful garden of Malmaison, form the sweetest souvenir of the conquests of your illustrious consort and the most charming proof of your well-used hours of leisure."

Napoleon might well be mentioned; Joséphine, with her great influence on him, knew how to spend money and spent it liberally. The book, however, has proved to be of far higher intrinsic value than the considerable sum which it cost Joséphine (and consequently Napoleon)—over 120,000 francs.

The year 1804 brought Joséphine to her highest glory: Empress of France. Ventenat was appointed "Botanist to her Majesty the Empress and Queen"; Redouté, at a salary of 18,000 francs per year, became Joséphine's official painter. Mirbel, however, being disliked by Napoleon, was shortly afterwards transferred to Holland.

The first parts of the second Malmaison book, *Les Liliacées*,¹⁰ were published almost simultaneously with the *Jardin de la Malmaison*. This book, with its nearly 500 colored plates, all by Redouté, surpasses in size and equals in beauty the *Jardin de la Malmaison*. The only name on the title-page is that of Redouté: he was his own editor and publisher. He had come a long way since his first plates were published in L'Héritier's *Stirpes novae* with only a simple designation at the bottom of the engravings. In the *Plantes grasses* the names de Candolle and Redouté had equal prominence on the title-page, but in the *Liliacées* Redouté's name stands alone. The names of the authors of the botanical descriptions, de Candolle, De la Roche, and Raffeneau-Delile, are not found in the book: their conspicuous absence from the title-page is evidence of Redouté's fame.

The book was a success with the government; the minister of the interior, Chaptal, recognized it as a "status symbol" for cultural France. After the barbaric events of the revolution and its aftermath, the time had now come in which France could again lead the world in cultural affairs. Publication was continued under the auspices of Chaptal. In the fifth part (May 1803) Redouté printed an "hommage public" addressed to this *citoyen*. The dedication was a success: a year later, Chaptal subscribed to eighty copies that were to be sent abroad on behalf of the new emperor to friendly heads of state, ambassadors, and influential statesmen. It is no miracle, therefore, that Redouté

could live easily those days; he had plenty of means, but he found himself spending even more. He occupied a small house in town and a large house in the country near Paris at Fleury-sous-Meudon where he grew his own flowers, especially roses and irises.

The history of the printing and publication of this book is rather involved and has been elucidated among others by B. B. Woodward (1905) and W. T. Stearn (1946). Publication was started in 1802 with an ordinary folio edition. In 1807 a large paper edition appeared with the same text but with the plates finished by Redouté himself. Only eighteen copies received this special treatment, making the edition a botanical-bibliophilic blue ribbon. The originals of the *Liliacées* were for a long time in the possession of the Beauharnais family; in 1935 they were acquired for the Weyhe collection (now in New York).

Napoleon divorced Joséphine in 1809. Redouté remained faithful to her and frequently visited her until her death in 1814. However, he was also appointed teacher of painting to the new Empress, Marie-Louise, and it was through him that the two Empresses once met, by accident, for the only time in their lives.

Redouté was able to adapt himself easily to great changes in his surroundings. He moved first in the circles of the *ancien régime* and was teacher to Queen Marie-Antoinette, wife of Louis XVI; he even went to the Bastille when she was imprisoned there, to paint a night-blooming cactus for her. After the difficult times under the Convention, however, he was able, in 1793, to secure an appointment at the newly organized Muséum national d'histoire naturelle. With the coming of the Consulate Redouté easily dropped his republican clothes and found in Joséphine somebody who profoundly influenced and stimulated him and under whose patronage he reached the top of his career. After the change from Joséphine to Marie-Louise, Napoleon's second wife, life moved on as usual although Marie-Louise never caused Redouté to publish books of the Malmaison type. He was her teacher of painting, but that was all. After Joséphine's downfall in 1809, however, the third of the great Malmaison books with plates by Redouté was still to be published: the *Description des plantes rares cultivées à Malmaison et à Navarre*.¹¹ After Ventenat's death in 1808 Joséphine had appointed Aimé-Jacques Goujaud Bonpland (1773-1858) as her court botanist, to take care of and to describe the plants of Malmaison and those of the estate of Navarre near Évreux in Eastern Normandy, to which she retired temporarily late in 1810. Since she had been heavily endowed by Napoleon, she could still afford to keep her rich gardens and to continue her patronage of horticulture and botanical art.

As usual, however, she easily and lavishly overspent. The book was published in parts: the first part came out late in 1812, the last part (the eleventh) not until early 1817. The book has the same great qualities as its more voluminous counterparts, and has the further distinction of including eleven plates by Pancrace Bessa (1772-1835) another of van Spaendonck's pupils and also a botanical artist of great distinction. The plates by Redouté include the finest he ever made: the magnolias and the peonies. The technique used was the same as for the larger works: Redouté had now finally perfected this technique and, thanks to the collaboration of a remarkable group of expert engravers and printers, he was able to reach great heights of perfection. Much of course depended upon the engraver, and this circumstance accounts for some of the differences in artistic quality between the plates of these three books. Redouté himself, after his effort on the special edition of the *Liliacées*, took part only occasionally in the process of finishing by hand. In the future he could depend mostly on his collaborators for this; France could at that time boast of extremely good craftsmen.

In retrospect it can be said that between 1800 and 1814 Redouté reached the summit of his career, artistically, socially and perhaps even psychologically. In his first phase, before 1800, he had learned the techniques, botanical as well as artistic, and had also learned how to use his creativeness. In the years of his association with the first empress of France, Redouté found the necessary scope for the development of his great talents and for the maturing of his artistic temperament. We owe to him three of the finest flower books ever produced, in addition to a dozen or so others of lesser importance. These three books alone are sufficient to put him in the highest ranks of botanical artists of all time. The coming years were bound to bring changes: the end of the first Empire in which Redouté had risen to wealth and fame marked the end of his affluence, though not yet of his renown.

Of Redouté's many productions in his last phase, the longest of all, 1815-1840, I shall discuss in some detail only the book by which he is now known all over the world and of which good and bad reproductions may be found almost everywhere in living rooms, over mantelpieces, in bathrooms and boudoirs. The reproductions have even found their way onto lamp-shades, the highest indication of popular artistic success that one can think of: posthumously Redouté has now reverted to his original calling as an interior decorator. Mostly these are simple reproductions, but sometimes they are original prints cut from the books themselves. How many copies of fine flower-books are destroyed by so-called art-dealers (the "breakers") in order

to sell the engravings singly, I do not know, but the number must be considerable. This activity of unscrupulous dealers is clearly also responsible for the increasing rarity of these books.

The book of which the engravings have been lamp-shaded is of course *Les Roses*.¹² This book was published in thirty parts between the years 1817 and 1824 but the first paintings may have been made during Redouté's association with Joséphine.

Les Roses is so well known that it seems superfluous to add any more praise after nearly a hundred and fifty years. The execution was again almost perfect and the artistic quality high: the best plates do not rank below those of the great Malmaison books. However, we find already the writing on the wall: the quality of some of the lesser plates in *Les Liliacées* can be attributed to poor engraving and to the speed of execution. When one compares originals and engravings it becomes clear how much depended on these engravers and printers. The originals, of which there are some at the Hunt Botanical Library, are as usual water-colors, occasionally touched with some body color to suggest a certain brightness. The point about *Les Roses* is, however, that we find a certain inclination towards a more elegant effect which may not essentially harm the artistic or botanical qualities, but which is indicative of a certain inclination to deviate from the sheer harmonious beauty of *Les Liliacées*. The *Roses* stands at the beginning of Redouté's third phase (or perhaps at the end of his second), the phase that can be described as that of elegance after the academic botanical painting and the artistic and botanical harmony in the first two phases.

Joséphine—whose full name was Marie-Josèphe-Rose—was greatly interested in roses, and during her last years at Malmaison she grew hundreds of varieties in her garden, forming a collection at that time unique. Redouté's book, although it contained few if any plates from paintings made at Malmaison, is a tribute to Joséphine's patronage of the arts of horticulture and botanical illustration. This enigmatic but exuberant woman had exerted a great cultural influence: only a part of her puzzling psychology becomes clear in her association with flowers, books, and, above all, Redouté.

The book had an immediate success. Its 169 colored plates were made in the familiar way. The author of the botanical descriptions was Claude-Antoine Thory (1758-1827), an inconspicuous botanist whose modest claim to fame lies in a few monographic publications on roses. Thory and Redouté seem to have been on very intimate terms, meeting together in cafés and cabarets.¹³ The book retains its botanical significance, admittedly smaller than that of its predecessors but not to be neglected.

A large folio edition was printed on vellum paper. Fifteen copies were issued with uncolored plates on brown paper as well as with colored plates on white paper. Only a few copies with this double sequence are known; it is almost certain that in this special case Redouté himself again finished the prints by hand. There was also a small folio edition. Several octavo reprints were published in later years; reprints in which the plates suffer greatly from the reduced size. Some new plates were added and the reprints derive some interest from this, but it must be said that Redouté should not be judged from these sloppily executed publications, which, alas, are the most common.

Only a few of the original vellum paintings of the *Roses* have been preserved. The collection was bought in 1828 by Charles X, the last of the Bourbons, for his daughter-in-law Marie-Caroline, Duchesse de Berry, who greatly admired Redouté's art. Redouté had sedulously kept the originals but his always precarious financial situation forced him at last to sell them. Charles X paid 30,000 francs, barely sufficient to cover Redouté's debts and needs at that time. There is a story that the originals were deposited in the Louvre library and that they were burned during the Commune of May 1871. This is unlikely; they probably came into the possession of the Orléans family who disposed of them later in small lots. Originals are now encountered in small numbers in several private collections.

After the *Roses* Redouté published mostly *recueils* of previous paintings and engravings or more or less elegant collections of bouquets and other compositions.¹⁴ He had ceased to be a major force promoting botanical illustration although he still had many pupils—mainly young ladies; of these some, however, later achieved fame. The elegant productions of this period are usually botanically and artistically of little importance, the principal exception being the justly famous *Choix des plus belles fleurs*¹⁵, published in 36 parts from 1827 to 1833. Redouté is still at his best here, but it is already clear from the title that elegance had become an economic necessity. His debts were always greater than his takings and he was in continuous financial trouble. After the *Choix*, he gave in more and more to popular taste and produced books which he hoped would sell easily, since he lacked great patrons.

He still had his associations with royalty: the famous Marie-Caroline, Duchesse de Berry—for Redouté in many ways the real successor to Joséphine—frequently visited him and engineered the sale of the originals of *Les Roses*. It was to her that the well-known *Album de Redouté* of 1824 was dedicated, a book which contained some of the best plates from *Les Plantes grasses*, *Les Liliacées*, the *Jardin de la Malmaison*, and *Les Roses*. A facsimile reproduction

of 25 of its plates (original copies have from 24 to 30 plates) was issued in 1954 (see *Sitwell* and *Madol*). It is through this splendid facsimile that Redouté's best work has found its widest recent dissemination. Later there was Marie-Amélie of Orléans, the fifth and last of Redouté's royal patrons named Marie (Marie-Antoinette, Marie-Josèphe or Joséphine, Marie-Louise, Marie-Caroline, Marie-Amélie); but Redouté's fame was no longer what it had been. During the last ten years of his life he witnessed the coming of the technique of lithography which completely replaced his own more individual method of color printing by means of stipple-engraving and touching up by hand. This was a tragic time for Redouté. The early lithographs were still crude and glossy and never a match for the delicate products of Redouté's method. However, the technique was definitely cheaper and fitted the revolution in book printing by the increasingly general use of the mechanical press and the improvement of communications, which allowed for a considerable increase in the numbers of copies printed of any publication.

One of Redouté's last original publications was the *Choix de soixante roses* of 1836. The book contains an introduction by a well-known writer of those days, a man who also paid a perceptive tribute to Redouté after the latter's death on 20 June 1840. He said that by means of his water-colors Redouté gave flowers "an unexpected immortality; he achieved those precise shades, firm and velvety, whose secret he shared with nature; he was like the honey-bee: he had an instinct for beautiful flowers . . . He composed a bouquet with the intelligence and the happiness of a young girl at her first ball; and yet he created those delicate masterpieces with thick hands which resembled the feet of some antediluvian animal."

Notes

1. This paper is based in part on *Redouté: Peintre de fleurs* (*Staflou*, 1963b). Some phrases from that article are repeated here without further reference. I am grateful to Dr. H. W. Rickett for his linguistic and editorial help.

2. Saint-Hubert was then part of Belgium. The house in which Redouté was born was destroyed on 26 December 1944 during the Ardennes offensive. A photograph of the ruins is given by G. Hoyois in his *L'Ardenne dans la tourmente*, (Marcinelle, n.d.). I am grateful to M. André Lawalrée for drawing my attention to these additions and corrections to my 1963 article on Redouté. For further details on Redouté and Saint-Hubert see Delcourt, Lawalrée, et al. (1964).

3. C.-L. L'Héritier de Brutelle, *Stirpes novae aut minus cognitae*. Paris 1784-1785 [publ. 1785-1791]. Broadsheet, 91 line engravings of which 54 are of drawings by Redouté. The plates are numbered I-LXXXIV with the additional numbers VII β , XXX β , LXX bis, LIII bis, LVI bis, LVII bis, LIX β . The book was published in six parts, of which the dates on the title-pages do not correspond with the actual dates of issue (see *Rickett and Staflou* 1961, *Stevenson* 1961, *Staflou* 1963a and b).

The sixth part was published, after a long delay in 1791. Before that date L'Héritier had provided proofs or incomplete copies to some of his colleagues in order to enable them to quote from the forthcoming part.

The plates in the published part are of drawings by the following artists: Redouté (54), Fréret (25), Fossier (4), Bruguière (2), Jossigny (2), Aubriet (1), Prévost (1), Sowerby (1). One plate (59 β) is anonymous: judging from the style the drawing was probably made by Fréret.

Copies of the *Stirpes novae* with more than 91 plates contain unpublished plates which were either sent out as proofs or preprints without text by L'Héritier, or which stem from the 1805 sale of unpublished plates from L'Héritier's estate. A copy with more than 40 unpublished plates is described by Woodward (1910).

An extensive study of the *Stirpes novae* was published since the present account was written: G. Bochheim, "A bibliographical account of L'Héritier's 'Stirpes novae'", *Huntia* 2:29-58, 1965.

4. *Mémoire sur un nouveau genre de plantes appelé Redoutea* par Ch. Louis L'Héritier, unpublished manuscript at the Laboratoire de Phanérogamie, Muséum national d'histoire naturelle, Paris.

5. A.-P. de Candolle acquired L'Héritier's manuscripts and herbarium in 1805 from the publisher Garnery on condition that he would edit the final parts of the *Stirpes novae*. De Candolle, partly because of Garnery's laxity in later years, did little else but prepare the seventh and eighth parts, which, however, still remained unpublished (see *de Candolle* 1862, p. 121).

6. I am grateful to Mr. John Brindle of the Hunt Botanical Library for his description (by letter) of the plates of the HBL copy. See also *Van Schaack* 1959 for the description of a similar copy at the Missouri Botanical Garden. Dunthorne mentions also a copy with engravings colored by hand with opaque color. The colored plates of the University of Kansas Library copy are the numbers I-VII, VII β , VIII-LII, LII bis, LIII, LIII bis, LIV-LVI, LVI bis, LVII, LVII bis, LVIII-LIX, LIX β , LX-LXIV; it lacks XXX β and LXV-LXXXIV. The black and white plates are complete.

7. C.-L. L'Héritier de Brutelle, *Sertum anglicum*. Paris, 1788 [publ. 1789-1792] Broadsheet, 35 line engravings of which 22 are of drawings by Redouté, 10 by Sowerby, 2 by Bruguière, and 1 by Pernotin. For full details see the facsimile edition, Pittsburgh 1963, with introductory articles by Blunt (1963), Gilmour *et al.*, and Stafleu (1963c). Three more originals are now known to exist (see Lawalrée in *Delcourt, Lawalrée, et al.* pp. 21-22; these two are wash-drawings with details in color. They are now in the Wittert collection at the Liège University Library: two are by Redouté (*pl.* 11 and 12), the third is the only drawing by Pernotin (*pl.* 14).

8. A.-P. de Candolle and P.-J. Redouté, *Plantarum historia succulentarum. Histoire des plantes grasses*. Paris, An VII [publ. 1799-1832] Folio and quarto. The number of plates varies up to 187; four unpublished plates are known from a copy in the Kew library. For further details see *Rowley* (1956-57), *Lawalrée* (1962) and *MacPhail* (1963). Most of the originals for the *Plantes grasses* are at the Bibliothèque centrale, Muséum national d'histoire naturelle, Paris. This collection is bound in four volumes which contain 156 original water-colors of published plates, on vellum, 310 \times 220 mm. In addition there is a volume with 24 unpublished plates by Redouté. Several of the unpublished plates are annotated: "à supprimer".

The history of the publication of the last three fascicles (29-31) can be learned, in part, from the unpublished letters from Guillemain de Candolle of the years 1829-1832, now at the Conservatoire Botanique, Genève. The plates for fascicles 29 and 30 were printed in 1829 and 1830, but not distributed (letter 25 Nov. 1830). Part of the accompanying text was printed but not distributed in 1830; the full text was finally printed only after 23 June 1831. It is probable that distribution did not take place before 1832.

9. E.-P. Ventenat, *Jardin de la Malmaison*, 2 vols. Paris, An XI-1803 [1803-1805]. Folio, 120 numbered plates which are colored stipple engravings of plants painted by Redouté. Published in 20 parts. See *Stearn* (1939) and *MacPhail* (1963, p. 47).

10. P.-J. Redouté, *Les Liliacées*, 8 vols. Paris, An X-1802-1808 [1802-1816]. Folio, 486 numbered stipple engravings (and 8 asterisked extra plates) of plants painted by Redouté. Published in 80 parts (*Woodward* 1905, *Stearn* 1946). The text of volumes 1-4 was written by A.-P. de Candolle (see *de Candolle* 1862, p. 497), that of volumes 5-6 by François de la Roche, and that of volumes 7-8 by Alire Raffeneau-Delile. This attribution of the text of volumes 5-8 derives from Pritzel, *Thesaurus* no. 7453; the text gives no indication.

11. A.-J.G. Bonpland, *Description des plantes rares cultivées à Malmaison et à Navarre*. Paris, 1813 [1812-1817]. Folio, 64 numbered plates which are stipple engravings, color printed and finished by hand; 52 from paintings by Redouté, 11 by P. Bessa, 1 unsigned. For dates of publication see *Stearn* (1942), for accounts of Bonpland at Malmaison see *Sarton* (1943) and *Bouvier* (1950). For an account of the Navarre garden by Joséphine's cellarman see *Brouwet* (1926).

12. P.-J. Redouté, *Les Roses*, 3 vols. Paris, 1817-1824. Folio, 169 unnumbered stipple engravings. Text by C.-A. Thory. Published in 30 parts, see *Woodward* (1905). A second edition was issued in octavo, in 40 parts between 1824 and 1826. The third edition, also octavo, was issued in eight single and eleven double parts between 1828 and 1830. The third edition contains a new *Traité du Rosier* by C.-A. Thory. See *MacPhail* (1963), pp. 57, 60-61.

13. See *Lawalrée* (1963): letters from Redouté to Thory. Thory was an amateur botanist who at the time of *Les Roses* earned his living as a civil servant ('adjoint au maire du premier arrondissement', Paris).

14. Listed in the Redouté bibliographies of *Madol* (1954) and *MacPhail* (1963). *MacPhail* mentions 63 items.

15. P.-J. Redouté, *Choix des plus belles fleurs prises dans différentes familles du Règne végétal . . . gravées, imprimées en couleur et retouchées au pinceau avec un soin qui doit répondre de leur perfection*. Paris, 1829. [1827-1833]. Folio and quarto editions, 144 unnumbered stipple engravings. The few folio copies were printed on extra large paper and finished (*retouchées au pinceau*) by Redouté himself. The number of folio copies prepared is uncertain, see *Dunthorne* (1938) and *MacPhail* (1963). For dates of publication and contents of the 36 parts see *Woodward* (1905) and also *Revue bibliogr. Pays Bas* vols 6-9, 1827-1830. The folio and quarto editions were published simultaneously.

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The Founding of Peale's Museum

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When we call to mind the great moments in the development of natural history, we like to think of naturalists in the field: of Aristotle studying the behavior of the cuttlefish in the clear Mediterranean waters, of Linnaeus setting out for Lapland in his picturesque costume, of Darwin seated astride a Galapagos turtle or digging fossil bones out of the soil of the pampas. On second thought, however, we realize that much of the work of the naturalist has taken place in the study, in the herbarium, in the museum. How could Buffon, the Jussieus, Cuvier, and Lamarck have achieved what they did without the Jardin des Plantes and the Museum of Natural History? And what would British naturalists have done without the Linnaean collections, Kew Gardens, and the British Museum? Institutions as well as geniuses are requisite for the progress of science.

In the United States the first substantial institution devoted to the cause of natural history was Peale's Museum in Philadelphia. For more than a quarter of a century it displayed a handsome, scientifically arranged collection of animals from all parts of the world, including a splendid array of birds and the first mastodon skeleton ever exhumed and mounted. Incidentally, it also contained a gallery of excellent portraits of Revolutionary War heroes, American statesmen, and distinguished men of science.

This Museum was the singlehanded creation of Charles Willson Peale, portrait painter and amateur naturalist. Peale had begun life in humble circumstances. Apprenticed to a saddler, he discovered early in life that he possessed considerable talent for drawing and that money could be made by portrait painting. He managed to get to London for a brief period of study, returned to America and fought in the Revolutionary War, tried his hand at Pennsylvania politics for a short time thereafter, and then settled down to portrait painting, displaying his wares in a sky-lighted gallery adjoining his house at Third and Lombard Streets in Philadelphia.

One summer day in 1784, a Hessian officer brought Peale a small collection of mastodon bones belonging to Dr. John Morgan and requested Peale to make sketches of them. These bones caught the eye of Peale's brother-in-law, Colonel Nathaniel Ramsay, who suggested that there were many people, like himself, "who would prefer seeing such articles of curiosity than any paintings whatever." About this time Professor Robert Patterson of the

University of Pennsylvania gave Peale a paddlefish caught in the Allegheny River, and Peale began to entertain the idea of building up a natural history collection in connection with his portrait gallery. The idea appealed to him for many reasons. Portrait painting furnished but precarious support for his large and growing family. Besides this, Peale was a man of many projects and of great zeal for human welfare. When an idea struck him that promised to redound to the public good, he could not rest until he had put it into execution, whether it concerned a natural history museum, improvements in dentistry, better farming methods, the construction of a polygraph, or the invention of a better stove. He had, moreover, a genuine interest in nature, and his practical ingenuity was challenged by the problems involved in creating a museum. Having lost an Angora cat, a present from Franklin, through inadequate knowledge of taxidermy, Peale began to experiment with ways of preserving animals. Spirits of turpentine proved damaging to the plumage of his birds. He then tried an arsenic solution. It was hard on Peale's hands and lungs, but it kept the insects away. The motives that inspired him amid these difficulties are recounted by Peale in his own individual style and orthography:

The many difficulties he had encountered in this new business, had made him often repent that he had began so arduous a task, yet by great diligence he hoped that he would get a museum in such order and perfection that in the end, it might become a benefit to him, if he should live to be old, also of consequence to his children, yet the same application and a sufficiency of Portrait painting might very probably have produced him more wealth. But the idea of handing down to posterity a work [which] if judiciously managed might become equal to any undertaking of the like kind in Europe—this was a stimulus to exertion The Portrait business was the chief resorse of the maintainance of his family, as the exhibition of the Museum and picture Gallery made very little aid in pecuniary matters, and it might be wondered how an individual could have succeeded to amass such a number of articles in so many departments of natural history to furnish a Museum, intended to diffuse a general knowledge of the wonderfull works of creation, but the gratification which every new object produced in the mind of an enthusiastic man is all powerful.

If Peale was to have a museum of natural history, he must have collections. Here again he was on his own; he must be his own collector.

Every year, especially in the spring when the birds were in their finest plumage, Peale sallied forth to collect specimens, some to be added to his own exhibits, others to be used in foreign exchange. These trips were usually combined with visits to his wife's relatives in New York or to his daughter and her family in Baltimore. In 1795, while visiting in Baltimore, he made the acquaintance of a Reverend Mr. Kirtz, an enthusiastic collector of beetles. Peale had done something already with butterflies and moths, but he had never collected beetles. Now, under the tutelage of his reverend acquaintance, he learned to look for beetles under stones, rags, dung and carrion and for other insects in the flowers and small bushes along the meadows. Midday was the best time for collecting. It was hot, uncomfortable work, but Peale's enthusiasm did not flag, even though he had no insect net. He describes his difficulties in catching a small fly with a forceps!

In 1798, Peale and his family made one of their many trips to New York to visit Mrs. Peale's relatives, the De Peysters and the Staggs, who were engaged in commerce there. Peale's summary of the events of this trip gives an idea of his tremendous energy and activity:

Arriving in New York he assists Major Stagg in putting his store in order, and finished the portrait of Mr. Stagg Sr., also a portrait of Mr. Abraham De Peyster brother of Mrs. Peale, the picture for her. Peale finished 6 fire-places in the Alms-House [of his own design], and gave orders to the blacksmith to make the work for 40 fire-places ordered by the Corporation [of the City of New York], and having been absent from home five months besides doing the fire-places and one for Mr. William De Peyster and painted 14 portraits and 5 miniatures, preserved near 30 animals of different sorts besides his labours with the sick [his son Titian died on this trip], he leaves New York with saying that he has not been a lazy man.

On the return trip he took with him an entomologist named Fenton, whom he had met at Baker's Museum in New York. Largely self-taught, Fenton was an excellent mechanic and optician, very useful to Peale in arranging the entomological collections at the Museum and in making microscopes for the use of Museum patrons. Peale also took back with him a good many specimens of fish he had collected at the New York fish market, where a much greater variety could be obtained than in Philadelphia.

Peale's most famous and scientifically productive collecting trip was his expedition to Orange and Ulster counties in New York in 1801 in search of a complete skeleton of the "mammoth," the giant incognitum whose

remains had been turning up in various parts of North America since the days of Cotton Mather. The story of this expedition has been told too often to bear repeating here and has been immortalized in Peale's own painting "Exhuming the Mastodon." Suffice it to say that Peale displayed in this enterprise the same enthusiasm, tenacity, and ingenuity that characterized all of his endeavors. He was rewarded with two nearly complete skeletons of the mastodon, one of which was mounted and exhibited in a special room in Peale's Museum, where it excited as much popular as it did scientific curiosity. The other was exhibited in London by Rembrandt and Rubens Peale, after which it was displayed in the coastal cities of the United States as far south as Savannah before coming to rest in Rembrandt Peale's museum in Baltimore. Drawings and casts of the mastodon skeleton, as well as a verbal description by Rembrandt Peale, reached the great comparative anatomist Georges Cuvier in Paris. In 1806 Cuvier described *le grand mastodonte* at length, giving full credit to the Peales for their contribution to the founding of vertebrate paleontology.

Peale also augmented his collections by foreign exchange. Duplicates of birds were sent to the Museum of Natural History in Paris, to the Royal Academy at Stockholm, and to various provincial societies in Europe. Paris and Stockholm sent specimens in exchange, although this commerce was interrupted by the Napoleonic wars. In London, Peale obtained many valuable specimens from a commercial dealer, Mr. John Hall. Peale complained of the high exchange rate exacted by Hall, but he could not resist the opportunity to obtain a specimen of *Menura superba*, one of the Australian lyrebirds, and of the platypus, "a Quadruped with a ducklike bill from New Holland."

As Peale's collection grew, he felt the need to expand into larger quarters. In the summer of 1794 he made arrangements to rent the unfinished rooms of Philosophical Hall, the premises of the American Philosophical Society next to the State House (now Independence Hall). Apparently there was considerable unused space, for Peale moved his whole family as well as his museum into the new quarters. It was no simple task to transport the museum specimens to the new location, but Peale solved the problem with typical ingenuity. He tells the story himself:

... he hired men to go with the hand barrows, but to take the advantage of public curiosity he contrived to make a very considerable parade of the articles, especially those which was large, and as Boys generally are fond of parade, he collected all the boys of the neighborhood and he began a range of them at the head of which was carried on men's

shoulders the American Buffalo, then followed the Panthers, Tyger Catts and a long string of Animals of smaller size carried by the boys. The parade from Lombard to the Hall brought all the Inhabitants to their doors and windows to see the cavalcade.

Once established in Philosophical Hall, Peale secured permission from the Governor of Pennsylvania to fence in part of the State House grounds as a yard for living animals. These were young animals that Peale was keeping until they were full grown and ready to be stuffed and mounted for display in the Museum. The menagerie included a bald eagle, kept at the top of Philosophical Hall in a cage with "Feed me daily 100 years" emblazoned on it in letters of gold. There was also a female elk, staked in an open space outside the yard. When the elk got loose one day, Peale went out with a rope and halter and threw the halter over the elk's neck. The elk bolted, the rope jammed in Peale's pocket, and Peale was thrown to the ground and dragged thirty or forty feet before his coat tore loose. It was a narrow escape.

Amidst these adventures, Peale was bending every effort to make his museum a useful scientific and cultural institution. The exhibits were arranged in Linnaean order, each tagged with a number referring to a gilt-framed catalogue giving the Linnaean and common names of all the specimens. The French naturalist Palisot de Beauvois was engaged to prepare a catalogue of the Museum for publication, but this project had to be abandoned for lack of money. Meanwhile Peale was busy preparing a course of lectures on natural history, delivered in the winter of 1799 to "a small class of very respectable citizens." There was more natural theology than natural history in these lectures, in keeping with Peale's conviction that the study of nature should reveal the Creator's power and wisdom manifested in His works. "Was our ministers of the gospel more frequently to illustrate the goodness of the Almighty in the provisions he has made for the happiness of all his creatures," Peale wrote, "that excellent code of christianity would produce more votaries of charity, love, and forbearance."

In 1801 Peale's literary labors were brought to an end by the expedition to dig for mammoth bones. A year later the Pennsylvania legislature voted to allow Peale the use of the State House free of rent. Peale lost no time in moving his exhibits into these more spacious quarters. From that time until 1816, when the State House was deeded to the City of Philadelphia by the state legislature, the Museum enjoyed a high prosperity. People came in great numbers to see the "mammoth" skeleton, the splendid collection of

birds, the portrait gallery, and the other exhibits. For those curious about natural philosophy there were lectures on electricity and magnetism, with experimental demonstrations. In the evening there were musical concerts. Peale himself describes the attractions of his Museum in a brochure entitled *A Walk with a Friend Through the Museum*. He takes us in through the front door, inscribed "Museum, Great School of Nature," and up the great stair to the turnstile, where a chime of bells gives notice of the arrival of visitors. After paying twenty-five cents for admission, we pass through the lobby, where our guide points out a large machine for generating static electricity, "the subtle fluid so actively associated with Life, matter & motion." This machine, Peale tells us, is "frequently resorted to by Professional advice, in various complaints."

The first display room, forty feet in length, is devoted to quadrupeds, exhibited in lifelike poses against naturalistic backgrounds. "The Lama of South America is rearing up, in the act of spitting through the fissure of his upper lip, which he used to do when he was alive in the Museum." The orang outang stands "erect and holding a staff in its right hand." Then come the baboons and monkeys. "That Rib-nosed Baboon was alive at the Museum several years—his sagacity in drawing fruit that was thrown to him, if out of reach of his hands, by making use of a stick (which if he found too short, he would change for another), plainly demonstrates that he was not devoid of reflection." Next in line are the sloth, the anteater, and the armadillo, followed by the order *Ferae*, including the grizzly bear, a raccon, and a badger presented to the Museum by President Jefferson. Lastly we see the opossum, mole, shrew, hedgehog, porcupine, cavy, and the American buffalo—"but alas! they are destroyed wantonly! and, in a little while must be extinct."

From the quadrupeds Peale escorts us to the Long Room, his pride and joy, stretching the length of the building. Along the inside wall are ranged the cases of birds, with two rows of portraits above them. Opposite the bird cages are nine windows divided by partitions holding cases of insects, minerals, and fossils. Over the center window is a "neat and welltoned" organ for the use of "such Visitors as understand Musick." There are also microscopes for exhibiting small insects and, at the lower end of the Room, a physiognotrace for making profiles of visitors. At that end also is a painting of a flight of stairs, showing Raphaele and Titian Peale descending in so lifelike a manner that we imagine they are actually entering the room. Finally, on the payment of an additional fifty cents, Peale takes us to another building to see the skeleton of the mastodon and various models, wax

statues, and the like. The tour is finished. Our aged guide, now nearly seventy, is obviously proud of his museum, and justly so.

From the outset of his labors, Peale had hoped that the Museum would eventually become a public institution equipped with library, experimental rooms, and lecture halls. At various times he made overtures to the Federal Government, to the State of Pennsylvania, and to the City of Philadelphia to assume sponsorship of the Museum, but his efforts were unavailing. If he had been willing to donate the Museum outright to some government, perhaps his offer would have been accepted. But the Museum was a very profitable enterprise, and Peale was reluctant to divest himself and his otherwise impecunious family of their financial interest in the Museum. After 1816 the Peales were charged rent for the use of the State House, other museums sprang up in competition, standards were lowered, and the Museum gradually ceased to be a useful scientific institution.

Peale died in 1827 without having achieved his ultimate goal. But his labors had not been in vain. In exhuming and exhibiting the first skeletons of the mastodon he had made a signal contribution to paleontology. In creating and maintaining a scientifically respectable museum of natural history in one of the nation's leading cultural centers he had served the interests not only of science but of his fellow citizens as well.

Note

The foregoing account of the rise of Peale's Museum is based on the Peale manuscripts at the Historical Society of Pennsylvania and in the Library of the American Philosophical Society at Philadelphia, which the author was enabled to consult by research grants from the American Philosophical Society and the National Science Foundation. For a general account of Peale's life and work, see Charles Coleman Sellers, *Charles Willson Peale*, 2 vols. (Philadelphia: American Philosophical Society, 1947).

Early American Botany and its Sources

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When I first approached the task of outlining the “broad and specific areas” which require “immediate attention on the part of bibliographers,” I was momentarily taken aback. It was dismaying to think of the immensity of material falling within these boundaries, and it soon became apparent that, if bibliographical justice were to be done—and that is the *ratio essendi* of the Conference—severe restrictions, either chronological or topical, would be necessary.

With this necessity in mind, I have restricted myself to a consideration of American botany from its beginnings to the Civil War. Even within this limited period, the primary source material amounts to several hundred items and the secondary literature is three times that figure. On this basis alone, completeness cannot be expected, nor is it intended. Rather, it is my purpose to call attention to some of the available material bearing on the history of American botany. In order to present this material (all of which ultimately subserves a bibliography of the history of early American botany) in as compendious and palatable a form as possible, I have divided it into sections. The sectional headings represent some of the traditional areas of research in the history of botany, and in order to show how they relate to the history of American botany, I have cited representative studies for most of the main points. It must be emphasized that the following aims at comprehensive coverage rather than bibliographical completeness. For this reason, I have felt justified in mentioning, here and there, what Whitfield Bell neatly termed “needs and opportunities.”

Bibliography

Before the history of American botany can be written, the raw materials must be collected and, at the very least, provisionally analyzed and classified. Ideally, this means much more than an enumerative bibliography. At present, however, no existing study satisfies these requirements. There have been, to be sure, studies touching upon one or another phase of American botany, but the material is widely scattered over many reference books and monographs, while the secondary literature increases with each passing year and only the major libraries can succeed in keeping abreast of the new periodicals.

It may be worthwhile, before we begin to examine the bibliographical resources, to record some of the attempts at a history of American botany. Once the historical bases are established, a context is furnished for a more systematic approach to specialized subjects and lacunae can more easily be repaired.

The most useful starting point for a study of the early period of American botany is a short sketch by William Darlington entitled "Progress of Botany in North America".¹ In many respects it is outdated, and the combination of incompleteness and imprecise citation make caution mandatory. But for all its shortcomings it marked the start of American botanical historiography.² Darlington lived to witness the momentous changes that occurred between the 1820's and the 1860's. If the contemporary botanist showed little inclination to investigate the history of his own discipline, the spirit of historical scholarship was becoming firmly entrenched in the academic world and the material for future historians was steadily accumulating.³

There is, as if to compensate for the failure of Darlington's successors to take up the subject where he left off, a wide range of later studies devoted to one or other of the many facets reflecting the growth of natural history and the biological sciences.⁴ These studies form a mixed lot comprising bibliographies, biographies, historical and literary accounts, dictionaries and the like. Short of ploughing through them all there is no way of determining in advance what one will find. Many an important lead has been stumbled upon accidentally while in search of other, perhaps unrelated material.

Numerous recent studies of the history of science in colonial times provide not only precious bibliographical material but supply evidence of the problems engaging our ancestors' minds—and some worthy of renewed study today.⁵

Several older botanical bibliographies are still invaluable. Certainly one cannot safely maintain that the contents of older bibliographies have been absorbed by later ones. Among current activities, special mention must be made of the *Bibliographia Huntiana*, now in preparation under the overall direction of G. H. M. Lawrence. It is intended to constitute nothing less than "a comprehensive and analytical catalogue of all works in systematic botany and allied subjects published during the period 1735-1850".⁷

Until such time as the *Bibliographia Huntiana* is available, the historian of American botany must search the many possible repositories of relevant information. Some of these will be mentioned below.

It is well-known that several of our early botanists, such as Bartram and Marshall, carried on a sizeable correspondence over a period of years with

leading European naturalists and botanists.⁸ A good portion of this material is now available and it, no less than the domestic correspondence, must be examined in order to understand the multifarious botanical activity of the eighteenth century.⁹ Scholars have long been in the habit of referring to J. E. Smith's collection of Linnaeus' correspondence, but other European printed sources have not been as fully utilized.¹⁰

The increase in botanical publications in America from 1830 onwards, both quantitative and qualitative, is one of the effects of the expansion of education and the professionalism fostered by local and state societies. In the founding years of our country the societies were identified with scientific activity. By providing a means of publication, the societies were responsible for the communication of botanical research and news items far beyond the city or state nominally supporting them. News and plants were exchanged, not only among the colonists but with European botanists as well. Yet the relation between such institutions and the botanically-oriented segment of their membership requires continual examination in the light of new discoveries.¹¹

While every historian of colonial science knows the *Philosophical Transactions of the Royal Society*, the role of this publication in the diffusion of botanical knowledge has received only indirect attention.¹² Even less is known of other European societies and publications which from time to time printed reports of new species or matters of historical import.¹³

Following the European serial publications, we come to the least studied of all the sources of early American botany. I refer to our domestic serial publications which, because of their frequently short-lived nature, can easily be overlooked and are usually difficult to find in profusion in any but the greatest libraries. Twenty-five of these journals have been analyzed by Meisel, but there probably exists an equal number which remains, forgotten and dusty, on the shelves of lesser known libraries. An important serial such as *The American Journal of Science and Arts*, better known as Silliman's *Journal*, after its founder and editor, has been the subject of a special study.¹⁴ But this same coverage must be extended to other serial publications before the bibliography can pretend to completeness.

Checklist of Botanists

Just as a reasonably complete bibliography is lacking, so too is a checklist of the botanists working in the United States before 1860. Naturally there will be some correlation between the names in the checklist and in the bibliography, but it is of the greatest importance to call attention to the

men and women who contributed in ways other than literary. Before a biographical account of American botany can be compiled, a checklist must be in hand. Only by this means, for instance, can the nearly-anonymous collector be placed in proper relation with the botanist who later described and published the specimens. Even a cursory review of the literature will reveal the names of many contributors who are not mentioned in any of those few accounts specifically devoted to the history of American botany. As an illustration there follow the names of a few persons each of whom has been credited with contributing to American botany: Joseph Barratt, William Douglass, William Downey, John Eberle, and Stephen Williams. Not even one of these—and the many others whose names could be added—contributed in a major way to the scientific inheritance of a later day, but each shared in the quickening of botanical activity, and for that reason merits inclusion in the checklist.

In addition to native Americans, many Europeans should also appear in the checklist. Some were avid collectors who published their own accounts abroad,¹⁶ while others merely supplied specimens for publication.¹⁶ Not all botanists who published on American flora visited the United States, but their publications or their correspondence with American botanists yet earns them a place in the checklist.¹⁷ As we shall see below, the name of many a traveller and botanical explorer will also appear in the checklist, despite the fact that it may often be better known to historians than to botanists.

Biobibliography

There exist several substantial studies of a biobibliographical nature in addition to the numerous biographical accounts,¹⁸ but the fact remains that the sources are widely scattered and vary in reliability and completeness.¹⁹

One study calls for special attention. Not only is Harshberger's *Botanists of Philadelphia* the best study of its kind for the botanical activity associated with the scientific capital of colonial America, but it could serve as a paradigm for comparable studies of other regions.²⁰

That more studies like Harshberger's are needed should be clear to anyone who has gone to the *Dictionary of American Biography* in search of data, only to come away empty-handed.²¹ One can scarcely expect all the botanists to be included in the *D.A.B.*, but if not there, where can one turn?²²

There exists ample material for biobibliographical studies, and much can be accomplished within the confines of a fifteen to twenty page journal article.²³ Larger studies, such as those by Baker,²⁴ Fagin,²⁵ McAllister,²⁶ and

Weiss and Ziegler,²⁷ and the more ambitious series by A. D. Rodgers indicate the range that can be covered and, by their omissions, what future authors must strive to include.²⁸ Recent studies, such as those by Davis,²⁹ and Dupree³⁰ call attention to the need for relating the scientific aspect of the botanist's work to the wider social milieu. The Berkeleys' recently-published study of John Clayton deserves special mention as an example of how a biographical study leads to the unearthing of new documents that future historians and biographers will undoubtedly use.³¹

Biographies and bibliographies should go together, but this is by no means always the case. In order to assess properly the contributions of a man who has published scores of papers, it is essential to have an accurate and complete bibliography. George Engelmann is a case in point: he richly deserves study. In his case, a bibliography of his 112 published papers and books is available, and his correspondence, scrapbooks, notebooks and annotated herbarium are still preserved at the Missouri Botanical Garden. Other botanists have not been so fortunate. Gray wrote a necrology of Élie Durand but no biobibliographical account has been published and a list (complete?) of his publications is spread out over three volumes of the Royal Society's *Catalogue of Scientific Papers*.³²

Related to the biobibliography, indeed essential in many cases and an exciting chase in some others, is the location of rarissima and unica. A census of really rare items should always accompany biobibliographical studies.³³ It is not entirely impractical to consider the preparation of a census of botanica¹ books and pamphlets of which five copies or less are known. The only known copy of Rafinesque's *American Florist* (1817) is one of the treasures of Yale University, while one must be prepared to visit Paris in order to examine the only recorded copy of the 1814 edition of the catalogue of the Bartram Garden.

No library is known to possess one of the rarest pieces of Americana—Martha Daniel Logan's *Gardener's Kalendar or A Treatise on Gardening*. The very uncertainty regarding the title is a measure of its rarity.³⁴ Of course the possibility always exists that such an item as this is a ghost. But ghost-laying, like other bibliographical sports, can be useful even while being fun. A little book, at least twice ascribed to Cadwallader Colden, has recently turned out to be such a ghost.³⁵

Manuscripts

From rarissima, unica, and ghosts, let us return to the more substantial but hardly less challenging domain of manuscripts. Like printed books, they

are no respecters of political boundaries, and one must be prepared to visit many libraries here and abroad. Letters from Alexander Garden of Charleston to Charles Alston are in Edinburgh;³⁶ Petiver's letters are in the British Museum (Natural History);³⁷ and it has been suggested that material relating to one or both of the Michaux probably can be found in France.³⁸

Last year, one of the most interesting of American botanical manuscripts was published, some two centuries after it was written. Travelling to Germany in the baggage of a Hessian surgeon, then to England and to Sir Joseph Banks' private library, Jane Colden's descriptions and drawings of plants native to New York finally returned to America, albeit in facsimile form!³⁹

There remains, however, much further work that can be done, both in editing registered manuscripts and in the search for the unknown. Paul Dudley's essay "A Description of the Evergreens of New-England", cited by Gronovius as one of his sources, still remains unedited, according to Hindle.⁴⁰ That new manuscripts are continually coming to light is attested by Pace's recent report of two hitherto unknown letters by the colonial physician John Morgan.⁴¹ One of these letters is of particular relevance in that Morgan recommends Domenico Cirillo, a well-known Italian botanist, for membership in the American Philosophical Society. The next step is for some scholars to examine Cirillo's published writings and to locate any manuscript remains in the hopes of continuing a little known Italo-American contact.

The role played by the American Philosophical Society in stimulating scientific activity cannot be overemphasized. In the last decades of the eighteenth century and on into the early years of the nineteenth century, the Society was the headquarters for the botanists of Philadelphia and its environs, yet its influence was national. To this day, the libraries of Philadelphia with their unparalleled manuscript treasures occupy a central position in the annals of American botany. The list of botanists who are represented by manuscripts reads like a *Who's Who* of American botany: John and William Bartram, John Bordley, Mark Catesby, Amos Eaton, James Logan, John Mitchell, Gotthilf Muhlenberg, Constantine Rafinesque, and many lesser lights. Philadelphia is not alone in possessing important unpublished material as recent studies reveal.⁴²

In addition to unpublished correspondence and other texts, much of illustrative material and unpublished drawings awaits editing. A notable step has recently been taken in this direction with the announced publication of the drawings of John White.⁴³ These drawings, many of them never before published, were made during the years 1577-1590 and are almost

certainly the earliest illustrations of American plants. Mystery surrounds the whereabouts of other illustrative material. We would like to know, for instance, the fate of a 45-page notebook written by Auguste Trécul entitled "Structure et développement du Nuphar Lutea" and illustrated with drawings of plants in pencil as well as in color.⁴⁴ If the manuscript still survives it is a well-guarded secret, for the latest research on Trécul makes no mention of it.⁴⁵ Other illustrative materials have long been located and await only their editors.⁴⁶

Herbaria

From manuscripts to herbaria is but a short step, for both, in the language of the botanist, may fairly be described as *exsiccatæ*. Although not usually the subject of historians, still less of bibliographers, the location of herbaria and a description of their contents may help to unravel a historical problem.⁴⁷

Despite an occasional reference to herbaria in historical papers, it is the botanist who most frequently uses and cites them. The specimens in the herbarium are to the taxonomist what an inscription is to the epigrapher, and both ultimately will refer back to the data in support of their respective claims. Thus, it is of considerable importance to know the location of those plants collected and identified by our early botanists. In the majority of cases, it is the taxonomist who will examine the specimens in an effort to authenticate a matter of nomenclature or in other cases to add weight to other evidences of priority.⁴⁸

It may be noted in this connection that there is no lack of material or of partisanship to prevent the publication of an American counterpart to Clarke's *First Records of British Flowering Plants*. A book such as this would be of considerable value to the historically-minded botanist and the botanically-trained historian, both of whom are addressed in one of Gray's early papers.⁴⁹

At still another level, herbaria are important for historical investigations. Beginning in Colonial times, botanists such as Clayton, Colden, Kalm, Garden and others instituted the practice of sending specimens to Linnaeus and other European systematics, in some cases for the purpose of identification. This practice reached its peak under the aegis of Gray, who acted as a one-man clearing house in dispatching bundles of specimens to almost all of the leading European taxonomists. The records of Gray's transactions are well-known, but, due to the loss or dispersal of much of the correspondence of the colonial botanists, annotated herbarium specimens may provide the only extant evidence of a collecting trip or of the flow of information across the Atlantic.

Even domestic issues might be resolved by the study of certain specimens over which controversy concerning identification and nomenclature or priority of authorship later arose.⁵⁰ Since many herbaria formed in this country or composed of American plants ended up in European collections, it would be a useful service to index the widely scattered material and to provide succinct descriptions of pertinent data.⁵¹

News Media and Text Books

The information channels of the colonial period resembled those of a century ago more closely than the latter resemble the variety of news media available today. The weekly newspaper, and in some of the larger cities a daily, constituted the primary communication system.⁵² This was supplemented by magazines and the proceedings of academies, societies and the like. The day of the technical, professional and professionalized scientific journal was yet to come. There were journals, to be certain, but the function of communicating scientific news for the scientifically-minded was largely in the hands of magazines and other news media.⁵³

No one involved in American studies need be told of the *North American Review* and its role in the popularization of science and the dissemination of scientific information.⁵⁴ Likewise, the *Atlantic Monthly*, itself the subject of a study by Austin, carried Gray's review of Darwin's *Origin of Species*.⁵⁵ But less well-known are the articles and brief communications which appeared in other magazines and at times in newspapers.⁵⁶ So little known, in fact, that one is hard-pressed to find a better example than two articles which appeared in the *Gentleman's Magazine* for the years 1754 and 1755. Zirkle has demonstrated their importance for eighteenth century American botany and that long gray dawn preceding the final establishment and acceptance of the science of genetics.⁵⁷

Some surprises may be in store upon the completion of studies in a related area. The identification of authors of unsigned and anonymous reviews and pamphlets may shed no little light on the period when the espousal of certain scientific theories meant more than eccentricity.

Only a thin line separates the popularity of news media from that of the text book. When we think of text books today, we think in terms of formal instruction, often at the university level, conducted by a professionally trained scientist who has at his disposal a panoply of laboratory equipment and teaching devices. Things were different in the not too distant past.⁵⁸ In the absence of laboratories and audio-visual gimmicks, and lacking in many cases the guidance of a scientist, botany was bookish. When it was not, it

was only because of the occasional excursion or herbarization.⁵⁹ Yet comparatively little has been written about the text books before 1836, the date of Gray's *Elements of Botany*. An analysis of these books together with what can be learned about where and when they were used, the length of the course, the instructors, etc. would be welcomed by American historians generally.

The text book, more than any other form of science publication, is an index of the level of instruction at a given time and place. As contemporary evidence of the state of science, it is invaluable in providing an insight into the methods and problems, and the sources used. About a dozen books, designed as elementary texts, and with an American imprint before 1836 are recorded.⁶⁰ To these may be added American editions or adaptations of English text books, translations, generally from the German, glossaries and dictionaries, and elementary texts in materia medica.

At still another level are the juvenilia and that once-popular genre of "Botany for Ladies".⁶¹ Though books of this ilk catered as much to moral edification and romantic sentiment as they did to the care of house and stove plants, they represented the popular conceptions and misconceptions of botany to the close of our period.

Since some of the books falling into the aforementioned class were English imports, it is well to consider another subject that has important bearings on the development of American botany. Due, in part no doubt, to the low state of botany as represented by the above books, technical books of the highest caliber were eagerly sought and carefully studied.⁶² As true as this is, and it can be documented in some cases by the presence of contemporaneous marginalia, the entire subject of the availability of European publications and their influence needs to be reviewed. Inventories of libraries, institutional as well as private, sales catalogues, and the miscellaneous jottings on end-papers of older books, help to fill out the picture of what was available at a given time and place and perhaps suggest how it was transmitted.⁶³

From the time of the first settlers, books have been carried to the New World, and colonial correspondence echoes with requests for more books.⁶⁴ Armed with a knowledge of what actually was available, scholars can begin the task of tracing the ideas and influences which helped to shape botanical thought in the New World. Occasionally a passage betrays by its phraseology its European source, but until much more evidence is available it is difficult to validate some of the claims to originality.⁶⁵

Botanic Gardens and Horticulture

No less important than the text book in the educational process was the botanic garden. Bibliographically speaking, we are on more solid ground, for

there exists a sizeable literature.⁶⁶ However, its sheer quantity and the occurrence of much of it in magazines and leaflets of a regional nature make it difficult to assemble for the purpose at hand. Much of it is non-botanical and there is a certain amount of local pride concerning the 'first' botanic garden which can safely be ignored. Rather than enter the fray, let it merely be said, on high authority, that Bartram's garden, reputedly the oldest, "was not so much a botanic garden in the strict sense, not being arranged in a systematic fashion for botanical study, as a garden of acclimatization."⁶⁷

Whatever the final verdict respecting this or another claimant, physic, botanic, and horticultural gardens flourished and multiplied apace. The purposes served by the various gardens, ranging from *materia medica* to sheer aesthetic pleasure, belong to the history of American botany, as do the botanical explorations which, in some instances, subserved them. For it was in these gardens that many rare plants were first grown and thus made available for study or for further propagation.⁶⁸

Physic gardens, with their obvious educational functions, have received some attention, but here as elsewhere there are lacunae. The garden associated with Harvard is well-known,⁶⁹ and several studies have been made of Hosak's garden at Elgin.⁷⁰ But of the garden laid out at Yale College by Eli Ives *ca.* 1813, no trace remains, unless it lies buried in the University Archives or in Ives' unpublished papers. Botany was so long the handmaid of medicine that it is not unreasonable to suppose that other colleges or medical institutions had physic gardens, some of which may have been modeled after famous European gardens, visited by young physicians on the 'Grand Tour'.⁷¹ Then too, there were the physic gardens of the Southern plantations and the kitchen gardens of New England which would bear further examination.⁷²

Famous private gardens have called forth numerous studies.⁷³ William Hamilton's "Woodlands" where some of our now common trees were first planted furnishes a prime example.⁷⁴ This garden will always be remembered, not only for its trees, but for its first full-time director, Frederick Pursh. It was here that he acquired the expertise that was later put to good use in describing and drawing the plants of the Lewis and Clark expedition.⁷⁵ The combination of Pursh and "Woodlands" may be unique, but much could be done for the history of American botany by emphasizing some of the other gardens, with contemporary lists of their plants. We would like to know, for instance, more of the gardens planted outside the stockades, mentioned by the early French travellers. What percentage of plants were raised from seed brought from Europe and what trees, if any, were borrowed from the Indians, perhaps with an eye towards making grafts? Questions

like these can be answered only by detailed studies incorporating the findings of historians of American horticulture and agriculture.

From colonial times onward, gardening has provided diversion for men of affairs. Governors Oglethorpe, Stuyvesant, and Winthrop had their gardens into which they may have retreated.⁷⁶ The *locus classicus* is the garden of Thomas Jefferson, whose description is now readily accessible to all.⁷⁷

Due to the industry of such amateurs as Jefferson and Winthrop, and nurserymen like Lyon and M'Mahon there is a continuous tradition in horticultural practice and in the literature which grew up around the more successful practioners.⁷⁸ Because of this continuity and the number of original documents still available, the history of American horticulture is one of the better explored areas.

But further investigations are required in order to relate this literature to the history of botany. There is, surprisingly, no bibliography which can better that of Bailey's, originally written almost half a century ago.⁷⁹ This in itself is a deterrent to some types of research, while in other areas little seems to have been published. Judging from the number of commercial establishments that have issued seed lists and catalogues, an entire literature remains virtually untouched. To be certain, some of the lists have received attention, but largely for reasons of rarity or for their association with the work of a particular individual. A full-scale study of nursery catalogues is required, incorporating the horticultural, economic and biobibliographical data in such a fashion as to show the relation between the nursery industry and the development of American botany.

One aspect in particular deserves more notice than it has received. A study of some of the seedsmen and orchardists would reveal that they had a more thorough knowledge of the European literature than might be expected. It would be important to know their role in the diffusion of scientific botany. To what extent their writings offset the meagre college training in botany of the early days is problematic. But some interesting results may await critical studies of the contributions of enlightened horticulturalists such as Goodrich, Meehan, Parsons and Pringle.⁸⁰

The practical as well as the theoretical contributions of American horticulturalists call to mind a subject on which woefully little has been accomplished. I refer to botanico-historical studies of those genera or species whose success was destined to alter the economic and cultural patterns of the nation. Despite an unprecedented boom in books treating of the Old South, the Civil War and its aftermath, there is no botanico-historical study of cotton which is acceptable by contemporary standards. It is surprising when one

considers the availability of evidence and the models supplied by similar studies of other economically-important plants.⁸¹ Some of these well-known studies abut on the American scene, but few were written with the present needs in mind.⁸² Distinctively American plants which ought to receive monographic treatment include maize and the sugar maple, while a fascinating study could be devoted to the cactus and the vogue it has enjoyed to this day in European botanical gardens.⁸³

Botanical Exploration

Probably no part of the history of American botany has received more attention than the botanical explorations. From the efforts of the first hardy travellers, the flora of unknown and nearly inaccessible places has become part of the expanding disciplines of taxonomy and phytogeography. Though travelling alone amidst incredible hardships, they created collections and log-books which allow us to retrace, if only vicariously, their routes.⁸⁴ At a slightly later date, collectors were sent out with specific goals in mind, either geographical or systematic in nature. Sometimes they too travelled alone, but at other times they accompanied one of the Federal geological or boundary surveys. There is, happily, no need to discuss this story in detail, for the sources of the history of botanical exploration in America have been masterfully assembled by McKelvey.⁸⁵

However, since McKelvey's study, full as it is, is restricted to the explorations of trained botanists in a circumscribed area, and expressly excludes the reports of travellers and those lacking a scientific training, it may be worth-while to note the virtually unlimited resources for future historians.

Beginning in the late sixteenth century, and perhaps influenced by the attempts of the scholar-naturalists in Europe to break away from the limitations of their classical botanical inheritance, Spanish, French and English travellers enthusiastically reported on the new and unusual plants they encountered.⁸⁶ Because of the enormous variations in these reports and the difficulties of explaining certain passages in the absence of suitable parallels they have usually been excluded from the histories of American botany or relegated to the limbo of an erudite footnote. This does not mean, however, that they can be ignored entirely, for in many cases our earliest evidence derives from the pages of travellers such as Cabeza de Vaca, Cartier, Champlain, De Soto, Harriot, Oviedo, John Smith, and Thevet, all of them in this country prior to 1600, save for Smith who arrived in Virginia in about 1606.⁸⁷

For the purpose of understanding the historical setting of botanical exploration in a specified area, it is desirable to know what information was

available prior to the arrival of the first scientifically-trained observers and collectors. Thus a vast area of research is opened up by investigations concerning, say, the reports of the early visitors to what is now California. This is a timely subject to investigate insofar as the journal of José Martínez, seemingly unknown to McKelvey, has recently been published.⁸⁸ Investigations must continue in other regions too, even those about which we are most fully informed. The names of many of the early botanizers of the South are known and some of their accounts have been published.⁸⁹ But further work can be done in determining their itineraries, locating and analyzing their herbaria, collecting their correspondence or other literary remains and, of course, accumulating the pertinent biobibliographical information.

The travellers and collectors of the eighteenth century are better known, perhaps because they usually wrote in English, perhaps also because their accounts are more accessible. Whatever the reason, botanical gems can still be extracted from their writings: witness Lawson's reference to the Bastard-Spanish oak in 1714. Zirkle has shown this to be an instance of a hybrid between two species of oak which do, in fact, hybridize.⁹⁰ The roughly contemporaneous writings by Burnaby, Coxe, Cutler, Filson and Roman, though occasionally cited by the perspicacious, are far from being exhausted.⁹¹

Naturalization of Exotica

Private gardens imperceptibly merge with nurseries and both are stocked with choice specimens gathered from the impassable reaches of mountain and plain. Naturalized, here or abroad, these plants and trees were collected with avidity, and at times, cupidity.

Since the traffic between America and Europe was a two-way affair, it is necessary to consider both the introduction and naturalization of American plants in Europe and the reception of exotics in America.⁹² The initiative in sending seeds to England and securing English varieties in return was taken by individuals, some of whom did it for scientific purposes and some for profit.⁹³ But whatever the purpose, it is due to the labors of John Bartram more than anyone else that American plants were introduced into England. The gardens of Peter Collinson and Philip Miller, Bartram's principal patrons, Lord Petre, the Duke of Richmond, and others became famous for the collections of American plants.⁹⁴ Because of the correspondence that passed between the members of this set we are well-informed about the introductions and their dates. Our information about introductions in the seventeenth century is comparatively meagre, and widely scattered in the pages of the great folio herbals that Americans have delighted in at all times. From

Gerarde and Parkinson and the less pretentious works of Meager and Rea, supplemented by Miller's later but invaluable *Gardener's Dictionary*, we can form some idea of the Old World setting of New World species.⁹⁵

Being a part of the English *Kulturkreis*, it is not surprising that little attention has been paid to American species naturalized, or at least enduring, in the continental gardens.⁹⁶ European writers have long been studied for their descriptions of New World plants, but little has been done in the way of collecting information about the plants themselves, when they were received, and from whom, the collectors and their patrons.⁹⁷ There is little doubt, however, that the plants or plant-products from the New World formed an important part of the economy and were, in one case at least, directly responsible for grandiose plans on the part of the Spanish Crown.⁹⁸

While New World plants were making their way to Europe, plants indigenous to or long naturalized in Europe were being introduced here. They came in a variety of ways, not all of them purposeful, and some were later to prove themselves unwelcome guests. By the fullest utilization of the sources—herbals and floras, travellers' reports, gardening manuals, correspondence and annotated herbaria—our knowledge of introduced plants can gradually be extended.⁹⁹

The introduction of non-European plants poses special problems of its own and calls for specialized training in disciplines as widely separated as comparative linguistics and archeology. Except for the plants which were introduced by the Spanish from Central or South America, or which actually migrated northward in prehistoric times, no general study is available.¹⁰⁰ Chinese plants were known in England early in the eighteenth century and in France somewhat later.¹⁰¹ But the story of when and how Far Eastern species came directly to this country still has to be told.¹⁰² Since Japan was not opened up until the close of our period, its insular flora cannot be said to have become widely disseminated before the Civil War. As regards plants from tropical Africa and adjacent regions, I know of no relevant studies. Nor does the literature seem to be over-stocked with material relating to the seeds or roots brought by immigrants, yet there can be little doubt that, in an effort to transplant some of the Old Country, plants would have been included in their luggage.

Regional Studies

As McKelvey's book amply demonstrates, the botanical activities of some regions have been more intensively studied than others. Reference has already been made to Harshberger's *Botanists of Philadelphia*, yet equally welcome are

studies by Geiser and Ewan which treat of Texas and the Rocky Mountains respectively.¹⁰³ With such studies as these at the disposal of scholars, it is a wonder that comparable studies have not been devoted to other regions. Boston, the seat of much scientific activity, with its influential societies and a maritime trade, has yet to receive its due.¹⁰⁴ Charleston¹⁰⁵ and St. Louis,¹⁰⁶ on the other hand, provide further examples of focal points where small but active botanical fraternities made contributions disproportionate to their size.

It is not for want of materials that such regions have been less carefully studied than others. The merest glance at many a regional study of non-botanical intent will reveal the existence of pamphlets and leaflets not appearing in any of the standard bibliographies nor in earlier studies devoted to the botany of the area in question. A systematic bibliography, indexed on regional lines, is a desideratum of high order for the historian of American botany.

Further regional studies, following the well-executed plan of Ewan, should integrate the biographical data with the writings of the botanists whose work is identified with the region in question. The Pacific Northwest is an example. While the journals of Douglas, Menzies and Vancouver are readily accessible, as well as some scholarly secondary material, the activities and contributions of other botanists associated with the same area are unknown save to a few.¹⁰⁷

Regional studies also embrace state and local floras. Darlington's sketch, alluded to above, listed most of the state and local floras up to 1849. Though incomplete, it provides a basis for further studies. Among the problems that it might be profitable to examine are the models adopted by the various floras, the taxonomic systems employed, a critical review of the reportedly new species or new stations for recognized species, and an investigation of the herbaria and systematic treatises, if any, consulted by the authors.¹⁰⁸ Some of the floras mentioned by Darlington have received, so far as I can determine, little attention in recent years. But the fact that the older floras are seldom cited raises a series of interesting questions concerning their datedness, real or apparent as the case may be. Some of our more recent floras acknowledge their predecessors in such an elliptical manner as to suggest that from a historical point of view, something may be gained by returning to the pages of Bachman, Curtis, Hitchcock, Walter and others.¹⁰⁹

The authors of some of the early floras are well-known but, as in the case of Barton or Sullivant, their fame depends on other factors. Yet other botanists, whose floras long provided the only reliable guide to a specific region, are virtually unknown despite their many other writings.

Social Dimensions

The fact that I have touched but lightly upon the social, economic and general institutional framework should not be taken to mean that I minimize the relations between botany and society. Far from it, for the history of early American botany would be badly truncated without reference to the societies, museums, universities and other agencies which supported botanical activity.¹¹⁰

Before botany *qua* science became a generally recognized academic discipline, instruction was for the most part in the hands of the tutor or the over-worked factotum at a private school. Research, on the other hand, was prosecuted largely by amateur botanists who were otherwise engaged in carrying out their professional duties as physicians or clergymen.¹¹¹ This combination of educational decentralization was soon to be changed by the convergence of several lines of force.

Mention has been made above of the role of the societies and academies in promoting botanical activity. Fully as important in its long-range consequences was the support of various federal agencies. Jefferson's vision, seen most clearly in the eventful travels of Lewis and Clark, was soon translated into different though related enterprises by which new botanical information was processed. The botanical consequences of the Lewis and Clark expedition have been the subject of many inquiries.¹¹² Following the lead of what was, up to that time, the greatest direct governmental contribution to botany, other federal and state surveys were undertaken in quick succession.¹¹³ Despite several good studies, a large field awaits the student who will assemble and organize the array of material pertaining to governmental interest in botany and who will, moreover, relate that material to the activities of other institutions competing, if not always for funds, at least for their educational prerogatives. This would include, in addition to the several types of federal and state surveys, the museums, the railroad surveys and the various agricultural agencies which, more than once, have taken the initiative in some particular phase of research.¹¹⁴

Passing from governmental interest in botany, to the university, with its explicit educational aims, we find no lack of material, though it is usually scattered and little of it is expressly devoted to instruction in botany.¹¹⁵ On the subject of the university and how it has fostered higher standards of competence for instructors and better training for students, much remains to be done.

The most pressing need is a thorough investigation of the rise of specialization. It may exceed the evidence to say that specialization, as we know

it today, could not have occurred in the absence of the universities. Nevertheless, the rise of the diverse botanical specialities, from algology to xerophytology, is inseparable from the traditional domination of science by the universities. Here, more than in any other area of botanical history, the historian and the botanist must work together.¹¹⁶

What the first separate or specialized discipline was in America is not easily determined. Before Asa Gray and his circle placed specialization on an academic footing, taxonomic and monographic studies were well established and provided the chief means for botanical immortality—commemoration by a genus bearing such a name as *Bartramia*, *Claytonia*, *Grayia* and the like.¹¹⁷ With the paleobotanical publications of Lesquereux further branching out was made possible.¹¹⁸ Yet several decades passed before today's specialities came to be part of the normal curriculum.

There are, undoubtedly, many reasons for this, and a recital of a few of them may help to call attention to promising subjects of inquiry. The vast size of the continent with its inaccessible localities, and the amount of time and effort required merely to collect the representative floras, left little time for other types of research. Then, too, the fact that the early generations of teachers and instructors were composed primarily of systematists engaged in taxonomic and floristic studies meant that the burgeoning European literature on anatomy, morphology and physiology, if it was available at all, was largely ignored. It was probably the conviction of most of these early workers that until a comprehensive American flora was written little could be accomplished in such related fields as ecology and phytogeography.¹¹⁹ *Mutatis mutandis*, until plant physiology and genetics and such basic sciences as chemistry and biochemistry were fully established, plant pathology and even agricultural chemistry would not make any spectacular advances save by the genius of the few who transcended academic compartmentalization.¹²⁰

Side by side with the hesitant steps toward specialization, botany still retained some of the older alignments. Well into the nineteenth century, for example, phenology was still considered, if not an autonomous discipline, at least a subject of sufficient respectability to be included in Silliman's *Journal*.¹²¹

At the level of the university, it must also be noted that professorships in botany were few and far between until the end of our period. Teaching botany, in many instances, was possible only by assuming the title, and sometimes the attendant chores, of "Professor of Natural History" or "Professor of *Materia Medica*". This flexibility and variation in title, together with the often precarious finances which prevented some professorships from going

beyond the planning stage, contributes more than the usual uncertainty to the nature of the early university appointments. If for no other reason than to minimize the conflicting and sometimes partisan claims, a study is called for. Utilizing the university archives, matriculation records, course catalogues and the like, some of the controversy about the identity of the first professor of botany may be laid to rest. Among the claimants for this title, I have found no less than seven: B. S. Barton, Gray, Hosack, Ives, Kuhn, Nuttall, and Waterhouse.

Materia Medica, Agriculture and the American Indians

The grandiloquent title of this concluding section is meant to convey the fact that the history of American botany would be more lacunose than necessary if one neglected the above sources.

A high proportion of our early botanists were physicians who probably acquired their initial training and their zeal for collecting in their student days. To exclude materia medica, as some would, as being irrelevant to our theme would also render inexplicable at least part of the activities of J. M. Bigelow, Darlington, Durand, Engelmann, Garden, Short, Torrey and a host of other physicians-turned-botanists.

When it is recalled that the majority of the drugs of materia medica have always been drawn from the vegetable kingdom, it is not surprising to find the attention of the early settlers drawn to the therapeutic potential of the new flora.¹²² At the request of Franklin, John Bartram first broke into print with a preface, appendix, and annotations to the 1751 edition of Thomas Short's *Medicina Britannica*.¹²³ Whether or not Bartram's interest in botany was aroused by this event or by the famous incident of the "white daisy" is problematic.¹²⁴ But there is no question that many an American botanist was stimulated by the possibility of finding a new or more effective cure among the native plants.

In other ways, too, medicine and botany were allied. It is possible to note only a few examples from a field not conspicuously represented by recent scholarship. The medical schools with their emphasis on materia medica promoted clinical and laboratory investigations of the properties of indigenous plants. Although some of these plants may well have been used by the Indians, in other cases it was purely academic curiosity that prompted the numerous short papers and dissertations. Some notable contributions to pharmacognosy were made by physicians, and the refinement of chemical analysis and laboratory techniques can be measured by comparing similarly conceived studies over a twenty or thirty year period.¹²⁵ Until a bibliography

of dissertations written on vegetable material medica is printed, however, it will be difficult to gain an overall picture.

The developments in pharmacology, especially chemotherapy, soon led to a parting of the ways. After about 1840, there sprang up a number of sects most of which had in common only their adherence to an outmoded armamentarium. While no botanical contributions of note came from the Thomsonians, Neo-Thomsonians, or Eclectics, their rise and fall trace one of the interesting byways of American botany and its relation to the intellectual issues of the times.¹²⁶

Materia medica and botany did, however, coalesce at the level of the text-book. It has been pointed out above that little is known of text-books before 1836. The few titles recorded can be supplemented with the titles of several compendia and other elementary texts on the principles of botany written from a medical or pharmacological standpoint. It would be interesting to examine the botanical portions of these books and to compare them with the corresponding sections in the non-medical text-books used in other schools and academies.

Not only medically-oriented text-books, but herbals, medical floras and "Home Dispensatories" were widely studied, and it is possible that many a lad owed his first introduction to botany to a perusal of the color plates in the herbals which abounded, particularly in rural areas.¹²⁷

Turning from materia medica to agriculture, we find the same pragmatic approach that was responsible, in large measure, for the progress of American botany. "It is difficult," Bailey once wrote, "to determine the first American book on agriculture."¹²⁸ Despite uncertainty on this point, we know that the first settlers were particularly concerned with the welfare of their crops. They were accordingly quick to take advantage of the possibilities afforded them by the richness of the new lands and its resources. Their successes and failures have been recounted many times, but not always with the accuracy demanded, and seldom from the standpoint of the history of botany. It would be necessary to go through the early narratives, many of which are listed in Meisel, and to abstract the pertinent material. From the writings of Ashe, Bullock, Strachey, Van Der Donck and others, a sizeable body of acute observations and precise, if quaint, descriptions awaits a full-scale study.¹²⁹ Not only is this an important subject in its own right, but the achievements of the first settlers had profound effects upon the agricultural practices of later times.¹³⁰

When one recalls the great plans associated with establishing the silk, indigo and grape industries in colonial days, it becomes apparent that here are fit subjects for the interdisciplinarian.¹³¹

The timber resources of the new-found world provided a continual source of amazement to the settlers. Just so did the timber supply, literally, the foundations of their colonies, and a not insignificant portion of the economy was based on the seemingly never-ending stands of forest. Out of the variety of trees, some like sassafras and, further to the south, guaiacum wrote their own histories by their reputed pre-eminence as panaceas.¹³²

Information relating to the agricultural practices of the eighteenth century is abundant and, what is of more moment, the connection between agriculture and botany becomes more evident. Jefferson's interest in gardening and farming is well-known, but it must not be forgotten that Washington, too, interested himself in agricultural matters by his concern over the national economy.¹³³ One of the immediate consequences of his interest was the publishing of the technical literature. Precisely how the agricultural press responded is a matter which bears further scrutiny.

Many other factors conspired to hasten the passage of agriculture from a traditional occupation to a profession with a program. Among these factors were the rise of agricultural and farming societies and periodicals,¹³⁴ the wider selection of seeds and fruit trees pioneered by such capable nurserymen as the Downing brothers, and, of course, the stimuli provided by the efforts of enlightened farmers on the Atlantic seaboard and elsewhere.¹³⁵

A subject that fairly goes a-begging for competent scholarship concerns the nature and extent of the contributions made to American botany by the Indians. It is not always easy to assess the reports of the white man's indebtedness to the Indian's vaunted knowledge, especially since much of the literature is based on second-hand reports. Nonetheless, there is sufficient evidence to suggest that a knowledge of the therapeutic, alimentary, and dyeing properties of many plants was widespread before the arrival of the Europeans.¹³⁶ But how much was learned from the Indians directly and how much by the European's efforts to improve what they found must remain unanswered until critical studies are forthcoming. Travellers' accounts frequently mention, but often only *en passant*, the native uses and methods. But the older collections of many of these reports are difficult to obtain today and almost all of them require careful commentary on matters linguistic as well as botanical.

Naturally, in a subject so romantically linked to America, there are numerous studies devoted to the ethnobotanical, the ceremonial and the medical employment of plants by various tribes.¹³⁷ The quality is often uneven in such studies, as it would be in any discipline which is parcelled out to anthropologists, ethnographers, linguists and others. To date, the botanical

side of American Indian studies has received little serious attention and there is no convenient study where even the majority of titles are made accessible to the historian of early American botany.

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15. The North American travels of Hooker have been examined by W. B. TURRILL, *Pioneer Plant Geography*, The Hague, 1953, pp. 105-120. Of particular interest is E. D. MERRILL, "Palisot de Beauvois as an Overlooked American Botanist." *Chronica Botanica*, 10 (1946) 280-86.

16. JAMES PETIVER, "Remarks . . . on some animals, plants . . . sent from Maryland by the Rev. Hugh Jones." *Phil. Trans.*, 20 (1699) 393-406. For Petiver's many services to botany and the other sciences as well, cf. RAYMOND P. STEARNS, "James Petiver, Promoter of Natural Science, c. 1663-1718." *Proc. Amer. Antiq. Soc.*, n.s. 60 (1952) 243-365.

17. The classical example is GRONOVIVS' *Flora Virginica* which was based on material gathered by John Clayton of Virginia. DASSOW'S dissertation which was based on Cadwallader Colden's descriptions provides another example: *Nova plantarum genera, quae . . . praeside . . . Carolo Linnaeo . . . publico bonorum examini submittit Carolus Magnus Dassow . . . Holmiae, 1747*.

18. J. CHRISTIAN BAY, *Bibliographies of Botany: A contribution toward a bibliotheca bibliographica. Progressus rei botanicae*, ed. J. P. Lotsy. Jena, 1909, pp. 331-456; JOHN HENDLEY BARNHART, *Biographical Notes upon Botanists*. N.Y. (Scheduled for 1965). Less valuable, except for later writers, is HARRY BAKER HUMPHREY, *Makers of North American Botany*. New York, 1961.

19. A critical study of JAMES LOGAN should be given high priority. The author of an influential study in hybridization—"Some Experiments Concerning the Impregnation of the Seeds of Plants." *Phil. Trans.*, 39 (1736) 192-95—he has not received a full-scale study since WILSON ARMISTEAD'S *Memoirs of James Logan . . .* London, 1851, which is now outdated. The best study on Logan's over-all contributions to science is FREDERICK B. TOLLES, "Philadelphia's First Scientist: James Logan." *Isis*, 47 (1956) 20-30.

20. JOHN W. HARSHBERGER, *The Botanists of Philadelphia and Their Work*. Philadelphia, 1899.

21. There is no entry for Joseph Barratt (1796-1822), well regarded for his work on the willows by Gray and Torrey, cf. FRANK K. HALLOCK, "Joseph Barratt, M.D.,

Physician and Botanist of Middletown, Conn." *Bull. Soc. Med. Hist. Chicago*, 3 (1923) 151-67. On the other hand, there may be sufficient reason for the non-occurrence of a name, cf. J. H. BARNHART, "Some fictitious botanists." *Journ. N.Y. Bot. Gard.*, 20 (1919) 171-181.

22. A convenient summary is provided by PAUL H. OEHSE, "A Handlist of American Naturalists, Based on the Dictionary of American Biography." *The American Naturalist*, 72 (1938) 534-546. Oehser's list, however, is far from complete. He does not mention, for instance, William Douglass, Paul Dudley or James Logan—all of whom are to be found in *D.A.B.*, though their botanical contributions are minimized there.

23. Cf. CONWAY ZIRKLE, "John Clayton and our Colonial Botany." *Va. Mag. of Hist. and Biog.*, 67 (1959) 284-294.

24. RAY STANNARD BAKER and JESSIE BEAL BAKER, *An American Pioneer in Science: The Life and Service of William James Beal*. Amherst, 1925.

25. NATHAN BRYLLION FAGIN, *William Bartram, Interpreter of the American Landscape*. Baltimore, 1933.

26. ETHEL M. McALLISTER, *Amos Eaton, Scientist and Educator, 1776-1842*. Philadelphia, 1941. Among the merits of this book is the location of many of Eaton's unpublished letters.

27. HARRY B. WEISS and GRACE M. ZIEGLER, *Thomas Say, Early American Naturalist*. Springfield, Ill., 1931. Say (1787-1834) published on nearly every subject of biology, and a bibliography will be found in Weiss and Ziegler pp. 190-94.

28. Of the several publications of ANDREW DENNY RODGERS, 3RD, those which concern us here are: "Nobel Fellow" *William Starling Sullivan*. New York, 1940; *John Torrey, A Story of North American Botany*. Princeton, 1942; and, *American Botany 1873-1892: Decades of Transition*. Princeton, 1944. The last of the three books, despite the title, is as much concerned with botanists like Engelmann, Gray and Lesquereux, whose work began a generation earlier.

29. RICHARD BEALE DAVIS, "The Abbé Correa in America, 1812-1820." *Trans. Amer. Philos. Soc.*, 45/2 (1955) 87-197.

30. A. HUNTER DUPREE, *Asa Gray, 1810-1888*. Cambridge, Mass. 1959.

31. EDMUND BERKELEY and DOROTHY SMITH BERKELEY, *John Clayton, Pioneer of American Botany*. Chapel Hill, 1963.

32. Cf. WILLIAM J. ROBBINS, "Les Botanistes Français et la Flore du Nord-Est des États-Unis: J. B. Milbert et Élias Durand," in *Les Botanistes Français . . .* pp. 41-51.

33. T. J. FITZPATRICK, *Rafinesque: A Sketch of his life, with Bibliography*. Des Moines, 1911, lists 939 published papers and books. This figure has been passed since then, principally through the efforts of ELMER D. MERRILL. See the latter's *Index Rafinesquianus: the plant names published by C. S. Rafinesque with reductions, and a consideration of his methods, objectives, and attainments*. Jamaica Plain, 1949.

34. For the little that is known of this elusive book and some of the curious facts associated with a later pamphlet bearing Mrs. Logan's name, see L. H. BAILEY, *The Standard Cyclopaedia of Horticulture*. 3 vols., New York, 1941, II, 1510, 1520-21.

35. SAUL JARCHO, "Biographical and Bibliographical Notes on Cadwallader Colden." *Bull. Hist. Med.*, 32 (1958) 322-34.

36. BELL, *op. cit.* (Note 5), pp. 58-59 (including a brief bibliography).

37. J. E. DANDY, ed., *The Sloane Herbarium*. London, 1958, p. 177.

38. BELL, *op. cit.* (Note 5), p. 66. Cf. also, RODNEY H. TRUE, "François André Michaux, The Botanist and Explorer." *Proc. Amer. Philos. Soc.* 78 (1937) 313-327.

39. *Botanic Manuscript of Jane Colden, 1724-1766*. ed. H. W. Rickett and E. C. Hall. New York, 1963.

40. J. F. GRONOVIVS, *Flora Virginica*. Lugduni Batavorum, 1762, cites Dudley's MS on fol. *4r, cf. HINDLE, *op. cit.* (Note 5), p. 30. For a brief sketch of Dudley's life and references to the bibliography, cf. BELL, *op. cit.* (Note 5), p. 54 and FRICK and STEARNS, *op. cit.* (Note 9), 117-19.

41. ANTONIO PACE, "Two New Letters from John Morgan's Italian Travels." *Isis*, 54 (1963) 475-79.

42. Cf. EDWARD LURIE, "Some Manuscript Resources in the History of Nineteenth Century American Natural Science." *Isis*, 44 (1953) 363-70. Of particular importance is the Historic Letter File, Gray Herbarium, Harvard University, which contains in some eighty cases, Gray's international correspondence; only a fraction of this correspondence has been published.

43. *The American Drawings of John White*. ed. Paul Hulton and David B. Quinn. 2 vols. London. (Announced for publication.)

44. Sotheby Sales Catalogue for 15 June 1937. Item no. 326.

45. PAUL JOVET and R. WILLMANN, "Trécul, botaniste Français en Amérique du Nord (1848-1850)," in *Les Botanistes Français* . . . pp. 83-106.

46. E.g. John Banister's drawings, in Sloane MS. 4002. For a description, cf. DANDY, *op. cit.* (Note 37), p. 85 and for an example of Banister's graphic abilities, cf. JOSEPH EWAN, "First Fern Records from Virginia: John Banister's Account of 1679-1692." *Amer. Fern Journ.*, 53 (1963) 140.

47. Valuable information is included in J. LANJOUW and F. A. STAFLEU, *Index Herbariorum*. Utrecht, 1952- . (Fourth edition, 1959.) As an example of how a historian can use herbarium records cf. J. CHRISTIAN BAY, "Sequoia and Washingtonia: In History and Bibliography." *Quarterly Bull., Northwestern Univ. Med. Sch.*, 20 (1946) 13-17.

48. Cf. the interesting exchange: L. H. SHINNERS, "Non-validity of Nuttallian names in Fraser's Catalogue." *Rhodora*, 57 (1955) 290-93; ARTHUR CRONQUIST, *et. al.*, "Validity of Nuttall's names in Fraser's Catalogue." *Rhodora*, 58 (1956) 23-24; L. H. SHINNERS, "Nuttall not the Author of Fraser's Catalogue." *Rhodora*, 58 (1956) 281-89.

49. A. GRAY, "Notes of a Botanical Excursion to the Mountains of North Carolina." Reprinted in *Scientific Papers of Asa Gray*, ed. C. S. Sargent. Boston, 1889, vol. II, 22-70.

50. K. R. MACKENZIE, "Concerning the Proper Identification of Linnaean Species, Especially those Based on Material Collected by Clayton." *Rhodora*, 30 (1938) 232-37; E. C. MERRILL, "In Defense of the Validity of William Bartram's Binomials." *Bartonia*, 23 (1945) 10-35.

51. ASA GRAY, "European Herbaria." *Scientific Papers of Asa Gray*, II, 1-21.

52. L. B. WRIGHT, "The Purposeful Reading of our Colonial Ancestors." *Journ. Engl. Lit. Hist.*, 4 (1937) 85-111.

53. S. H. SCUDDER, *Catalogue of Scientific Serials of all countries including the transactions of learned societies in the natural, physical and mathematical sciences 1633-1876*. Cambridge, Mass., 1879; H. C. BOLTON, *A Catalogue of Scientific and Technical Periodicals 1665-1895*. 2nd ed. Washington, D.C., 1897.

54. Cf. JOHN DAVIS, "An Address to the Linnaean Society of New-England, at their first anniversary meeting, at the Boston Athenaeum, June 14th 1815." *North-American Review*, I (1815) 314-28.

55. For Gray's review, cf. HUNTER DUPREE, *Asa Gray*, p. 295. For a general study cf. JAMES C. AUSTIN, *Fields of the Atlantic Monthly*. San Marino, Calif., 1953.

56. A letter published originally in the *Columbian Centinel* of Boston for 16 June 1790 is reprinted in BAILEY, *op. cit.* (Note 34), II 1510.

57. CONWAY ZIRKLE, "The First Recognized Plant Hybrid?" *Journ. Heredity*, 49 (1958) 137-38.

58. ERNST A. BESSEY, "The Teaching of Botany Sixty-five years Ago." *Iowa State Coll. Journ. Sci.*, 9 (1935) 13-19.

59. In one of the popular textbooks of the period, ALMIRA LINCOLN's *Familiar Lectures on Botany*. Rev. ed. New York, 1850, pp. 14-15, the advantages of outdoors collecting are described at length. For a study of this very remarkable woman, see EMMA L. BOLZAU, *Almira Hart Lincoln Phelps: Her Life and Work*. Philadelphia, 1934.

60. See DUPREE, *Asa Gray* p. 51, where some interesting facts are given. A study of these text-books is now in preparation and will appear elsewhere.

61. On the level of botany found in juvenilia see SMALLWOOD, *op. cit.* (Note 4), 217-28.

62. About 28 authors are cited in H. MUELENBERG, *Descriptio Ueberior Graminum et Plantarum Calamariarum Americæ Septentrionalis*. . . . Philadelphia, 1817. How many of their writings he had before him is problematic, but he cites page and plate numbers in his references to Lamarck, Michaux, Plunkenet, Scheuchzer, Schreber and Willdenow and occasionally comments on the quality of the illustration. Even assuming he had access to all of these writings, only those by Elliott and Walter were published in the United States.

63. E. M. SOWERBY, *Catalogue of the Library of Thomas Jefferson*. Washington, 1952- , I, 297-554; FREDERICK G. KILGOUR, "The First Century of Scientific Books in the Harvard College Library." *Harvard Libr. Notes*, 3 (1939) 217-225; *ibid.*, *The Library of the Medical Institution of Yale College and its Catalogue of 1865*. New Haven, 1960 (Botany on pp. 63-64). On the botanical books in Daniel Parke Custis' library, see SWEM, *op. cit.* (Note 8), 155-56.

64. Cf. Peter Collinson to John Bartram 20 January 1734-5 (DARLINGTON, *Memorials* . . . p. 60) and an undated letter, probably 1736, (DARLINGTON, 80). DARLINGTON's *Memorials* is not indexed, but a great deal of useful information can be traced by the use of JOSEPH FWAN, "Analytical Index to Darlington's Memorials of Bartram and Marshall (1849)." *Journ. Soc. Bibliogr. Nat. Hist.*, 3 (1957) 263-72. R. J. FAVRETTI, *Early New England Gardens, 1620-1840*. Sturbridge, 1962, p. 4, states that GERARDE's *Herball* was "widely used in New England," but offers no documentation.

65. For example, Erasmus Darwin is favorably referred to, but without any specification of book or page, for having "ingeniously shown the analogy between the functions of the leaves of plants, and the lungs of animals." JOHN B. BECK, "Observations on Salt Storms, and the Influence of Salt and Saline Air upon Animal and Vegetable Life." *Amer. Journ. Sci. and Arts*, 1 (1819) 393. In a similar fashion, one of Goethe's aphorisms is quoted in German by HARLAND COULTAS, *What May Be Learned from a Tree*. New York, 1860, p. 97, in an effort to support the author's claim of a "Life Wave".

66. A. W. HILL, "The History and Functions of Botanic Gardens." *Ann. Missouri Bot. Gard.*, 2 (1915) 185-240; D. WYMAN, "The Arboretums and Botanical Gardens of North America." *Chronica Botanica*, 10 (1947).

67. WILLIAM T. STEARN, *Botanical Gardens and Botanical Literature in the Eighteenth Century*. Reprinted from volume II, without change in pagination, of the *Catalogue of Botanical Books in the Collection of Rachel McMasters Miller Hunt*. Pittsburgh, 1961, pp. lxxxi-lxxxii.

68. J. H. BARNHART, "Significance of John Bartram's Works to Botanical and Horticultural Knowledge." *Bartonia*, Supplement to vol. 12 (1931) 24-34.

69. BENJAMIN L. ROBINSON, "The Removal of an old Landmark." *Harvard Graduates Magazine*, 75 (1911) 418-21; ERNEST INGERSOLL, "Harvard Botanic Garden and its Botanists." *Century Magazine*, 32 (1886) 236-48.

70. M. A. HOWE, "New York's First Botanical Garden." *Journ. N.Y. Bot. Gard.*, 30 (1929) 49-58; A. BROWN, "The Elgin Botanic Garden, Its Later History, and Relation to Columbia College and the Vermont Land Controversy." *Bull. N.Y. Bot. Gard.*, 5 (1906-08) 314-72.

71. For example, Thomas Bond to John Bartram, 20 February 1738-9 (DARLINGTON, *Memorials* . . . pp. 316-17) mentions his acquaintance with Bernard de Jussieu and hopes "to improve" himself at the Jardin Royal in Paris.

72. M. I. WILBERT, "Some early botanical and herb gardens." *Amer. Journ. Pharm.*, 80 (1908) 412-27.

73. Worthy of mention is Middleton Place, the garden of Henry Middleton of Charleston. It was here in 1783 that Michaux introduced the first camellia trees in the United States. For Middleton Place and other historically-important gardens of Charleston, see PETER COATS, *Great Gardens of the Western World*. New York, 1963, pp. 182-193.

74. S. P. STETSON, "William Hamilton and his 'Woodlands.'" *Pa. Mag. of Hist.*, 73 (1949) 26-33.

75. HARSHBERGER, *op. cit.* (Note 20), 113-17 and R. H. TRUE, "Some Neglected Botanical Results of the Lewis and Clark Expedition." *Proc. Amer. Philos. Soc.*, 67 (1928) 1-19.

76. Cf. D. B. RUTMAN, "Governor Winthrop's Garden Crop: The Significance of Agriculture in the early commerce of Massachusetts Bay." *William and Mary Quarterly*, 20 (1963) 396ff. and GRACE TABOR, *Old-Fashioned Gardening: A History and a Reconstruction*. New York, 1913, Ch. 4, "New Amsterdam Gardens". On Oglethorpe, see JAMES W. HOLLAND, "The Trustees Garden in Georgia." *Agri. Hist.*, 12 (1938) 271-77.

77. *Thomas Jefferson's Garden Book, 1766-1824*. ed. E. M. Betts, Philadelphia, 1944. Cf. R. H. TRUE, "Thomas Jefferson in Relation to Botany." *Scientific Monthly*, 3 (1916) 345-60.

78. JOSEPH EWAN and NESTA EWAN, "John Lyon, Nurseryman and Plant Hunter, and His Journal, 1799-1814." *Trans. Amer. Philos. Soc.*, n.s. 53/2 (1963) 1-69; JOSEPH EWAN, "Bernard M'Mahon (c. 1775-1816), Pioneer Philadelphia Nurseryman, and his 'American Gardener's Calendar'." *Journ. Soc. Bibl. Nat. Hist.*, 3 (1960) 363-380.

79. ULYSSES PRENTISS HEDRICK, *A History of Horticulture in America to 1860*. New York, 1950, is readable but inaccurate and fails to mention Bailey in either the bibliography or the index.

80. For sketches of their contributions see BAILEY, *op. cit.* (Note 34), II, 1577, 1587, 1590, 1591. See also HELEN B. DAVIS, *Life and Work of Cyrus Guernsey Pringle*. Burlington, 1936.

81. A good basis is provided by LEWIS CECIL GRAY, *History of Agriculture in the Southern United States*. Washington, 1933, II, 673-770: an extensive bibliography occurs on pp. 945-1016. For the North, see C. F. WARE, *The early New England cotton manufacture*. Boston, 1931.

82. SARAH AUGUSTA DICKSON, *Panacea, or Precious Bane*. New York, 1954; REDCLIFFE N. SALAMAN, *The History and Social Influence of the Potato*. Cambridge, 1949; S. TOLKOWSKY, *Hesperides: A Study of the Culture and Use of Citrus Fruits*. London, 1938; IRENE A. WRIGHT, "The Commencement of the Cane Sugar Industry in America." *Amer. Hist. Rev.*, 21 (1916) 755-80. A model for future botanico-bibliographers is IRA J. CONDIT and JULIUS ENDERUD, *A Bibliography of the Fig*. Berkeley, 1956.

83. There is an enormous literature on maize. Especially valuable are the publications of P. C. MANGELSDORF and his associates, many of them listed in GEORGE F. CARTER, "Plant Evidence for Early Contacts with America." *Southw. Journ. Anthropol.*, 6 (1950) 161-182. On the sugar maple, see PETER KALM, "Description of How Sugar is Made from Various Types of Trees in North America." *Trans. Esther L. Larsen. Agric. Hist.*, 13 (1939) 149-156 and R. L. BUTTERFIELD, "The Great Days of Maple Sugar." *New York History*, 39 (1958) 151-64. Interesting material on cactus appears in

JOSEPH EWAN, "Andrew Alverson (1845-1916) of California and his 'Cactus Catalogue.'" *Journ. Soc. Bibl. Nat. Hist.*, 4 (1963) 170-177.

84. FRANCIS HAPPER, *Travels of William Bartram*. New Haven, 1958, and FRANCIS W. PENNELL, "Travels and Scientific Collections of Thomas Nuttall." *Bartonia*, 18 (1936) 1-51.

85. SUSAN DELANO MCKELVEY. *Botanical Exploration of the Trans-Mississippi West, 1790-1850*. Jamaica Plain, Mass., 1955.

86. This subject is fully discussed in JERRY STANNARD, "Dioscorides and Renaissance Materia Medica" in *Materia Medica in the XVIth Century*, edited by Marcel Florquin. London, 1966, pp. 1-21.

87. The reports of these and other early travellers are fully utilized in the scholarly review of ASA GRAY and J. HAMMOND TRUMBULL, "De Candolle's Origin of Cultivated Plants." *Scientific Papers of Asa Gray*, I, 311-354.

88. *Journal of José Longinos Martínez. Notes and Observations of the Naturalist of the botanical expedition in old and new California and the South Coast, 1791-92*. Trans. and ed. by Lesley B. Simpson. 2nd ed. San Francisco, 1961.

89. Cf. E. and D. S. BERKELEY, *op. cit.* (Note 31), *passim*. and H. HAROLD HIME, "Botanical Explorers of the Southeastern United States." *Florida Hist. Quarterly*, April 1943. Still useful is C. W. ALVORD and L. BIDGOOD, *The First Exploration of the Trans-Allegheny Region by the Virginians, 1650-1674*. Cleveland, 1912.

90. CONWAY ZIRKLE, "A Possible Early Eighteenth Century Record of Introgression in Oaks." *Journ. Heredity*, 41 (1950) 315-17.

91. On these writers, see JUNE RAINSFORD BUTLER, "America: A Hunting Ground for Eighteenth-Century Naturalists with special reference to their Publications about Trees." *Papers Bibl. Soc. Amer.*, 32 (1938) 1-16.

92. SARAH P. STETSON, "Traffic in Seeds and Plants from England's Colonies in North America." *Agr. Hist.*, 23 (1949) 45-56.

93. Bartram combined the two motives: cf. DARLINGTON'S *Memorials*, *passim*. For a study of the merchant who was, in many cases, the actual go-between, see ELIZABETH DONNAN, "Eighteenth Century English Merchants: Micajah Perry." *Journ. Econ. and Business Hist.* 4 (1931) 70-98.

94. Cf. R. HINGSTON FOX, *Dr. John Fothergill and His Friends*. London, 1919. Fothergill numbered Peter Collinson, and the Bartrams among his many friends. A list of the boxes of seeds sent by Bartram, many of which were destined for the gardens of the English aristocracy, is printed by Fox, pp. 163-165.

95. On these writers, see JUNE RAINSFORD BUTLER, *Floralia: Garden Paths and By-Paths of the Eighteenth Century*. Chapel Hill, 1938, which contains a good bibliography. A larger, but less accurate bibliography will also be found in RICHARDSON WRIGHT, *The Story of Gardening*. New York, 1963.

96. But cf. G. C. KRAUS, *Geschichte der Pflanzeneinführungen in die europäischen botanischen Gärten*. Leipzig, 1894, pp. 19-26, 45-53.

97. Especially useful in this connection are CHARLES DE L'ESCLUSE, *Rariorum aliquot stirpium per Hispanias observatarum Historia*. . . . Antwerp, 1576, and his *Exoticorum libri decem*. . . . Antwerp, 1605. Many of the plants described by Cornut were brought from Canada by Pierre Morin in 1633 and naturalized in the Paris gardens of Jean and Vespasien Robin. Cf. JACQUES CORNUT, *Canadensium plantarum aliarumque nondum editarum historia* (Paris 1635). Edited with a new introduction by Jerry Stannard. New York, 1966.

98. For the events leading up to the botanical exploration of H. Ruiz and J. Pavón, beginning in 1777, see ARTHUR ROBERT STEELE, *Flowers for the King*. Durham, 1964.

99. Cf. the list "Of such Garden Herbs (amongst us) as do thrive there, and of such as do not," from, JOHN JOSSELYN, *New-Englands Rarities Discovered: in Birds, Beasts, Fishes, Serpents, and Plants of that Country*. London, 1672. This list is conveniently reprinted in BAILEY, *op. cit.* (Note 34), II, 1504.
100. The most important studies are: ENRIQUE ALVAREZ LÓPEZ, "Las Plantas de America en la Botánica europea del Siglo XVI." *Revista de Indias*, 6 (1945) 221-88; C. HARTWICH, *Die Bedeutung der Entdeckung von Amerika für die Drogenkunde*. Berlin, 1892, and IDA K. LANGMAN, "Works prior to 1800 useful for studies in Mexican Botany." *Revista Interamericana de Bibliografía*, 10 (1960) 219-43.
101. E. BRETSCHNEIDER, *History of European Botanical Discoveries in China*. 2 vols. Leipzig, 1962, I, 404.
102. As an instance of what can be done in this area, see LOUIS K. MANN and WILLIAM T. STEARN, "Rakkyo or Ch'iao T'ou (*Allium Chinense* G. Don, Syn. A. Bakeri Regel): A Little Known Vegetable Crop." *Economic Bot.*, 14 (1960) 69-83.
103. JOSEPH EWAN, *Rocky Mountain Naturalists*. Denver, 1950; SAMUEL WOOD GEISER, *Naturalists of the Frontier*. Dallas, 1937; 2nd ed. 1948.
104. Various aspects are treated in: T. T. BOUVÉ, *Historical Sketch of the Boston Society of Natural History, with a Notice of the Linnaean Society which preceded it*. Boston, 1880, and ROBERT MANNING, *History of the Massachusetts Horticultural Society, 1829-1878*. Boston, 1880. Interesting observations on the Boston area are frequent in GEORGE B. EMERSON, *A Report on the Trees and Shrubs growing naturally in the Forests of Massachusetts*. Boston, 1846. Three-quarters of a century later the same trees are described and often illustrated with photographs in JAMES RAYMOND SIMMONS, *The Historic Trees of Massachusetts*. Boston, 1919.
105. Charleston was a publishing center for many distinguished Southern floras, the home of important botanists, one of whom, Alexander Garden, is mentioned above, the site of some famous historical gardens, and the first city to establish a public museum (1773). Fittingly enough, J. L. E. W. SHECUT, the author of *Flora Carolinaensis* . . . 2 vols. (Charleston, 1806) was one of its founders. Another Charlestonian is the subject of a brief note by JOSEPH EWAN: "John Bachman, and the Hapoldt European Journal." *Rhodora*, 64 (1962) 92-94. See also RICHARD BEALE DAVIS, "Forgotten scientists in Georgia and South Carolina." *Georgia Hist. Quart.*, 27 (1943) 271-84.
106. PERLEY SPAULDING, "A biographical history of botany at St. Louis, Missouri." *Popular Science Monthly*, 73 (1908) 488-499; 74 (1909) 48-57, 124-133, 240-258. See also CLARENCE E. KOBUSKI, "Formative Days of Mr. Shaw's Garden." *Missouri Bot. Gard. Bull.*, 30 (1942) 100-110.
107. Cf. A. G. HARVEY, *Douglas of the Fir*. Cambridge, Mass., 1947, and McKELVEY, *op. cit.* (Note 85), pp. 26-60.
108. Cf. M. L. FERNALD, "Overlooked Species, Transfers and Novelties of the Flora of Eastern North America." *Rhodora*, 46 (1944) 1-21, and EDGAR T. WHERRY, "The Eastern Long-styled Phloxes." *Bartonia*, 13 (1931) 18-37; 14 (1932) 14-26.
109. For these early floras, cf. DARLINGTON, *op. cit.* (Note 1), pp. 23-29. As an example of the good use of the older floras may be put, cf. M. L. FERNALD and LUDLOW GRISCOM, "The Identity of *Lobelia glandulosa* Walt." *Rhodora*, 39 (1937) 497.
110. Cf. A. HUNTER DUPREE, *Science in the Federal Government. A History of Policies and Activities to 1940*. Cambridge, Mass. 1957, and C. B. HAYES, *The American Lyceum. Its history and contribution to education*. Washington, 1932.
111. Cotton Mather, though not a physician, pioneered the smallpox inoculation so successfully, that he has been termed the "first significant figure in American medicine," the sub-title of a study by O. T. BEALL and R. H. SHRYOCK, *Cotton Mather*. . . . Baltimore 1954. More germane to our study is, "Cotton Mather, An Extract of several letters . . . to John Woodward. . . ." *Phil. Trans.*, 29 (1714-16) 62-71. His observations

on hybridization have also received recognition, cf. CONWAY ZIRKLE, *The Beginnings of Plant Hybridization*. Philadelphia, 1935, pp. 104-06.

112. Cf. MCKELVEY, *op. cit.* (Note 85), 67-85 (with bibliography).

113. The most useful studies are: L. F. SCHMECKEBIER, *Catalogue and Index of the Publications of the Hayden, King, Powell, and Wheeler Surveys*. Washington, 1904; LOUIS N. FEIPEL, "The Wilkes Exploring Expedition: Its Progress through Half a Century, 1826-1876" *Proc. U. S. Naval Institute*, 40 (1914); G. P. MERRILL, *Contributions to a History of American State Geological and Natural History Surveys*. Washington, 1920; DANIEL C. HASKELL, *The United States Exploring Expedition, 1838-1842, and its Publications, 1844-1874*. New York, 1942.

114. A. C. TRUE, "Origin and Development of Agricultural Experiment Stations in the United States." *Rept. of the Commissioner of Agriculture for 1888* (Washington, D.C.) pp. 541-558. See also, L. B. CASWELL, *Brief History of the Massachusetts Agricultural College*. Amherst, 1917.

115. THEODORE HORNBERGER, *Scientific Thought in the American Colleges, 1638-1800*. Austin, Texas, 1945.

116. R. E. JANSSEN's *Some Fossil Plant Types of Illinois*. Chicago, 1940, is a good example of how a botanist can put his scientific training to use in interpreting the earlier literature from a historical viewpoint; in this case, the paleobotanical activity of Leo Lesquereux. Cf. GEORGE SARTON, "Lesquereux (1806-1889)." *Isis*, 34 (1942) 97-108.

117. HOWARD A. KELLY, *Some American Medical Botanists Commemorated in our Botanical Nomenclature*. Troy, N.Y., 1914.

118. Cf. A. D. RODGERS, *American Botany* . . . (1944) pp. 162-197.

119. The level of ecology can be gauged by a paper by CALEB ATWATER, "On the Prairies and Barrens of the West." *Amer. Journ. Sci. Arts*, 1 (1819) 116-25, and a criticism thereof by R. W. WELLS, "On the Origin of Prairies." *ibidem* pp. 331-37.

120. Cf. HERBERT H. WHETZEL, *An Outline of the History of Phytopathology*. Philadelphia, 1918, for the rise of plant pathology in the United States. As an example of agricultural chemistry before chemistry was understood in the modern sense, see EDMUND RUFFIN, *An Essay on Calcareous Manures*. Ed. J. Carlyle Sitterson. Cambridge Mass., 1961.

121. STEPHEN W. WILLIAMS, "Floral Calendar kept at Deerfield, Massachusetts, with Miscellaneous Remarks." *Amer. J. Sci. and Arts*, 1 (1819) 359-73. For the continuing appeal of such "research", see LEO STOLLER, "A Note on Thoreau's Place in the History of Phenology." *Isis*, 47 (1956) 172-81.

122. For a review of the problems and literature of ancient materia medica, see JERRY STANNARD, "Materia Medica and Philosophic Theory in Aretaeus." *Sudhoffs Archiv f. Gesch. d. Med.*, 48 (1964) 27-53.

123. J. H. BARNHART, "Bartram Bibliography." *Bartonia*, vol. 12 Suppl. (1931) 51.

124. J. H. BARNHART, "John Bartram's First Interest in Botany." *Bartonia*, vol. 12 Suppl. (1931) 35-37.

125. JOHN REDMAN COXE, "Some observations on the plant that produces the official jalap, as established by its culture during three successive seasons." *Amer. J. Med. Sci.*, 5 (1829-30) 300-07. For the role of this paper, see JERRY STANNARD, "Materia Medica in The Locke-Clarke Correspondence." *Bull. Hist. Med.*, 37 (1963) 205.

126. Cf. ALEX BERMAN, "A Striving for Scientific Respectability: Some American Botanics and the Nineteenth-Century Plant Materia Medica." *Bull. Hist. Med.*, 30 (1956) 7-31, and "Neo-Thomsonianism in the United States." *Journ. Hist. Med.*, 11 (1956) 133-155.

127. PETER P. GOOD, *The Family Flora and Materia Medica Botanica*. . . . rev. ed. 2 vols. Cambridge, Mass. 1854.

128. BAILEY, *op. cit.* (Note 34), II, 1509. A useful study is P. W. BIDWELL and J. I. FALCONER, *History of Agriculture in the Northern United States, 1620-1860*. Washington, 1925. For recent bibliography, see M. L. WILSON, "Survey of Scientific Agriculture." *Proc. Amer. Philos. Soc.*, 86/1 (1942) 52-62.

129. References to these writers occur in STURTEVANT'S *Notes on Edible Plants*, ed. U. P. Hedrick. Albany, 1919, and in CHARLES PICKERING, *Chronological History of Plants: Man's Record of his own existence illustrated through their names, uses, and companionship*. Boston, 1879. Pickering (1805-79) was himself a botanist of note, see "Gray's necrology," *Scientific Papers of Asa Gray*. II, 406-10.

130. JAMES CUTBUSH, *The American Artists' Manual, or Dictionary of Practical Knowledge in the Application of Philosophy to the Arts and Manufactures*. 2 vols. Philadelphia, 1814. Cutbush (1788-1823), best remembered for his activity in early American chemistry, was a vice-president of the Linnaean Society. Despite an article on him in the *D.A.B.* he is not mentioned in Oehser's list.

131. On silk culture see L. P. BROCKETT, *The silk industry in America*. New York, 1876, cited by STRUIK, *op. cit.* (Note 5), p. 491, and HINDLE, *op. cit.* (Note 5), pp. 200-204. The need for a study on early American viticulture is indicated by Bailey's remark, "In America, no crop has been the subject of so much book-writing as the grape. Counting the various editions, no doubt a hundred books have appeared, being the work of at least fifty authors." BAILEY, *op. cit.* (Note 34), p. 1515.

132. For representative accounts and a good bibliography, see GENEVIEVE MILLER, "First Description of the Sassafras Tree." *Bull. Cleveland Med. Libr.*, 6 (1959) 1-7; R. S. MUNGER, "Guaiacum: The Holy Wood from the New World." *J. Hist. Med.*, 4 (1949) 196-229.

133. *Thomas Jefferson's Farm Book*. ed. E. M. Betts, Philadelphia, 1953. (Especially valuable is the biographical appendix pp. 513-526). On Washington, see FRANKLIN KNIGHT, ed., *Letters on Agriculture from His Excellency, George Washington, to Arthur Young and Sir John Sinclair, With Statistical Tables and Remarks by Thos. Jefferson, Richard Peters and other Gentlemen on the Economy and Management of Farms in the United States*. Washington, 1847, and RICHARD PARKINSON, *A Tour in America, in 1798, 1799, and 1800, Exhibiting Sketches of Society and Manners, and a particular account of the American System of Agriculture, with its recent improvements*. . . . 2 vols. London, 1805. As Parkinson was a respected English agriculturalist who came to America to superintend Washington's farms, his book is essential reading for students of the subject.

134. A. L. DEMAREE, *The American Agricultural Press, 1819-1860*. New York, 1941.

135. JOHN BEALE BORDLEY, *A Summary View of the Courses of Crops, in the Husbandry of England and Maryland*. Philadelphia, 1784. Bordley was one of the most important of those farmers who gained by studying the English literature and applying the results, often in a sensibly-modified fashion suitable to American conditions. Among recent studies, see CARL RAYMOND WOODWARD, *Ploughs and Politics: Charles Read of New Jersey and his notes on agriculture; 1715-1774*. New Brunswick, 1941.

136. The dyestuffs employed by the Indians were considered of sufficient importance for a dissertation: PEHR KALM (praeses), *Norra Americanska Färge-Örter*. Af Esaias Hollberg. Åbo. 1763.

137. Some representative studies are: ARTURO CASTIGLIONI, "Herbs in the Medicine of Eastern Peoples and of the American Indians." *CIBA SYMPOSIA*, 5 (1943) 1536-40; V. K. CHESNUT, *Plants used by the Indians of Mendocino County, California*. Washington, 1902; M. R. GILMORE, *Uses of Plants by Indians of the Missouri River Region*. Washington, 1919; FRANCIS E. LLOYD, "The Oldest Piece of Manufactured Rubber in the World." *The Dominion*, 14 (1920) 150-52; JAMES MOONEY and FRANS S. OLBRECHTS, *The Swimmer Manuscript: Cherokee Sacred Formulas and Medicinal Prescriptions*. Washington, 1932.

Illustrated Botanical Works in China and Japan

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The uninterrupted course of the Chinese cultural continuum from the second millennium B.C. has resulted in a formidable bulk of literature in spite of several large-scale burnings of books. As may be expected from an agriculturally oriented people, the general field of botanical literature is proportionately large. Much of this literature has been listed or described in the following studies selected for their usefulness and accessibility. An early western survey of Chinese botany by Bretschneider lists over 1,100 titles, but many of them are basically historical or geographical works which also contain some botanical material. The most important works are described in considerable detail.¹ The monumental bibliography of modern Far Eastern botany by Merrill and Walker contains an appendix titled "Older Oriental Works." Although this is useful for its descriptions and references, it may mislead the uninformed because it lists only about one hundred Chinese and Japanese works combined—a small fraction of the total.² Another useful western survey, compiled by Huard and Wong, chronologically classifies and describes the most important materia medica and gives numerous illustrations from them.³ A short Chinese essay on the origin of *pen ts'ao* studies is also a useful chronological guide to the most important works in this field.⁴ The most useful work for historical studies is a critical bibliography recently published in Peking which is described in an introductory note as "a reference work on *Pen ts'ao* studies." It lists all known editions of each work, and in many cases gives detailed descriptions and bibliographical information which sometimes solve questions of filiation and authorship. Its usefulness is further enhanced by title and author indexes to the 278 works, including a few Japanese titles, which it treats.⁵ A similar descriptive bibliography, restricted to works on agriculture written before the influence of western technology, appeared in the same year.⁶

The term *pen ts'ao*, which seems to have made its first appearance in Chinese literature about 30 B.C., appears in the titles of many of the works which will be discussed below and will be used in this paper as a term of convenience. The two Chinese characters for this term mean, literally, woody and herbaceous plants, but it is used in a very broad sense and with various ramifications in book titles. We thus encounter it in the titles of works concerned with botany in general, pharmaceutical botany, dietetics, rhymed works on medicine, and materia medica in its broadest sense.

The earliest known Chinese illustrations from nature appear on the skillfully painted and technically well made neolithic pottery found in North China. These illustrations, however, seem to be limited to animal life and include no plant forms. Neither do identifiable plant forms appear on the richly decorated bronze ritual vessels made during China's first historic period, the Shang Dynasty (c. 1700—c. 1100 B.C.), although their surfaces are covered with many types of animal forms, both real and imaginary. But the writing which flourished along with this highly developed bronze art provides us with numerous examples of pictorial representations of plant life. The earliest Chinese writing now known, dating from about 1500 B.C., is well-developed and must have gone through a considerable period of evolution in which the earlier style was probably more detailed than this later and somewhat stylized writing. Nevertheless, in the writing now available a number of cereal plants and trees are clearly differentiated from each other because, even at this stage in its development, it was still more or less pictographic. This was especially true in the case of concrete objects, and the Chinese scribe seized upon the dominant characteristics of the plants and emphasized them, forming a sort of caricature, in order to distinguish them from similar species.

The beginnings of pharmaceutical botany in China are ascribed to one of the ancient culture-heroes, a mythical ruler of high antiquity named Shen Nung, or Divine Husbandman. The *Shen nung pen ts'ao*, traditionally regarded as the oldest herbal in China, is named in honor of this mythical ruler who is said to have taught the primitive Chinese the arts of agriculture and medicine. The bibliographical history of this work is obscure, but it seems to have been in existence by the second century A.D. It has not been transmitted directly, but was reconstructed in recent times from quotations found in various other early botanical works.

Numerous writings of a botanical nature were compiled during the first half of the first millenium, but the earliest original and complete botanical work still in existence is the *Nan fang ts'ao mu chuang* (plants and trees of the South) compiled about A.D. 300 by Hsi Han, then governor of the area around present-day Canton. This work briefly treats a total of eighty species and divides the vegetable kingdom into herbs, forest trees, fruit trees, and bamboos. It also contains what is probably the first reference in any literature to the biological control of plant pests. This occurs when the author describes the commerce in ants for the control of worms in tangerine trees, carried on by the Annamese.

The earliest medical botany still existing in any degree of completeness is the *T'ang pen ts'ao* (pharmaceutical codex of the T'ang dynasty, 618-906). It was compiled in 659 by order of the emperor and was based principally upon previous works of this nature. It originally consisted of 25 chapters of illustrations without text, 7 chapters of illustrations with explanations, and 20 chapters of text. Unfortunately, all of the sections containing illustrations have been lost, and only the 11 chapters of text remain. Chinese scholars now describe it as "the earliest medical work of our country and also of the entire world," and compare it to a government medical work produced in Nuremberg in 1542, pointing out that the Chinese work is about nine centuries earlier.⁷

Besides being the undisputed inventors of paper, block printing and moveable type printing, the Chinese can also claim some firsts in books in the field of agricultural botany. The most outstanding of these are the *Chü lu*, a monograph treating all aspects of the culture of oranges,⁸ and the *Li chih p'u*, a similar work on the popular litchi (lichee) fruit. Both were produced around the middle of the culturally brilliant Sung period (960-1280) and are generally regarded as the first works on fruit culture in any language.

These are but a very few of the earliest Chinese botanical books which served as prototypes for the flood of works to appear in the ensuing centuries. We must now consider, but only briefly, a few illustrated works from both China and Japan, and especially the latter. Although the Chinese were the first to illustrate books with engraved blocks, the Japanese appear to have produced many more illustrated books by this method.

Chinese culture was adopted on a very broad scale in the sixth century by the Japanese, who were still in a rather primitive state. The subsequent growth of civilization in Japan is reflected to a certain degree in the development of its botanical works. At first the Japanese copied Chinese works directly and tried to fit them to their own environment whether this was completely practical or not. At a later period they used Chinese works as a basis only and made their own contributions according to the differences in flora, and also created completely independent works. Finally, there was a period of great western influence which became apparent in Japanese works in this field long before it did in Chinese works.⁹

The works discussed below have not been chosen for the beauty of their illustrations, although many of them are quite beautiful and technically excellent, but as typical examples of illustrated books in such areas as general

materia medica, famine herbals, botanical monographs and floras, economic and agricultural botany, horticulture and miscellaneous works.

Among the general works, one of the most famous is the *Cheng lei pen ts'ao* (classified pen ts'ao). An incomplete copy of this work, printed in 1249, is in the Library of Congress. It is a revision of several earlier illustrated editions which seem to derive from a printed edition of 973. The later editions enlarged and improved upon the prototype, and the 1249 edition was in 30 chapters arranged in the following order: minerals, herbs, cereals, vegetables, fruits, trees, insects, fishes, birds, quadrupeds and man. This arrangement was rather closely followed in many of the later *pen ts'ao* and it should be noted that some of these general works closely approach natural histories. It was lavishly illustrated and, among other things, included illustrations of ephedra, salt-making and the banana plant which must be among the oldest illustrations of these subjects now extant. Most of the illustrations of plants appear to have been drawn from life and are readily identifiable. Many of them are superior to illustrations in European herbals of a much later date. The *Cheng lei pen ts'ao* very clearly prescribes ephedrin for relief of colds, congestion, and headaches, but the Chinese had been using the product of this plant for this purpose some 1500 years before it was officially entered into the American pharmacopoeia with the approval of the American Medical Association.¹⁰

The most widely known of the general works is the *Pen ts'ao kang mu* (general materia medica) by Li Shih-chen, who finished this great compilation in 1578 after twenty-six years of work. The preface of the first printed edition was written in 1590 and this work has now gone through some thirty editions. It soon became the standard pharmacopoeia of China and was widely used until recent times: some Chinese "herb doctors" in this country still follow it to some degree. A voluminous work, compiled from a great number of previous writings, it did not have the originality of some of the earlier herbals, especially that of the great *Famine Herbal* of 1406 which will be described later. The illustrations in the early editions of the *Pen ts'ao kang mu* were small and crude, but they were greatly improved in later ones. Many of the early drawings appear to be copies of older illustrations and some were made from literary descriptions. The latter is apparent in the case of the illustration of maize. In the illustration of this plant in the *editio princeps* the artist placed the ear on top of the stalk where the tassel should be. It is thus obvious that he did not draw from life, and he apparently misinterpreted Li Shih-chen's fairly good description. This error was corrected in later editions.

Some interesting material for the history of botanical iconography is given in a note preceding the sections on illustrations in vol. 35 of the 1885 edition, which is generally regarded as the best one. Here the editors, the brothers Chang Shih-yü and Shih-heng, suggest that former illustrations for the *pen ts'ao* had been symbolic rather than naturalistic interpretations and that they do not clearly differentiate between similar objects. They conclude by saying, "This is why naturalists are often in doubt about the differences between haws, pears, oranges and pumelos. In this book, however, we have made detailed studies and comparisons in order to obtain complete accuracy in our pictures. Even exotic products from distant places can be identified in most cases by relying upon these illustrations." At the end of the long section of illustrations, which are indeed superior to those in earlier editions of the *Pen ts'ao kang mu*, they add another note which gives interesting bibliographical information rarely found in Chinese works: "In the preceding 1,127 illustrations of minerals, grasses, trees, vegetables, cereals, fruits, birds, animals, insects, scaly creatures and mollusks, we have added seven illustrations to the cereals, ten to the grasses, and we have revised and corrected 412 others. Mr. Wang Ching-t'ang and Mr. Chu Tsao-ch'en were in charge of collation and editing. Mr. Hsü Kung-fu drew the illustrations. Mr. Fan Ching-ts'un superintended the engraving of the blocks and the printing which was started in the eighth month of 1883 and completed in the sixth month of 1885. When I and my younger brother had finally checked and approved the work, we wrote this colophon."

Finally, a Japanese first aid manual must be included among the general works because it contains such excellent woodcuts of most of the products usually found in the general herbals. This is the *Kōkesai kyūhō* which was compiled by a court physician, Tamba Gentoku (1732-1801), and published in 1790.¹¹ It was done by the order of the *shōgun* Iyeharu in order to disseminate some medical knowledge among the common people, especially for emergency treatment. Court patronage undoubtedly accounts for the superb quality of printing of both the numerous illustrations, described by Maggs as "very finely executed woodcuts," and the text. One of these illustrations which shows resuscitation of the drowned was used by Castiglioni in his famous history of medicine, but he erred on two accounts in his description of it. The print is not Chinese, nor does it illustrate induced vomiting, as he states in the caption of his illustration.¹²

Crop failure due to flood or drought has occurred in some part of China almost every year since ancient times, and various works were written to explain which plants, not normally used as food, could be used in these

emergencies. The outstanding work of this kind was compiled in a truly scientific manner by Prince Hsiao of the Ming dynasty between 1382 and 1400. The preface to the original edition of 1406, written by Pien T'ung, an official in the Prince's establishment, says that the Prince was a very humane person and was so distressed by the suffering of the people during famines that he decided to do something that would help them in such times. He therefore purchased from farmers and recluses, seeds and slips of over 400 plants, which could be used as emergency food. These he had planted in a garden on his estate near modern Kaifeng and personally studied them. When they were mature, he ordered artists to make drawings of them. He classified these into fifteen groups according to the edibility of the leaves, fruits, roots, flowers, stems, shoots, and combinations of these. Then, according to Pien's preface, he compiled the *Chiu huang pen ts'ao* (herbal for relief from famine).¹³

A new edition of this work was published by a scholar and official named Li Lien in 1525, and his preface contains some interesting material. He says that botanical works without illustrations can cause errors in the identification of plants, errors that could result in death for those using the plants. "This," he says, "is why the *Chiu huang pen ts'ao* was written. It has both illustrations and explanations. The illustrations closely resemble the plants, and the text explains how to use them. . . . There are 414 kinds of plants in this book; 138 of them can be found in older herbals while 276 are here newly added. If a crop failure should occur, these plants can be obtained without difficulty anywhere by using the pictures as a guide when hunting for them. If they are selected and eaten according to the instructions, one will be able to survive."

Although illustrated herbals were printed in China some four centuries earlier, the *Chiu huang pen ts'ao*, because of the size and quality of its 414 illustrations, is frequently used for comparison with the first woodblock herbals of the west such as Konrad von Megenberg's *Das Buch der Natur* (Augsburg, 1475) and the *Herbarium Apulei* (Rome, 1481). The illustrations in the Chinese work are generally considered to be superior.¹⁴ This work (and its Japanese version, the *Kyūkō honzō* printed in 1715) deserves much more attention, but we must leave it with a quotation from Sarton: ". . . it is worth while to stress once more the exceptional importance of the *Chiu huang pen ts'ao*, which was probably the most original compilation of its kind, not only in China, but anywhere."¹⁵

In contrast to the general materia medica which cover all three kingdoms of nature, there are a number of comprehensive and well-illustrated works which are limited to plants alone, and some of them are conceived on

a grand scale. The greatest of the pre-modern Chinese botanies is the *Chih wu ming shih t'u k'ao* (illustrated treatise on botany) by Wu Ch'i-Chün in 40 folio size volumes containing 1,714 full-page woodblock illustrations. The work was first published in 1848 after Wu's death so we do not have a preface by him. But the preface by the editor intimates that the drawings were done by Wu, and some evidence to support this is found in the text. The following is one of a number of examples of such evidence. In his description of the *kuei chiu* (devil's mortar), whose identity is not certain but which seems to be related to the umbrella plant, he says, "This plant grows deep in the mountains and not many northerners have seen it. . . . Once when I was travelling, I met one of the mountain folk carrying some to market. The flowers and leaves were very large, and I quickly drew a picture of it." On the other hand, it seems quite obvious that some of the illustrations are copied after the excellent examples in the *Herbal for Relief from Famine*. Whatever be the source of these drawings, whether they be originals by Wu or copies from other sources, they are generally of excellent quality. In these botanical works, unfortunately, the Chinese are not as careful as the Japanese about recording the names of the artists. Figure 1, chosen at random from the 1880 edition of the *Chih wu ming shih t'u k'ao* which was printed from the original blocks, is nine inches in height and is typical of most of the other illustrations in that it is done in outline and with no shading on the stems or leaves.

This voluminous work may be characterized as a descriptive botany based upon the previous literature and Wu's personal observations, and containing some information on the uses of these plants as food and medicine. Numerous passages scattered throughout the work clearly show that during his many travels as a high official throughout the empire Wu personally hunted for the plants of particular areas and carefully studied them. This type of field work allowed him to point out errors in earlier texts and illustrations. Bretschneider describes this lavishly illustrated and profusely documented compilation as "undoubtedly the best Chinese pictorial work of this class and entitled to special attention on the part of students of Chinese botany," and Merrill and Walker call it "the most important source of Chinese information on native plants." Its importance was also recognized by the Bureau of Plant Industry of the U. S. Department of Agriculture which prepared a three-part index to this work between 1912 and 1922 entitled "Indexes to the Great Chinese Botany *Chih wu ming shih t'u k'ao*." A feature article on the drug trade in *The Wall Street Journal*, 28 April 1959, reported that the leading pharmaceutical houses of this country, after having neglected botanicals to

a certain degree in favor of synthetic products, are now making world-wide hunts for plants which might yield new and more potent medicinal compounds, and are searching through the ancient literature of Egypt and other early civilizations for clues to unknown drug sources. China was not mentioned in this article, but surely the above work which has been recognized by scientists, and the pharmacological literature of China as a whole, should be promising fields for such investigations.

At about the same time that the above work was being compiled in China, another flora of the same magnitude, but with some marked differences, was being compiled in Japan. This is the *Honzō zufu* (illustrated manual of plants) a beautiful and monumental pictorial work by Iwasaki Tsunemasa (1786-1842), superintendent of a botanical garden. This work has a long and somewhat confused history in which three whole or partial editions of the work stand out clearly. The Japanese botanist Shirai Mitsutarō has written a brief history of the work and a detailed biography of its author.¹⁷

Iwasaki was concerned about the lack of accurate illustrations of plants, especially in color, so in 1828, after long years of botanical study during which he made careful paintings of about 2,000 plants, he began the ambitious project of publishing these illustrations in color. Judging from his own words, it appears that he intended to print the entire collection of drawings in black and white outline and have the colors added by hand. This project seems to have come to an end for financial reasons in 1830 with the printing of only four volumes on mountain herbs. In his personal diary Iwasaki states that in 1830 he borrowed a considerable sum of money for the engraving of the printing blocks, but the project proved to be too costly and printing was stopped but the production of the work was continued in manuscript. A colophon in the fourth printed volume of 1830 promises that two other series will appear, and one sees references to other small groups of volumes printed shortly after this time. But Shirai explicitly states in his history of this work that these four volumes were the only ones printed. He means, of course, that these were the only ones printed with Iwasaki's authorization.

Something of Iwasaki's method and his feeling about illustrations is contained in his preface to the 1830 edition. It is dated 1828 and was thus written two years prior to the actual publication of these four volumes. The following is a free translation of the pertinent parts of this long and philosophical preface.

“Although some previous works have explanations of excellent quality, the fact is that they overemphasize the explanations and neglect the illustrations. And although some of them do have illustrations, they are



FIGURE 1: Woodblock print of a tiger lily from the *Illustrated Treatise on Botany*, China, 1880.

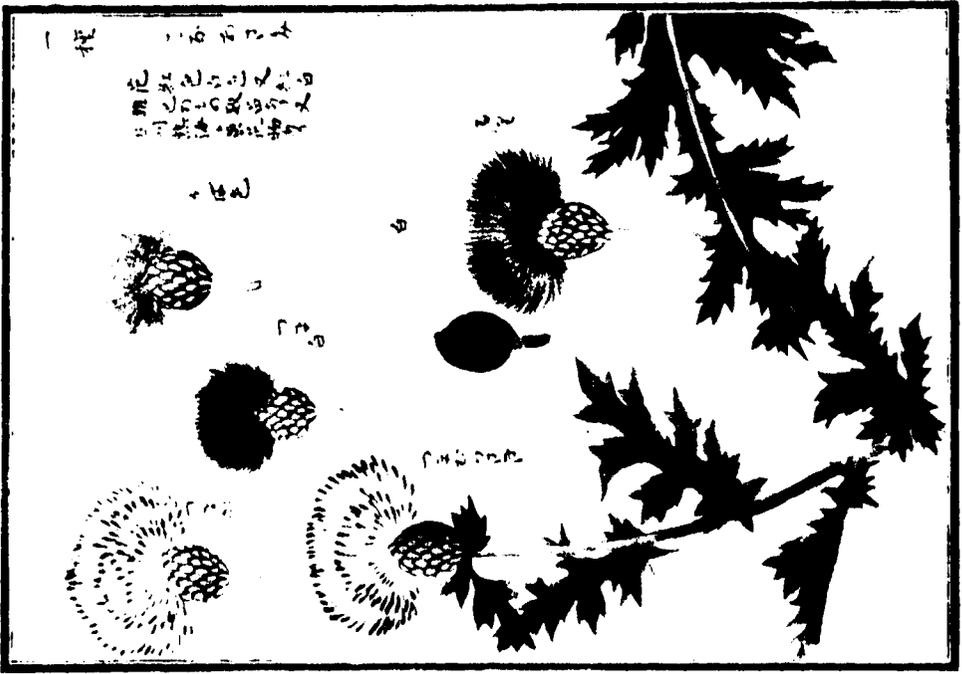
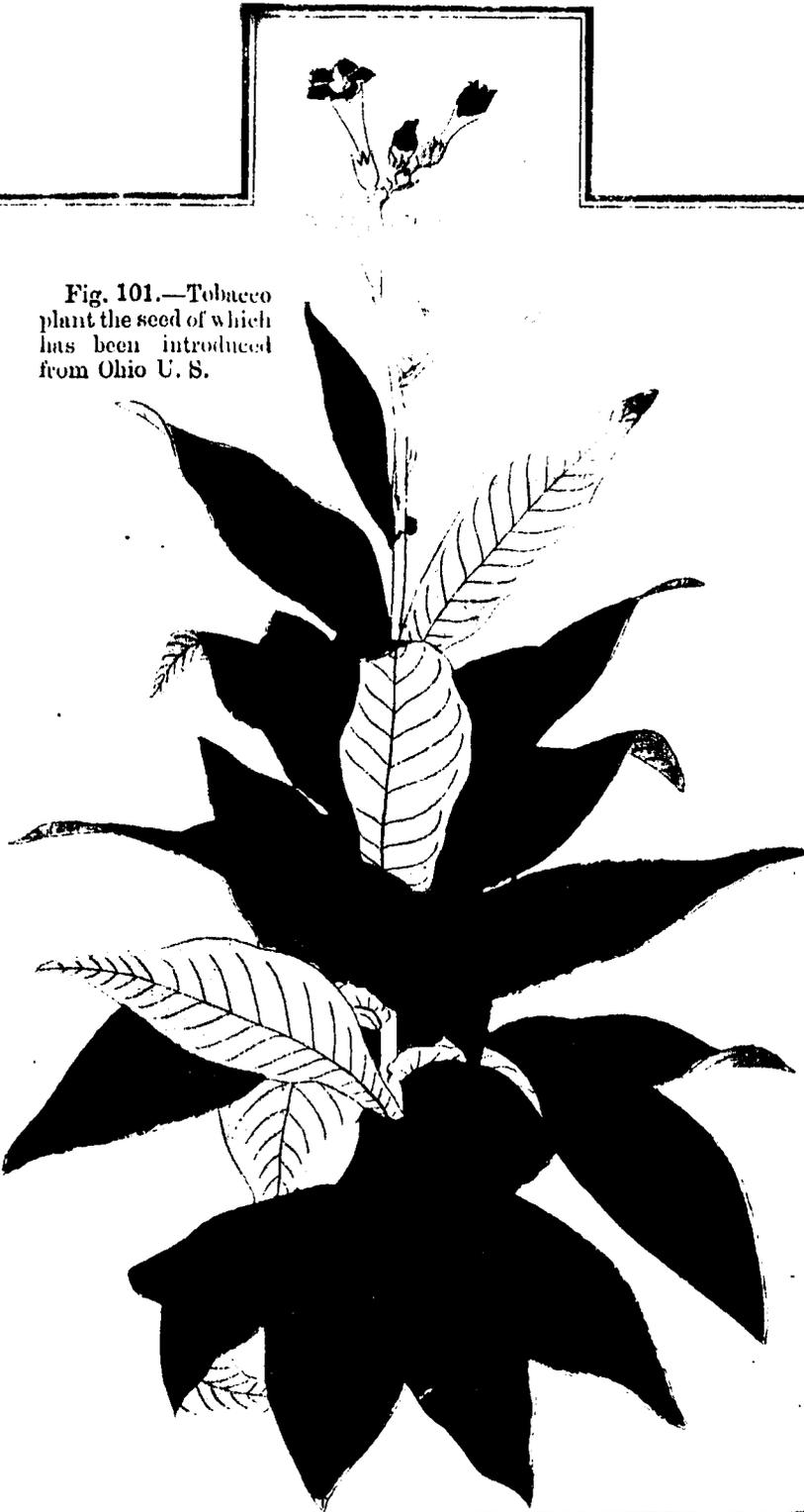


Figure 2: Double-page painting of *Cirsium incompitum* from a manuscript version of the *Illustrated Manual of Plants*, Japan, 1887.

Fig. 101.—Tobacco plant the seed of which has been introduced from Ohio U. S.



第百一圖 米國ノハイノ種煙草ノ全形ヲ示ス

FIGURE 3: Combination woodblock, lithograph and metal print from the first scientific Japanese work on tobacco, 1881.

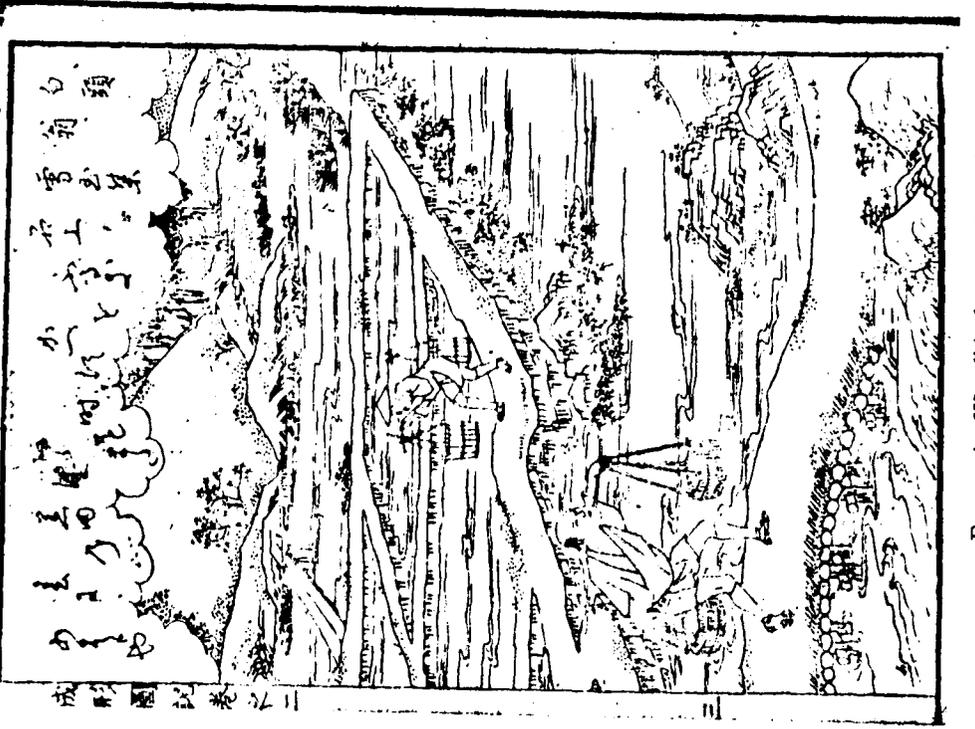


FIGURE 4: Woodblock print from the encyclopedic *Illustrated Explanations of Agriculture*, Japan, 1804.

sketchy and poorly executed. They have been copied and recopied many times, so that one can scarcely distinguish between flower and fruit, and a tiger can be mistaken for a cat. Those who later studied these works were utterly confused by them. What a pity! This is the reason why I made this illustrated manual.

“As far as the shapes of visible objects are concerned, nothing is as good as illustrations to distinguish one from another. This is not the case, however, with the taste and nature of plants which require a description in words to make them understandable. . . . This is why we have no choice but to combine illustrations with explanations. No matter how detailed a description may be, the reader may be plagued with doubts, even after he forms a mental image of the object, and find it very difficult to identify it with accuracy. This is not the case with an illustration—as soon as we look at it we immediately grasp its meaning and we do not have to weary ourselves with a profound study of a difficult text to come to a conclusion. Thus, the value of illustrations is obvious. And it is for this reason that they must be made with all possible skill and accuracy. If they are not, how then will it be possible to differentiate plants which closely resemble each other? . . .

“I personally hunted and collected plants in the mountains and fields and set them out in gardens and pots. Eventually, I had over 2,000 varieties and I made drawings from the living plants, at different seasons, of their stems, leaves, flowers and fruits. I did this for over twenty years, and then I arranged them into a number of volumes and named them the *Illustrated Manual of Plants*.

“As far as the illustrations in this work are concerned, the engraving is of the very best quality possible, and it faithfully renders the spirit of the original drawings. When color has been added to them, I will be completely satisfied.”

The production of the second, or manuscript, edition was a slow process. Manuscript volumes with water-color paintings were completed at the rate of about four volumes a year and the work was finished in about twenty-five years in ninety-two volumes with over 2,000 illustrations. It is probable that a few sets of the four volumes printed in 1830 were colored by hand and inserted into the manuscript versions, but this was not the case in the only complete manuscript copy seen by this writer.

The manuscript copy was so beautiful, and sets of it, and even separate volumes, became so truly “excessively rare,” that a new addition was obviously needed. Accordingly, a Society for the Publication of the *Honzō Zufu* was

organized early in this century for the purpose of printing a complete woodblock edition of the work in color. But again there were financial difficulties. The cutting of the blocks and the color printing of this enormous work lasted from 1916 to 1921, and an increase in costs due to the First World War forced the dedicated publisher. Mr. Iwamoto, to sell his personal library and cut down on his staff in order to complete the printing. The 2,000 illustrations were contained in ninety-two volumes measuring seven by ten inches, and each volume was provided with a Japanese binomial index by the botanist Shirai Mitsutarō. An additional volume contains Shirai's history of the *Honzō zusu* and biography of Iwasaki, and volumes 94-95, published in 1922, are detailed Japanese and Linnaean indexes to the entire work, compiled by Shirai. The publication of this monumental woodblock color edition of 1921 is a tour de force that demands admiration of technical skill and perseverance, and its illustrations are indeed beautiful, regardless of whether they are always completely accurate. But the manuscript work in color, especially when seen in a complete copy, is far more impressive and it excites admiration of the Far Eastern artistic ability and contempt for time.

Figure 2 shows two varieties of *Cirsium incomptum* from the fifth volume of a complete manuscript version, later than the Iwasaki copies, in forty-five volumes. Unfortunately, this photograph gives a very poor impression of the colors, their shading from vivid to subtle tones, and the crisp delineation of leaves, stems and flowers. Even a hasty comparison with the corresponding plate in the twelfth volume of the printed edition will clearly show the superiority of the painting. But there is no intention here to degrade the color prints in the 1921 production, for, while understandably not of the caliber of the best *ukiyo-e* prints of the past, they are of excellent quality and the publisher wisely shunned the use of the aniline dyes which were responsible for so many badly colored prints and books in Japan after the importation of these colors from the west. The printed illustration corresponding to Figure 2 has some ten different colors applied by blocks. It is not surprising that the dedicated publisher Iwamoto had to sell his book collection to meet the expenses of such an undertaking. The illustrations are always at least full-page, and a large proportion of them cover two pages. The rulings for the pages measure about $8\frac{1}{4}$ by $5\frac{3}{4}$ inches in both the manuscript and printed versions.

As to the source of these illustrations, Iwasaki Tsunemasa states in 1828, in his preface quoted above, that he drew them, as does Shirai in his biography of the botanist. But in an undated foreword following this preface Iwasaki gives further information. He first expresses dissatisfaction with several

illustrated works, saying that they were crude and lacked detail and accuracy, and certain Japanese works did not come up to his standards because their illustrations were either uncolored or, if colored, were not true to life. He then tells of a foreign source for some of his illustrations: "I drew pictures of all of those plants that I was able to examine personally. As to foreign plants like the spikenard, tulip, nutmeg, clove and others, these have been added from the western *u-e-i-n-ma-n* pictures owned by Udagawa Yōan. . . . and for each one I have given the scientific name and the foreign name. Moreover, although a plant may be indigenous to Japan, if I have used a picture made by someone else, I have given its source in the notes."

The western name indicated by the Japanese phonetic transcription as *u-e-i-n-ma-n* is presumably that of the German botanist Johann Wilhelm Weinmann (1683-1741).¹⁸ Actually, quite a large number of illustrations come from Weinmann and these can be spotted very easily because of the shading and cross-hatching used to indicate contours, devices which are truly foreign to early Japanese and Chinese art, but which in most cases have been faithfully copied from the foreign source. Acknowledgement is always given beside the picture or in the short text describing it. Other sources for illustrations noted by Iwasaki include "a Dutch book", Dodoens and Siebold.¹⁹

In several cases illustrations from Dodoens, in black outline only, are shown facing the corresponding illustrations from Weinmann in color. A short note points out similarities or differences between the two. In the illustrations of the dragon-tree (*Dracaena draco*, L.) the western cross-hatching is omitted in the manuscript copy showing Weinmann compared with Dodoens, but is retained in the comparison of the nutgall (*Quercus infectoria*, Oliv.). There is much material in this work for an instructive exercise in botanical iconography.

Iwasaki warns in his preface that he will emphasize illustrations and abbreviate the explanatory texts, and this he certainly does. However, although these texts are very short compared to those in similar Chinese works, they contain much highly interesting and important information. Besides a physical description of the plant (and often its medical uses), these texts frequently give information on the introduction of various plants, perhaps for the first time, into Japan. Many of these notes give the date of the importation of seeds, bulbs, roots or whole plants, and describe the subsequent planting in a specific botanical garden with data on their growth. These plants, according to Iwasaki's notes, came from Holland, China, Korea, the Ryukyu Islands and "overseas," and some were "brought to Nagasaki by the Dutch."

There are many other early Japanese flora which are of interest and importance because of their illustrations, but only a few can be briefly mentioned. The *Chikinsō* (summary of the earth's beauty) by Itō Ihei, in 20 volumes, was published in three series between 1710 and 1733. It contains hundreds of illustrations of flowers, many in habitat groups with name tags attached to them. The illustrations vary considerably in quality between the series, but in general those in the first series are the best. The *Ehon yazansō* (illustrations of mountain and field plants) published in 1755 by Tachibana Yasukuni in 5 volumes, contains good illustrations of isolated plants and habitat groups.

The *Ka i* (collection of flowering plants) was highly respected by early western botanists in Japan and was translated into French by Dr. L. Savatier, a naval surgeon and botanist who was stationed in Japan in the latter part of the nineteenth century. This excellently illustrated work in eight volumes is by Shimada Mitsufusa and Ono Ranzan, and was first published in 1759. In his preface, Shimada describes the reason for compiling this work, and the quality of his drawings, as follows:

“What is *Ka i*? It is a work intended to make known the appearance of certain plants and flowers. Since ancient times there have been many books with the figures of plants in them, for there have been many writers on this subject. However, if one compares the actual plants with the pictures in these ancient books, they are not easily recognized, or at least one is left in doubt; and it is always difficult to distinguish one species from another, for much still remains unclear even with the aid of these drawings.

“Ever since my youth I have been fond of plants and trees that grow on land and in the water, and I have roamed the mountains and streams and seas in search of them. I brought back those that were near and planted them in my garden. I made careful drawings of those that were distant and stored them away. This I did for more than twenty years.

“Because it was difficult for me to identify my specimens with the aid of the pictures in the old books, I made new drawings, when I found the time, so that it would be easier for others to identify these plants. I drew them so accurately that a single glance is enough to identify them. Although the appearance of plants varies somewhat according to the climate of the places in which they are found, this will not cause any difficulty in identifying them. . . .”

During the compilation of this work, Shimada asked the famous naturalist Ono Ranzan, called the Linnaeus of Japan by some early western botanists, to collaborate with him. Ono wrote a short preface to the section on trees which is very illuminating as far as botanical illustration at this time is concerned: "There are certain rules which require one to draw things in a certain manner, but I cannot comply with these rules if I am to represent things as they really are And if I have drawn these plants as they actually are in order to distinguish different species more clearly, please do not blame me for not having followed the traditional rules. . . ."

It is most unfortunate that Savatier's translation, *Botanique Japonaise, Livres Kwa-Wi* (Paris, 1873), does not contain the beautiful illustrations from the original work.

One of the most extraordinary of the illustrated Chinese works in the field of agricultural botany is the *Yü t'i mien hua t'u* (imperial comments on illustrations of cotton culture) compiled by the prominent official Fang Kuan-ch'eng in 1765 and presented to the Emperor. At first it consisted of sixteen drawings of all aspects of cotton growing and processing with explanations written for each picture by Fang. Other material was added, such as poems by two emperors and a history of cotton culture in China. Fang had the whole carved on stone slabs from which rubbings or inked-squeezes were made and bound up in albums. Wooden blocks were also carved after the stone slabs and additional copies were made from these. It is interesting to note that this text recommends the planting of heavy seed only, that is, seed that sinks in water, and also that the seed be immersed in very hot water before planting. The Chinese apparently preceded Americans in the knowledge that heavy cotton seed is superior to light both in germination and yield and that hot water destroys certain types of fungi and spores in cotton seed.²⁰

An elaborate work on tobacco in Japan, richly illustrated by 156 plates in color was published by Aoe Hide in 1881. This is the *Satsugu ensō roku*, (account of tobacco in Satsuma and Osumi provinces) in five volumes (generally bound in one western style volume with hard covers), and printed with moveable metal type. This work covers all phases of the tobacco industry and treats in detail and illustrates such things as morphology of the plant planting and care of seed beds, transplanting, pests and diseases, harvesting and curing, etc., and it even has a section on the history of tobacco smoking. The plates are of technical interest because the outlines for the drawings were printed from metal plates and colors were added by lithograph. But the colors of some of them, the author says, were unsatisfactory, and these were overprinted with wooden blocks. All plates are carefully described in

a separate section at the end of the work and there is also a short English summary. Figure 3 is typical of the plates, many of which are over-size and printed on two separate pieces of paper pasted together.

Plans were made in 1793 for the compilation of an encyclopedic treatise on agriculture and agricultural botany under the sponsorship of the Lord of Satsuma Province. This great project was undertaken by Sō Senshun, a well-known naturalist, and Shirao Kokuchū, and was named *Seikei zusetu* (illustrated explanations of agriculture). The work was planned to fill 100 volumes, but because printing blocks and manuscripts for it were twice destroyed by fires in 1806 and 1829, work was terminated with the publication of thirty volumes in 1804. These volumes deal with agricultural ceremonies and festivals, planting and tending crops (Figure 4), surveying, irrigation, flood control, farm implements, varieties of rice and various agricultural products. Fire, along with insects the great enemy of books in Japan, has not only terminated ambitious projects like this one, but has also been responsible for the great scarcity of many block printed books through the destruction of both printed copies and stored printing blocks.

The Japanese also produced an illustrated work on cotton culture, but it was more modest and more practical than the spectacular Chinese work already mentioned. This is the *Menho yōmu* by Ōkura Nagatsune, printed in 1833 in two volumes. It has excellent illustrations on all phases of the cotton industry from planting to marketing.

A remarkable work in the field of economic botany is the *Nōka eki* (profit for the farmer) which is concerned solely with the cultivation of the wax tree (*Rhus succedanea*) and the production of its wax. This also was written by Ōkura, who seems to have been sincerely interested in helping farmers to supplement their meager income. The work was first published in seven volumes between 1802 and 1818, and it is now very difficult to find complete sets. There was also a later and expanded edition which was completed in 1854. The work is fully illustrated with excellent woodcuts of the entire industry from the growing of the trees to the manufacture and marketing of the wax. Of particular interest are some of the detailed illustrations on grafting.

A less well-known work by the same author, Ōkura Nagatsune, is actually in the field of technology but is closely related to agriculture. This is the *Seiyū roku*, a manual printed in two volumes in 1836 which describes the manufacture of vegetable oil from sesame and other oil seeds. The illustrations are by a minor *ukiyo-e* artist, Matsukawa Hanzan, and they cover such subjects as grading of seeds, extraction of oil by presses and water mills, tools and equipment, refining and marketing.

In the same category is the very rare *Satō seisakuki* on the manufacture of sugar, written by Kimura Matasuke (or Yoshiyuki) and printed in 1797. It illustrates and describes the cultivation of sugar cane, different types of mills, crushing and refining. This is the *Satō seisakuki*.

There are many more excellent examples of illustration in the broad fields of botany and agriculture, but space permits only a few closing generalizations. Illustrated books in the field of horticultural botany offer perhaps the greatest display of the virtuosity of the Japanese printer of some two centuries ago. Books on cherry blossoms, plum blossoms, bamboo, morning-glories, chrysanthemums and other subjects fully demonstrate the great ability of artist, engraver and printer of that time. In monochrome block books like the *Asagao zufu* on morning glories, shading runs from very light to deep black, and in the *Sōmoku kinyōshu*, a work limited to plants with variegated leaves, there are very dramatic illustrations in sharply contrasting blacks and whites. Many works in this field deserve study solely for the quality of their illustrations. Brief mention should be made of a certain type of illustrated geographical work. These are called *meishō zue* because this term, or a synonym, forms the last part of the title, following a geographical name. The term means "pictures of famous places," and these generously illustrated works may cover the entire country or be limited to a province, city, or even a temple and its grounds. Many illustrations on botany, especially gardens, and on technology are found in these guidebooks, some of which are in as many as thirty volumes. Works on flower arrangement also should not be overlooked because many of them have beautiful and accurate illustrations of the flowers used in this aesthetic hobby.

The works with the greatest charm and subjective interest are those personal sketch books of botanists or naturalists that one finds only very rarely. They are generally in color and done with great skill, and often they are concerned with studies of details of flowers or seed pods, as well as of whole plants and habitats. Almost always there are marginal notes giving the date of the sketch and where it was made, references to botanical literature, and perhaps some incidental information like meeting a friend or visiting a temple. These are truly among the most delightful of all botanical illustrations.

Finally, after collecting books like those mentioned here for more than twenty years, I must conclude that, although much work has been done on the bibliography and scientific study of plants in these books, one important field—that of botanical iconography—remains entirely untouched in spite of the great amount of interesting material available.²¹

Notes

This is a revision of a lecture given on 27 June 1964 at Linda Hall Library, Kansas City, as part of the program of the American Library Association's Institute on Rare Books in Natural History, sponsored by the ACRL Rare Books Section, the University of Kansas Libraries, and the Linda Hall Library. Because the lecture was based on a large number of slides, considerable revision has been necessary to compensate for the lack of illustrations. It should be pointed out that in this short lecture only a few works could be mentioned and that they were chosen from a large number of similar works mainly because of the interest of their illustrations. It is with pleasure that I record my gratitude to the Guggenheim Foundation, the Fulbright Commission, and the American Philosophical Society, whose generosity made it possible for me to gather much of this material during numerous trips to the Far East.

1. Emil Bretschneider, "Botanicon Sinicum. Notes on Chinese Botany from Native and Western Sources," *Journal of the North-China Branch of the Royal Asiatic Society*, n.s. vol. 16 (1882), pp. 18-230. This is the most important part of his work for the present subject, but additional areas are covered in the second and third parts of this study in *op. cit.*, vol. 25 (1893), pp. 1-468, and vol. 29 (1896), pp. 1-623. Still further information, mainly on western work on Chinese flora, may be obtained from his *History of European Botanical Discoveries in China*, 2 vols. (Leipzig, 1935). Descriptions of individual Chinese botanical works may also be found in various issues of the *Annual Report of the Librarian of Congress: Division of Orientalia*, between 1922 and 1942; many of these have been utilized by George Sarton in his *Introduction to the History of Science*, 3 vols. (Baltimore, 1927-1947).

2. Elmer D. Merrill and Egbert H. Walker, *A Bibliography of Eastern Asiatic Botany* (Jamaica Plain, 1938), pp. 551-561. The *Supplement* (Washington, 1960) by Walker does not contain any older works, but the subject index contains references to articles on some of them.

3. P. Huard and M. Wong, "Evolution de la matière médicale chinoise," *Janus*, vol. 47 (1958), pp. 3-67. These two scholars have written many excellent articles on the history of Chinese medicine but they must be used with circumspection because they often contain minor errors in dates, spellings, bibliography and cross references.

4. Sun Chia-shan, "Pen ts'ao hsüeh ti ch'i yüan chi ch'i fa chan" (the origin and development of *pen ts'ao* studies), *Nung shih yen chiu chi k'an* (Journal of Studies in the history of agriculture), vol. 1 (1959), pp. 101-114.

5. Lung Po-chien, *Hsien ts'un pen ts'ao shu lu* (bibliography of extant *pen ts'ao*), (Peking, 1957).

6. Wang Yü-hu, *Chung kuo nung hsüeh shu lu* (bibliography of chinese agriculture), (Peking, 1957).

7. Lung Po-chien, *op. cit.* (Note 4), preface.

8. For an annotated translation of this early work on oranges, see M. J. Hagerty, "Han Yen-chih's *Chü lu*," *T'oung Pao*, ser. 2, vol. 22 (1923), pp. 63-96.

9. A very useful and well-illustrated survey of Japanese botanical writing is Harley Harris Bartlett and Hide Shohara, "Japanese Botany During the Period of Wood-Block Printing," *The Asa Gray Bulletin*, n.s. vol. 3 (1961), nos. 3-4. As may be expected in a bibliographical study of such detail and coverage, there are a number of minor errors; the most glaring error occurs on pp. 427-429 where the *Ka i* and the *Honzō zufu* are confused and an illustration from the latter is attributed to the former and is so labelled. A revised and expanded version of this excellent pioneer American work on early Japanese botany would be most welcome, and would make a fitting memorial to the late Professor Bartlett. Useful Japanese sources for this subject are, Tōkyō Kagaku Hakubutsukan (Tokyo Science Museum), ed., *Edo jidai no kagaku* (science in the Edo period) (Tokyo, 1934), and Shirai Mitsutarō, *Nihon hakubutsugaku nempyō* (chronological tables of the natural sciences in Japan) (Tokyo, 1934).

10. See the illustration of two varieties of ephedra from the 1249 edition of this work in *Annual Report of the Librarian of Congress: Division of Orientalia* (Washington, 1941), facing p. 155 where a description of the work is given. Both illustration and description have been reprinted: A. W. Hummel, "The Printed Herbal of 1249," *Isis*, vol. 33 (1941), pp. 439-441.

11. This work is listed in Maggs Bros. Cat. 520 (1929), item 683, where a typographical error makes the date 1730, two years before the birth of the author. An excellent illustration is also reproduced here.

12. Arturo Castiglioni, *Storia della Medicina* (Milano, 1936), Fig. 48. The American edition of this work repeats the errors under Fig. 40.

13. An excellent scientific study has been made on this work. See Bernard E. Read, *Famine Foods Listed in the "Chiu huang pen ts'ao," Giving their Identity, Nutritional Values and Notes on their Preparation* (Shanghai, 1946). For a good bibliography of such fundamental studies on Chinese materia medica, see Jacques Roi, *Traité des plantes médicinales chinoises* (Paris, 1955), pp. 443-446.

14. For further information on the illustrations and bibliographical history of this important work, see *Annual Report of the Librarian of Congress: Division of Orientalia* (Washington, 1936), pp. 193-201.

15. Sarton, *op. cit.* (Note 1), vol. 3, p. 1176.

16. Of the several editions of this work, including a Japanese one, the easiest to obtain today is the one published in Shanghai in 1957. This is a handy one volume work of slightly over 900 pages with a punctuated text (not used in texts published fifty years ago, punctuation is a decided aid to the westerner). The illustrations are greatly reduced, but an added advantage is a set of four excellent indexes to names of plants, persons, places and books mentioned in this great work. On the life of Ku Ch'i-chün and a brief description of this monumental work, see E-tu Zen Sun, "Wu Ch'i-chün: Profile of a Chinese Scholar-Technologist," *Technology and Culture*, 6(1965), 394-399.

17. These are in vol. 93 of the printed edition of 1921 and are a good source of information. The statements made in this paper, however, come chiefly from a hurried examination of the three editions of this work and from the preface and the foreword by the compiler. It should be noted that this is only a rapid and superficial study of this massive and complex work, and some of the present statements may require revision.

18. Since the writing of the present paper, it has been established that the book used by Iwasaki was the *Eigentliche Darstellung einiger Tausend in allen vier Welt-Theilen gewachsener Bäume, Stauden, Kräuter, Blumen, Früchte und Schwämme. . .* 2 vols. (Regensburg, 1735) with 175 copper plates, or another edition with a larger number of illustrations. See R. C. Rudolph, "Illustrations from Weinmann's *Phytanthoza Iconographica* in Iwasaki's *Honzō zusu*," *Huntia*, 2 (1965), 1-28. The Udagawa Yōan who had these illustrations was one of the leading naturalists and scholars of foreign science at that time.

19. This is Philipp Franz von Siebold who did much to encourage Japanese scholars to study western science. Iwasaki met him in 1826. The Japanese acquired many western scientific books from the Dutch who were the only Europeans allowed in Japan after the closing of the country around 1640. A great hoard of these early books was found in a long-forgotten storeroom in a library in Tokyo in 1954. Perhaps Weinmann's work is among them.

20. Admittedly ignorant of this field, I draw this conclusion from the fact that Clemson College researchers reported on the use of hot water (Barre and Aull, "Hot Water Treatment for Cotton Anthracnose," *Science*, n.s., vol. 40, 1914, no. 1020, pp. 109-110), and the Department of Agriculture reported on the advantages of heavy seed (Webber and Boykin, "The Advantage of Planting Heavy Cotton Seed," *Farmer's Bulletin*, 285, 1907).

21. It is indeed strange that western scholars who have done so much important work on botanical illustration have almost completely ignored the Far Eastern material. Thus, Agnes Arber, in the revised and enlarged second edition of her superb *Herbals, Their Origin and Evolution* (Cambridge, 1953), might be expected to give passing notice to some of the Far Eastern works, even though her work by definition is concerned with Europe, but she does not. Wilfred Blunt, *The Art of Botanical Illustration* (London, 1951), p. 163, mentions three older Japanese works and reproduces an illustration from one on p. 165. Claus Nissen, *Die botanische Buchillustration, ihre Geschichte und Bibliographie* (Stuttgart, 1951), vol. 1, pp. 241-242, gives the titles of a few older Japanese works which he had not seen. The present writer impatiently awaits the scientific and comprehensive treatment of Chinese materia medica and agricultural works in the forthcoming sixth volume of Joseph Needham's monumental *Science and Civilisation in China* (Cambridge, 1954-), now in its fourth volume.

Bibliography and the Ornithologist

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I was told that my thesis could be anything within the scope suggested by the words "bibliography and the ornithologist." Being a sort of unique hybrid, an ornithologist by inclination and training and a bibliographer by accident, it is only natural that I have some convictions in this area. Accordingly I shall comment briefly upon ornithology, as it has been in the past and is today, and of the relationships of bibliography to this field as I see them.

To start with, I may note that it takes a certain amount of suffering to be successful either in bibliography or in ornithology. In both fields there can be no achievement without drudgery. I have not seen this put more nicely than by Dr. Elliott Coues (1842-1899), himself among the greatest of ornithologists and certainly the greatest of ornithological bibliographers. (Besides being the author of some thousand pages of the most enlightened bibliography devoted to his field, Dr. Coues was the unquenchable author of penetrating opinions on everything from his colleagues' use and misuse of Greek and Latin, through the correct uses of alcoholic spirits in the field, to methods of collecting birds in the country of hostile Indians.) "Bibliography," Dr. Coues opined, "[is] a necessary nuisance, and a horrible drudgery that no mere drudge [can] perform. It takes a sort of inspired idiot to be a good bibliographer, and his inspiration is as dangerous a gift as the appetite of a gambler or dipsomaniac"

Now, what makes a bibliographer an idiot? And, in turn, what makes an idiot a good bibliographer?

A bibliographer becomes an idiot because he *copies* (the nice word is "transcribe"), and *copies*, and *copies*, until he becomes a sort of human Xerox machine but not, like the machine, mercifully insensate. But that is not the worst. Also, he *counts*!

Let us observe an imaginary ornithological bibliographer at work. Holding an ingenious little machine, less exquisitely technological, perhaps, than the Hinman Collator, but no less essential—it is called, I believe, a traffic counter—he is flipping the leaves of a great early folio, say Pierre Belon's *L'Histoire de la Nature des Oyseaux* of 1555. Each time he comes to one of Pierre Gourdet's quaint woodcuts, more or less depicting a bird, he operates the counter, which makes a monotonous "click." About midway, say at 85, a certain special providence unfailingly causes the telephone to ring or a companion to appear

at his elbow. After a bit, he resumes: 86 (click), 87 (click), 88 . . . wait! Did he *really* count 85? Better start all over! At last, it seems that Belon contains 160 woodcuts.

This is what makes a bibliographer an idiot. Now I'll tell you what makes an idiot a good bibliographer.

The poor chap does it again!

And really, can there be anyone so simple and trusting that he really thinks our bibliographer gets 160 woodcuts the second time through? Not at all; he gets *almost* 160, perhaps 159. This, of course, means a third count, resulting this time—perhaps you have guessed—in 161. No comfort is to be found by consultation of another bibliography, which can be counted on for an improbable 163, or some such number, raising the ugly issue of whether the consulted bibliographer had a variant or was merely sleeping.

And so it goes, until there is established a number—a pure, positive, almost absolutely worthless, incomparably minuscule *fact*, distinguished by the single, unassailable attribute of being correct. And I am sure I need not remind you of the value and dignity of a major fabric woven from such minuscule, hard-won facts.

But now let us get on to our subject. First I shall talk about ornithology. The definition penned in the 1890's by the great Professor Alfred Newton of Magdalene College, Cambridge, has perhaps not been improved upon:

Ornithology in its proper sense is the methodical study and consequent knowledge of Birds with all that relates to them; but the difficulty of assigning a limit to the commencement of such study and knowledge gives the word a very vague meaning, and practically procures its application to much that does not enter the domain of Science. This elastic application renders it impossible in any sketch of the history of ornithology to draw a sharp distinction between works that are emphatically ornithological and those to which the title can only be attached by courtesy.

This elegant statement clearly reveals the peculiar, multipartite nature of ornithology—the unique blend of science and esthetics and of professional and amateur involvement that sets this field somewhat apart from all other divisions of natural science.

Now the basic cause for this peculiarity is simply this: the communication of birds is organized around visual and auditory stimuli, or signals, and, save for certain fishes, for the lepidopterans among insects, and for the primates, and a few others, the birds are uniquely specialized in these respects in the animal kingdom. Such visually oriented groups are those whose integuments

are colorfully adorned and elaborately ornamented, and such aurally oriented animals are those whose conspicuous and complex vocalizations are sometimes interpreted by us as music. It is quite natural that variously colorful and noisy animals, communicating by media which we ourselves use and comprehend, have been those first and most to attract both the curiosity and the esthetic admiration of man.

Hence, too, the interest that birds long have aroused has resulted in the early accumulation of that considerable body of basic fact that must precede meaningful scientific synthesis and significant theoretical interpretation. The existence of this body of fact, in turn, early made the birds attractive as subjects for pure research. Thus even before 1859 the birds were by far the most useful animals in the now celebrated ratiocinations of Charles Darwin, and thus the literature of ornithology, although possessing, to be sure, a large dubiously scientific component, immensely exceeds that of any other vertebrate group both in volume and complexity.

Whether or not they would be wholly pleased with that they saw, if Dr. Coues and Professor Newton could return to view their chosen field they would be unable to believe their eyes.

Today, far from being the sole concern of cloistered professors of anatomy, of U. S. army surgeons dodging Apaches in the remote southwest, of lonely British majors in the palms and pines of far-flung outposts, or of the landed and leisured gentry of pre-war Europe—today ornithology is the burgeoning giant of the taxonomically defined zoological sciences, commanding alike the interest of numerous professional organizations, and of such as the Office of Naval Research, the National Institutes of Health, the U. S. Public Health Service, the National Science Foundation, and numerous other agencies and organizations, not to mention throngs of earnest amateur devotees.

Coordination and teamwork are the order of the new day. Armies of collaborators man telescopes the night long during the migration seasons, plotting the directions and numbers of birds crossing the face of the moon. Millions of birds are banded by thousands of workers on two continents, the efforts integrated and the results electronically assessed by government agencies. Teams of workers draw blood from hundreds or thousands of species of the temperate and tropical avifaunas seeking the reservoirs of arthropod-borne disease. Birds unavoidably killed in thousands at television towers are picked up, weighed, packaged, and frozen, later to be studied by quantitative laboratory methods designed to determine the patterns of migratory fuel expenditure, with revealing insights into the whole economy of migration. Radar is beamed at the skies; minute radio transmitters are attached to free-ranging

birds; experimental birds are subjected to real and simulated conditions of the heavens and their migratory orientations analyzed; others are exposed to varying conditions of light and nutrition in the search for the factors initiating and controlling migration.

And these are only some of the new approaches. The older ones go on but are pursued by more sophisticated methods and by far more workers; the study goes on of systematics and evolution, with its implications for the larger picture of whence we came and how, and whither we are bound; the fossil record becomes more fully known; morphology, zoogeography, ecology, and population dynamics are subjected to techniques borrowed from the physical sciences; the once haphazard study of bird behavior has given way to ethology, an objective method of study which has lately elicited, among other things, interest from the Menninger Foundation. And so on, indefinitely.

And under modern pressures all of these workers, good, bad, and indifferent, are affected by the doctrine of "publish or perish."

As the embattled editor of a major ornithological journal I know something of the pressures existing today to force this bloated camel through the needle's eye of the available publication outlets. And nearly all of it, somehow, *is* published, if not in the major periodicals then in the secondary and minor ones which have popped up like mushrooms, or in the reports and monographs of museum, trusts, and similar learned institutions. And all of it, sooner or later, must be retrieved and organized to sift the all-important 10 per cent of wheat from the 90 per cent of chaff so that further research can go forward with minimal waste.

It should by now be obvious, then, that no single subject is more compellingly important to the ornithologist today than bibliography, by which *he* means quick, accurate, well-organized coverage of the current and recent literature.

We do not begin to have the coverage we now need. *The Zoological Record*, to be sure, despite its all-too-limited resources, does yeoman service, yet it lags behind by three or four years and its coverage is far from complete. The 2,167 titles in ornithology listed and analyzed by the *Record* in 1955, for instance, probably represent no more than one-third of the wholly or partly ornithological articles published in that year. The *Biological Abstracts* is more current, but its coverage is woefully deficient. The ornithological journals try to take up some slack by publishing more or less organized lists of "recent literature," but they duplicate one another and are barely scratching the surface anyway.

Concern about this has led to the cooperation of The American Ornithologists' Union with science librarians of Colorado A. and M. University in exploring the feasibility of a pioneer project in electronic storage and retrieval of ornithological data on a worldwide, cooperative basis. The pilot project has shown that, while the idea is clearly practicable, its execution would be very expensive. Yet in time some such system must be resorted to.

It is appropriate at this stage to emphasize that the kind of bibliography I have been speaking of so far, the kind that is now so urgently needed in ornithology, is the only kind of bibliography that many contemporary workers in ornithology care about or have even heard of. When many working zoologists think of bibliography, they think of just that enumeration of the keys to the contemporary working knowledge of their field (and of indexes thereto and organizations thereof) that the true historical bibliographer scarcely thinks of as bibliography at all.

I have dwelt upon ornithology at some length in order to emphasize the ornithologist's immediate needs and to clarify his viewpoint. I have emphasized it here also to root out what I have found to be a persistent misconception among some of my friends in the humanities, who comprehend contemporary ornithology no more fully than the ordinary ornithologist comprehends analytical bibliography. This misconception is that, since bibliography—meaning now historical bibliography, in any of the senses more acceptable than mere enumeration or indexing—since this kind of bibliography is definitely of importance to ornithology, then it must be of vital importance to contemporary ornithological research. Nothing could be much further from the truth. Speaking as an ornithologist I should have to say that I think it quite improbable that any further ornithological discovery of major biological significance is likely to be made possible or even hastened by all of the descriptive and historical bibliography that has been or may be applied to our field. This point, while it need dismay no one, is worth recognizing.

Contributing to the misunderstanding, I expect, is the fact that this has not always been so. History enters here, and perhaps I can clarify the point I am trying to make by briefly examining the ornithological world of Elliott Coues. This has much to recommend it, for Elliott Coues, a great figure in a gracious age, represents something of the best of two worlds. He was a scientist, a leading scientist. Deeply involved at the forefronts of his time and specialty, he was also a bibliographer. And his religiously executed, erudite, and perceptive bibliography, which was both literature and as masterly bibliography as was then imaginable, was indeed of marked significance in the contemporary progress of his science.

The time was between 1870 and 1880. Victoria was on the throne of England and Ulysses S. Grant and Rutherford B. Hayes were Presidents of the United States. Scholars all spoke or at least understood Latin, Greek, French, and German. No one had ever heard of a research grant. Harvard was about the only university in North America that trained any zoologists, and all the rest with any professional training whatever had been trained as physicians.

In all the world there existed no more than three major ornithological periodicals (and as many parent societies): the *Journal für Ornithologie* (since 1853), *The Ibis* (1859), and the young *Bulletin of the Nuttall Ornithological Club* (1876), which in 1883 was to become *The Auk*. These, with the more general *Philosophical Transactions*, *Proceedings of the Royal Society*, *Annals and Magazine of Natural History*, *Comptes rendues*, and a few others were the sum total of the serial sources available for the publication of ornithological research.

Exploration of the great blanks then on the maps and inventory of the world's incompletely catalogued birds were still the chief business of the day, and books—great books according to the opulent Victorian tradition—whether produced for private gain or at the behest of governments competing for space and prestige, were its means of expression. Therefore, when Elliott Coues was applying the thorough and loving bibliography that major and complex books demand, he was dealing also, and often for the first time, with *primary* sources, and so ornithological research in an immediate sense and bibliography in a full sense were one.

Today, with the rarest exceptions, books are essentially secondary or tertiary sources and, even if they are not, they are physically inauspicious, mass-produced, mechanically uniform, comparatively error-free, and essentially devoid of bibliographic interest or complexity.

The serial and periodical have assumed the burden of publication of primary knowledge. Today, in place of the three major ornithological journals that existed when Dr. Coues wrote, there are at least 20 around the world, with 40 or 50 significant lesser journals devoted more or less wholly to ornithology, while the number of museum and other institutional publications, monographic series of varied sponsorship, and related sources runs into hundreds.

Now, to complete the circle, I must point out that my friends in the humanities have no exclusive claim to misconception. It is equally true that many—though I am happy to say not all—of my zoological associates regard me, for my bibliographic activities, as slightly deranged. If they are too

polite to ask me they still ask with their eyes, with reference to analytical bibliography in its relation to ornithology: "What good is it?"

How quickly (and how rightly) the ornithologist who asks the bibliographer "What good is it" would become incensed if a bibliographer (or even a congressional investigator!) asked him what good it was to know whether a Hairy Woodpecker scratches its head over or under the wing, to know the primary and secondary sex ratios of the White-breasted Nuthatch, the esoteric behavioral interactions of grackles and Red-winged Blackbirds on a Wisconsin marsh, the tail-flicking peculiarities of a Whinchat, or the protein chromatography of the Rhinocryptidae? Usually, when a man says "What good is it?" he really means "What good is it to me?" And he is usually thinking either of his pocketbook or his health. Sadly enough, if he does not know, it is usually too late to tell him.

The fact is that here the question "What good is it?" demonstrates man's age-old propensity for asking the wrong question. Let us not ask what is "good" here, but only what is interesting, informative, beautiful, inspiring; let us ask what satisfies our curiosity about our surroundings, ourselves, our works, and our goals. These things do not have to be good *for* anything; they are good in themselves. If in time they prove to be good *for* something, that is a special bonus!

Man's history properly interests him. And so it is not surprising that ornithology, which has perhaps the longest and certainly the richest history of all the compartments of systematic zoology, is endowed with a far greater number and variety of bibliographies than any related field. There would seem to be little doubt that the quantity and quality of the bibliography pertaining to a field are an important measure of the maturity of that field, for only as a study ages do its devotees look back as well as forward, assess their gains, treasure their past, study the routes to their present position, honor those who travelled them, and wonder how these things may relate to the future.

I emphasize this because, in the broad sense, bibliography and history are closely interrelated. The history of ornithology has been chronicled, in part, by Alfred Newton in his above-cited *Dictionary*, by Professor Erwin Stresemann in his *Entwicklung der Ornithologie*, by Coues in his famous *Key*, and by Mrs. E. G. Allen in her *History of American Ornithology before Audubon*. There will be still others, but the bibliographies are the all-important footnotes and appendices to these histories, the key to the fossil record, so to speak (in the form of printed books), of the knowledge, aspirations, successes, and failures of the past.

We have a long way to go, before the great works in ornithology will uniformly have received such treatment as that planned for the *Bibliographia Huntiana* in botany, to be sure, yet even now what other discipline in zoology is so endowed that it can rival at once the great practical bibliographies of ornithology? For examples: R. M. Strong's great *Bibliography of Birds*; the somewhat remarkable *Thesaurus Ornithologiae* of C. G. Giebel; the masterpieces comprising Elliott Coues' unfinished "Ornithological Bibliography;" the beautifully produced iconographical bibliographies of Jean Anker (*Bird Books and Bird Art*, with its careful catalogue of the Royal Library at Copenhagen), of Klaus Nissen (*Die illustrierten Vogelbücher*), and of Sitwell, Buchanan, and Fisher (*Fine Bird Books*); or especially Zimmer's meticulous *Catalogue of the Edward Ayer Ornithological Library*, the useful check-list of Dr. Casey A. Wood's *Introduction to the Literature of Vertebrate Zoology* (McGill University's holdings), the convenient list of Yale's holdings by S. Dillon Ripley and Margaret Scribner; not to mention the regional bibliographies of Mullens and Swann (on Great Britain), Whittell (on Australia), Ronsil (on France and the French colonies), and Hachisuka (on China); or systematic bibliographies such as Low's (on the Charadriiformes) and Kuroda's (on the ducks). And there are numerous more.

Ichthyology, to be sure, has a claim to eminence with the great scientific bibliography—the analogue of R. M. Strong's—of Bashford Dean; and Nissen's *Schöne Fischbücher* shows that ichthyologists are not without souls! The entomologists too may point to Hagen's great *Bibliotheca Entomologica* and to Mr. Lisney's devoted treatment of the bibliography of the British Lepidoptera.

But these are lonely landmarks. Our good friends the mammalogists, for example, who study warm-blooded, dun-colored, silent, furry, chiefly nocturnal beasts communicating primarily by smell have scarcely a major bibliography worthy of the name* save for Ruch's *Bibliographia Primatologica*, and for one barely started, interestingly enough, by Elliott Coues in collaboration with Theodore Nicholas Gill. They have also a fine early bibliography of the Cetacea, but it is by Joel Asaph Allen, the first editor of *The Auk*!

Of course, we have to grant that the mammalogists have some major problems. Ornithologists can easily produce books rich in the visual signals of birds, displaying the marvellous and behaviorally "loaded" images that birds present to other birds (and to humans). In addition—a new and

* A small step in the right direction is the classified bibliography occupying Vol. 3 of Ernest Walker's *Mammals of the World* (Baltimore, 1964).

growing dimension in bibliography—libraries of recordings of avian sounds are being assembled and can be keyed to texts upon need. But imagine the problems confronting a mammalogist who would produce a catalogue of the olfactory stimuli so vital to mammals. What kind of calibrated meter would be necessary for their objective evaluation? Rare book librarians may, perhaps, be glad of these difficulties.

What, then, do we now derive from the present battery of overlapping ornithological bibliographies?

Even now it is comparatively easy for a research librarian to fill out a collection of the great books in ornithology, to the benefit of his institution's staff and students; it is comparatively easy for an ornithological editor to check the citations of his often errant authors when they refer to the early works, preventing much confusion and waste of time; the dates of publication of the vast majority of generic and trivial names in ornithology are not matters of much dispute; it is usually easy for a dealer in rare books to know with what he is dealing in the realm of ornithologia, and so better to serve his clients; it is usually possible for a student of ornithological history to recognize the lineage of descent of a series of related works and the ideas and schools of thought they represent, or quickly to assess the productivity and impact upon his times of a Gilbert White, Gould, Levaillant, Audubon, of a Wallace, Cassin, or Baird; it is comparatively easy for a collector or purchaser of any kind to ascertain what he is getting, or should be getting, from a dealer advertising this or that work. Countless miscellaneous details can quickly be checked. These things, in the aggregate, are of considerable value. As Emerson's life unexamined is a life un-lived, a science uninspected by its own devotees and insensitive of its past is a science not fully comprehended.

Because of the comparative wealth of the bibliography available to him, the ornithologist sometimes finds himself in the odd position of receiving bibliographical queries, not ornithological at all, from his mammalogical, ichthyological, and herpetological colleagues and being able to answer them easily. This is because his dedicated forebears, in applying their bibliographic labors to those great early books devoted only in part to ornithology, exceeded the immediate call of duty (being gripped no doubt by that excess of zeal that Dr. Coues warned of in my initial quotation) and treated the whole instead of the part.

I have always felt a little pang of amused sympathy for these people on the occasions I have been able to answer their questions, and I have often detected a look of faint bewilderment on their faces as they left. They have honestly thought that my mysterious power derived from my being a

“bibliographer,” whatever that may be, when in fact I was only an ornithologist aware of the legacy of his field.

Ornithology, preoccupied with prosecuting ever more diversified research into an expanding future from a vigorous present, has already demonstrated a rigorous sense of a history that is inextricably bound up with the great books of the past. Bibliographic needs and methods may change in the future, but these great books deserve the study that we have given them and are still giving them. Ornithology may be proud that it has produced its great books, but in the last analysis it may be even more significant that it has cared for them.

“Un-Natural” History

By ALAN BOYDEN

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It would seem that the above topic could have no relevance to an “Institute on Rare Books in Natural History,” and that a report on such a topic must be foreign or “way out” from the serious work of the Institute. On the contrary, much that has been called “Natural History” is actually far removed in fact and spirit therefrom. Let us “come to terms” at once and thus proceed with some hope of mutual understanding of the issues involved.

Natural history, as the term is generally used in biology, includes the body of knowledge relating to the lives of plants and animals; to all aspects of their structures, functions, life cycles and interrelationships. One who contributes to natural history is entitled to the name of “Naturalist” and such a person is characterized by his interest in describing organisms as he finds them, comparing them and classifying them on the basis of their natures. His emphasis is on fact rather than theory and his writings are simple, clear and unambiguous.

Un-natural history differs from natural history (in the context of the present discussion) in significant ways: (1) its terms are confusing; (2) fact and theory are not clearly distinguished; and (3) even logic and reason may be hopelessly set aside. Let me take two quotations which may serve as texts for this discourse.

“Terms are the tools of the teacher; and only an inferior hand persists in toiling with a clumsy instrument when a better one lies within his reach.” Richard Owen, 1866. *Anatomy of Vertebrates*.

“Nothing is more striking in this science [biology] than the contrast between the brilliant skill, ingenuity and care, bestowed upon observation and experiment, and the almost complete neglect of caution in regard to the definition and use of concepts in terms of which its results are expressed.” Woodger, 1929. *Biological Principles: A Critical Study*.

Now there is our difficulty—needless confusion resulting from carelessness in the use of the terms relating to our most fundamental concepts. This is what has made much of our “natural history” *un-natural*, rather than ignorance or even faulty observation.

In Britain one of the better-known early naturalists was Gilbert White, sometime curate of Faringdon and Selborne, who lived during the greater part of the 18th century (1720-1793). He kept a journal in which he faithfully recorded his observations of the life about him: the progression of the seasons; the pageant of not only summer, but of the entire year. He prepared a Naturalists' Calendar based on many years of observation. But his best-known writing is the classic *The Natural History of Selborne*, published in 1789, which has appeared in so many editions since his death. This is characterized by its content of careful observation, its relative freedom from bias and preconceived notions, and its simple but effective language.

One of the things that I like about Gilbert White is that he knew where he was, as the very first sentence of Letter I indicates:

"The parish of Selborne lies in the extreme eastern corner of the county of Hampshire, bordering on the county of Sussex, and not far from the county of Surrey; is about fifty miles south-west of London, in latitude 51, and near midway between the towns of Alton and Petersfield."

Not all the editors of the various editions of *The Natural History of Selborne* have been so fortunate. According to Richard Jeffries (Preface, page xi, undated edition, No. 24 in "The Scott Library") "The mass of this book was collected in the little Surrey parish of Selborne."

To continue with our quotation from the first letter:

"Being very large and extensive, it abuts on twelve parishes, two of which are in Sussex, viz. Trotton and Rogate."

We see then that Jeffries was in error not only in regard to the county in which Selborne was situated but in regard to its size as well. How unfortunate to deal with natural history so carelessly as to make it un-natural! Richard Jeffries knew what should be done as the last sentence in his Preface says: ". . . and read the *Natural History of Selborne* as it was written."

Let us read further in his first letter.

"The soils of this district are almost as various and diversified as the views and aspects. The high part to the south-west consists of a vast hill of chalk, rising three hundred feet above the village; and is divided into a sheepdown, the high wood, and a long hanging wood, called The Hanger. The covert of this eminence is altogether beech,

the most lovely of all forest trees, whether we consider its smooth rind or bark, its glossy foliage, or graceful pendulous boughs."

There is not space enough for extended quotations, but these will suffice to characterize the writing of Gilbert White as simple and clear and unambiguous and, above all, accurate. This is natural history, and appropriately considered a classic in the development of natural history in Britain.

Another British naturalist of the greatest eminence was Charles Darwin. His great contribution is that he, aided also by Alfred Russel Wallace, Thomas Henry Huxley and others, brought about the acceptance of evolution as a natural rather than a supernatural process. Besides this, many of his books qualify as natural history, even though he was more deeply committed to the purely theoretical aspects of natural selection during most of his life. And he remained a naturalist to the very end, as his last written and published book, *The Formation of Vegetable Mould through the Action of Worms* (1882) bears witness.

This book contains the results of Darwin's long-continued study of the behavior of earthworms and emphasizes the importance of their function as agents for the burying of stones—accomplished by carrying earth out from under these stones and depositing it on the nearby soil surface. The famous "Worm stone" was used in measuring the rate of subsidence; and the collection of castings over measured areas provided data for the estimates of the amounts of soil brought to the surface annually (up to one-fifth of an inch!). Though Darwin complained of difficulty in writing (and being understood), the quotation from the last paragraph of this last book is one which is a good example of literate, effective, and pleasing writing.

"When we behold a wide turf-covered expanse, we should remember that its smoothness, on which so much of its beauty depends, is mainly due to all the inequalities having been slowly levelled by worms. It is a marvellous reflection that the whole of the superficial mould over any such expanse has passed, and will again pass, every few years through the bodies of worms. The plough is one of the most ancient and valuable of man's inventions; but long before he existed the land was in fact regularly ploughed, and still continues to be thus ploughed by earthworms. It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organized creatures."

But now we must not believe that only a parish curate or a country squire can be naturalists. There have been many others, even in recent times.

D'Arcy Thompson's *Growth and Form* shows him to have been one of the most scholarly of all naturalists; and in this country E. B. Wilson's *The Cell in Development and Heredity* qualifies him as a naturalist of equal eminence, even though he was never a field naturalist.

So far we have natural history—now some additional un-natural examples. Space permits extended discussion of only a single major example: one which is, however, representative of many.

The term "homology" was introduced to zoology by Richard Owen (1843) and used by him in all his great anatomical works. It has come to represent the "central concept" of comparative morphology. (Extended discussions may be found in *Boyden*, 1935, 1943, 1947.)

Homology refers to the essential structural correspondences which exist among the parts of the bodies of organisms. Homologous parts of the bodies of different organism should bear the same anatomical names, for they are in fact the same organs. Thus the forelimbs of all Vertebrata from fishes to mammals are corresponding or homologous parts, and no theory is necessarily involved in recognizing them and naming them. The criteria for establishing their homology are similarities in their adult structures and embryonic development and in their relative positions and connections in the bodies of the organisms compared.

Then came 1859 and Darwin's *Origin of Species* and the confusion of fact and theory began. Though Darwin knew very little about heredity he assumed that these essential structural correspondences were due to common ancestry and therefore could be interpreted as results of evolution and rough guides to its course in the past. In a general sense this may all be true: organisms built on the same structural plans, e.g., Vertebrates on one plan or Arthropods on another, had "community of descent" which would be a fair inference even if we could find no fossil connecting links.

But now, what happened to the definition of "homology" after 1859? The successive post-Darwinian meanings may be briefly represented as follows:

1. Essential similarity in structures *due to common ancestry*. ("The sole criterion required to establish the homology of parts is to show that they have been descended from a single representative in a common ancestor." *De Beer*, 1928).
2. Essential similarities in structures and functions *due to common ancestry* (*Hubbs*, 1944).
3. Any similarities *due to common ancestry* (*Simpson*, 1961).
4. Homology has nothing to do with similarities but only with common ancestry (*Bock*, 1963).

Thus the original meaning has been completely replaced by the meaning of common ancestry. But how can we determine that there may have been common ancestry? Only by the amounts and kinds of structural correspondence. There is no other way! Hence it is true that the kinds of structural correspondences referred to by Owen are still essential criteria of homology, yet all reference to them has been omitted from the recent definitions. *This is Un-natural History!* The fact is that we now have *no* term which carries the meaning of homology in Owen's sense—though that meaning is still the central concept of comparative morphology. We have a plethora of terms to refer to superficial structural correspondences or to those *not* due to common ancestry, but none for the central concept itself.

The situation in regard to homology has been made even more confusing when the opposite of homology in Owen's sense is considered. For example, the wings of all Vertebrata are homologous but the wings of Insecta are built of different material and on different plans. But instead of referring to wings of Vertebrata compared with Insecta as "non-homologous", which could not be misunderstood, the terms "analogous", or "homoplastic" are used.

As though this was not bad enough, our great vertebrate paleontologist and expounder of evolutionary taxonomy, G. G. Simpson, has claimed (1959) that Owen's criteria of homology were subjective or intuitive whereas Darwin provided a "theoretically objective" criterion of homology in the common ancestry which did or did not exist. But how do we reach this so-called objective criterion? Only by inference from Owen's subjective criteria.

I do not believe that Simpson or anyone else can have it both ways (*Boyden*, 1960). If the appraisal of morphological similarities can only be subjective or intuitive, inferences regarding their ancestry cannot even be theoretically objective. In fact, the inference of common ancestry must necessarily be more subjective than the appraisal of the similarities because additional assumptions regarding the operation of genetic mechanisms are required.

Now the confusions associated with the terms "homology" and "analogy" are not isolated instances. There are too many others, more than enough to justify Woodger's critical statement. We shall not discuss these in detail but present a few only in bold relief. These further instances of Un-natural History include:

(1) The characterization of parthenogenesis as "asexual reproduction" (*Darlington*, 1958; *Wilson*, 1925; *White*, 1954). Parthenogenesis refers to the development of an egg without fertilization and is often referred to as "virgin birth." It always requires a *female* gamete, the egg. Such eggs may

result from typical maturation processes as in the case of the honeybees, or they may result from modified gametogenetic processes as in many Crustacea, Insecta, and Rotifera. But those eggs are always produced in female gonads, ovaries, and they retain substantial mounts of the gametogenetic processes typical of sexual reproduction. These processes have nothing to do with budding and fission. To refer to them as asexual, which really means without sex, thus misrepresents their nature and derivation (*Boyden, 1950*).

(2) The characterization of Protozoa as "acellular animals" is another instance of Un-natural History. Dobell (1911) and Hyman (1940) have been the principal supporters of this opinion as stated in a report of mine (*Boyden, 1957*). Both of these authors admit that the organization of the bodies of Protozoa is fundamentally the same as that of the cells of Metazoa. By all the rules of logic and reason, we should therefore consider Protozoa to be cellular, for this is the term that has been applied to such an organization for more than a century. The reasons given for this departure from good usage are chiefly that since each Protozoan is an entire organism, each is therefore to be compared with a whole Metazoan (with many cells) rather than with the single cells of which the bodies of Metazoa are composed. But this view involves a violation of the rules of procedure in homological comparisons, for these refer to the corresponding parts of the bodies of organisms rather than with the whole organisms. The proper comparisons should be made between cell and cell and between the corresponding parts of these cells.

In order to implement this point of view, Hyman (*loc. cit.*) defined a cell as "one nucleated division of an organism." On this basis, an organism can be multicellular (as Metazoa) or "acellular" (as Protozoa are alleged to be) but never unicellular (as most Protozoologists appear to believe that Protozoa are, according to *Corliss, 1957*). Furthermore, Hyman's definition of a cell has the most fantastic implications for the development of Metazoa. Gametes are considered to be cellular as they are interpreted to be parts of organisms. The union of male and female gametes produces a fertilized egg or zygote, which is a whole organism at this early stage. But since the zygote is a whole organism it cannot be cellular, for a cell according to Hyman must be a division of an organism. But now when this zygote divides into two cells, it becomes cellular again, and the organism remains cellular the rest of its life.

So we have cellular gametes, uniting to produce an "acellular" zygote which becomes cellular again by division, and all this without any essential change in the protoplasmic organization of these various stages. There is no better illustration of Un-natural History than this, for it imposes an arbitrary

dictum that organisms cannot be unicellular while they, the Protozoa, show by their organization that they are.

(3) "The business of systematics viewed as a branch of general biology is that of detecting evolution at work" (*J. Huxley*, 1940).

It would be difficult to find a more inadequate and un-natural statement in regard to the "business" of systematics. For among the subjects of systematics, evolution, and phylogeny, only systematics is universal. It is that fundamental part of biology which is concerned with collecting, describing, naming, comparing and classifying the results of one or two billions of years of organic evolution.

"Systematics is at the same time the most elementary and the most inclusive part of zoology, most elementary because animals cannot be discussed or treated in a scientific way until some systematization has been achieved, and most inclusive because systematics in its various guises and branches eventually gathers together, utilizes, summarizes and implements everything that is known about animals, whether morphological, physiological, psychological, or ecological." (*Simpson*, 1961).

Let us be done with Un-natural History. The first duty of any naturalist is to describe nature as he finds it; to study organisms living or dead as they are when he finds them; to compare them and to classify them in accordance with their natures. Then, if he is able and circumstances permit, he will attempt to explain what determines (or has determined) the characteristics noted, but in every case he must clearly distinguish fact from theory and never use terms which fail to make evident such distinctions. Though the immense complexities of living organisms make understanding difficult, this cannot be used as an excuse for not obeying the rules of logic and reason and for not using terms clearly and effectively, and conservatively.

Who is to blame for such Un-natural History as has been mentioned? I do not believe we can take refuge in any supposed laws of semantic change which make them inevitable. The changes in meaning do occur, but they are not inevitable. What is lacking is a decent respect for our heritage of words and meanings. Continued understanding would be greatly increased if we were guided by some moderate rule of good procedure based on priority of usage. In essence this rule would say:

The original usage of a term shall have priority so long as it is needed, provided that its meaning is clear and remains adequate.

But who shall enforce the rule? We have no body established for securing the conservation of the terms which refer to our fundamental concepts. There are international commissions on nomenclature which provide rules for the

naming of species and other systematic categories and they meet regularly for their essential work. Are the basic concepts of biology of such lesser importance? Of what benefit is it to seek and find and preserve (and even read) rare and old books and then to ignore the wisdom they contain?

The role of the critic is not a happy one, but appears to be essential if Un-natural History is to be kept within bounds. May we now hope that there will be some reasonable restriction upon the propagation of unreason? That in the manner of action of natural selection the more fit terms and meanings will survive and greater understanding result? Or, must human thinking follow the wayward patterns of evolution which by trial and error and with enormous wastefulness progresses slowly towards its goals?

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Natural History Books from a Rare Bookseller's Point of View

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In all honesty I must say that there are many other dealers in the United States and England much more experienced in this field who should be talking on the subject assigned to me. I can think of Eric Lundberg of New Hampshire and more recently of Maryland, and, from my part of the world, of Frank Bassett, my old and revered friend. They have both handled ten rarities in this field to my one. In England there is, for instance, Mr. Kirke Swann whose bibliographical contributions have been notable, and whose experience eclipses mine by many magnitudes.

In a certain degree I can lay claim not only to a bookseller's point of view but also to the naturalist's point of view, a sort of stereoscopic way of looking at natural history. I used to be a little ashamed of my boyhood conceit. You see, I was a local bird watcher, an annual bird census-taker for the Biological Survey, and for a short time that odious thing—a bird's egg collector. I still cherish the permit issued to me in 1923 by the Biological Survey to collect birds for scientific purposes. Even more rare than Theodore Roosevelt's paper on Long Island birds is the *Census of the Birds of Tarrant County, Texas*, by Graham and Zeitlin. I was a footnote 42 times in a learned Carnegie Institute paper by George M. Sutton. That would qualify some men as scholars.

The first books I collected had such titles as Florence Bailey's *Handbook of Birds of the Western United States*, and Major Coue's *Key to North American Birds*, and I still proudly possess a copy of Bent's first volume on *The Life Histories of North American Diving Birds*, which came to me on publication from my congressman. How I used to pore through the volumes of Baird, Brewer and Ridgeway which Mrs. Scheuber took carefully from the locked case in the Reading Room of the Fort Worth Public Library for my privileged use!

My earliest bibliophilic delights are mingled with reading the *Journals* of Thoreau and the complete works of John Burroughs, which my high school principal bought especially for my use. *Wake Robin*, *Winter Sunshine*, and *Pepacton* led me into the forest of books as did also those nature fakers Long and Dallas Lore Sharp and Ernest Thompson Seton; I not only read Seton's

animal fantasies but as a boy I sat enchanted beside his campfire as he told his stories. And of course there was John Muir of California, poet of the Redwoods, bard of the High Sierras. These are the evidences I offer of my early indoctrination into not only the substance but the spirit of natural history books.

I cannot boast of any folio Audubons that came into my net in my Texas days, nor even an Elliott or Gould. If any of the major treasures ever came into that part of the world I never saw them, and being a dedicated bookstore browser from my youngest years, I think if any had come that way I would have seen them.

Of all places I know, Lawrence, Kansas is the most proper to hold a meeting on our subject. My first, and still foremost encounter with the full-feathered species Bibliomaniac Ornithologicus was when I met the legendary Ralph Ellis. Robert Vosper has already given a lively account in the *Papers of the Bibliographical Society of America* of "A Pair of Bibliomanes for Kansas" (the other was Thomas Jefferson Fitzpatrick). I will not attempt to repeat his most felicitous and kindly treatment of them. In the 1930's I would often travel to Berkeley to be admitted by white-coated guards into the great house where Ralph Ellis ruled. From cellar to attic it was stuffed with books on only one subject: birds. Ellis hoarded Gould's folios by the dozens. If one was good, ten were better. He bought steel safes wholesale and pamphlet boxes by the hundred. When the collection came to Kansas, it occupied one fifty-foot freight car and one forty-foot freight car.

As Vosper says, its "impassioned, almost violent haste" marks the forming of his collection as it did all of Ellis' career. It was his ambition to acquire every book, journal or pamphlet of which birds were the major subject. He came very near to succeeding. In November, 1945 Ellis came to my shop in Los Angeles and asked if his mail could be sent there. When he died in December 17th of that year, the packages of books and letters addressed to him made a pile four feet high in my office.

Fate and the law have worked well together to bring and keep this great collection here and Robert Vosper and Thomas Buckman have worked diligently to make this place deserving of its custodianship. We are impatient to see the completion of the catalogue that Robert Mengel is preparing.

The time has now come for me to talk like a bookseller. From our point of view the two most important factors are supply and price. Not very long ago a day's tour of London through the stocks of Quaritch, Sawyer, Maggs, Edwards, Joseph, and Wheldon & Wesley would yield one a good selection of the great books of natural history. Today one looks almost in vain. The

of Fine Arts). I once traveled to St. Francisville, Louisiana, down an avenue of moss hung oaks and into a classic white-pillared mansion. The two darling old ladies denied they had a copy with extra drawings in the closet, although they did show me a portrait of their aunt by Audubon. I fear they broke one of the Commandments, I did also; for to covet is as much of a sin as to prevaricate. That copy burned up in the fire which destroyed the mansion several years afterwards.

The price of any copy that might turn up in the future is unpredictable. This is a game where the stakes are getting bigger. Only the tycoon and syndicates can play it.

3. BARTRAM, WILLIAM. *Travels Through North & South Carolina...*
Philadelphia and London, 1791, 1792, & 1794.
1941—1791 edition. \$15 to \$75
1942—1794 edition. \$17
1946—1791 edition. \$25
1958—1791 edition. \$30
1961—1792 edition. £24

I cite this as an example of the lower priced and not too eagerly sought book. These are not rising in the same progression.

4. BUFFON, G.L.L. *Histoire Naturelle*. . . . 44 vols. Paris, 1749-1804.
This comes with plates colored and uncolored and I have not been able to determine in all cases whether the copies sold had colored or uncolored plates.
1942—\$120
1948—£45
1953—\$80
1962—£150 Wheldon & Wesley

Although not yet exhausted by the plate dealers, this is now a difficult set to find. It will rise.

5. GATESBY, M. *Natural History of Carolina, Florida and the Bahama Islands*. 1754.
1956—\$110
1957—\$1,297
1958—\$2,000
6. DARWIN, CHARLES. *The Origin of Species*. London, 1859.
1941-1945 \$22 to \$90
1946 \$115

1950-1955	\$50 to \$160
1956-1960	\$65
1960	\$340 with ALS
1962	£70-£75
1964	\$650

The celebration of the Darwin Centennial, the inclusion in the Grolier Club List, the fact that educators in backward states like California still regard Darwinism as a controversial subject, have all combined to raise the price. If influence on history is a criterion, this increase is well deserved. If scarcity alone is the measure, it has risen to an undeserved level: 2,500 copies of the first edition were printed and it is not rare.

7. ELLIOT, D. G. *A Monograph of the Tetraoniae. . . . [Grouse]* New York, [1864]-65.
- | | |
|-----------|----------------|
| 1938 | \$135 |
| 1941 | \$190 |
| 1951 | \$200 to \$350 |
| 1956-1960 | \$175 to £175 |
| 1961 | £135 |
| 1962 | £300 |

This covers a spread of 24 years. Once a common book, this book has been decimated by the breakers.

8. ELLIOT, D. G. *The New and Unfigured Species of the Birds of North America.* New York, [1866]-69.
- | | |
|-----------|----------------|
| 1941-1944 | \$200 to \$325 |
| 1956 | £275 |
| 1961 | \$425 |
| 1962 | £560 |
| 1963 | £780 |

Of course this is a better book than the Grouse. It has more plates and is more desired. Fashion is our friend at this time, bird plates are not the thing with the decorators just now. Piranesi is their current fad and the prices have shown their effect.

9. FUCHS, LEONHARD. *De Historia Stirpium. . . .* Basel, 1542.
- | | |
|------|---------|
| 1942 | \$290 |
| 1958 | £350 |
| 1962 | £340 |
| 1964 | \$2,000 |

This again is a case of an important book being recognized. It is a landmark in botanical illustration. The drawings were done by Hans Weiditz. It, too, is on the Grolier list. By standards of comparative values it is still below the Plimsoll line.

10. GOULD, JOHN. *A Century of Birds from the Himalaya Mountains*. London, 1832.
- | | |
|-----------|----------------|
| 1942 | \$110 to \$160 |
| 1952-1953 | \$225 |
| 1956-1959 | \$210 to \$450 |
| 1961 | £210 |
| 1963 | £170 |

This was once a very common book. Ralph Ellis had no less than ten copies. I have included it to show that this class of book has come up with the general trend. It is no longer common.

11. GOULD, JOHN. *A Monograph of the Trochilidae, or family of the Humming-birds*. 5 vols. London, 1849-61.
- | | |
|------|-------------------------|
| 1942 | \$1,450 |
| 1949 | £340 |
| 1952 | £1,400 |
| 1961 | £1,450 |
| 1964 | £2,250 Wheldon & Wesley |

Here is one of the finest of our feathered friends. It has been the prey of picture dealers and print peddlers as no other book I know. Once to be found in stock, when needed, at several dealers, it has now become a very shy creature and can only be lured out of the stacks of a few provincial or colonial libraries. If beauty of execution and spectacular subject matter are to remain the criterion it will not become less rare or dear.

12. HOOKE, ROBERT. *Micrographia*. London, 1665.
- | | |
|-----------|---------------------------------------|
| 1953 | \$325 |
| 1958-1960 | £75 to £150 |
| 1962 | \$1,000 |
| 1964 | \$1,500 and \$2,400 (Grolier Benefit) |

Hooke was an amateur who became a professional. He was inadequately educated and he was unfortunate in his human relations. Newton postponed publishing his *Optics* until after Hooke was dead. *Micrographia* is a classic in entomology, in microscopy, in optics and almost every area of what was once called "Natural Philosophy." It, too, has enjoyed the benefits of inclusion

in the Grolier List. It is still not a rare book. There are at least four copies on the market today. Nonetheless it deserves its rise in value and I foresee paying £1000 for a copy within five years.

13. HUTTON, JAMES. *Theory of the Earth*. Edinburgh, 1795.

1958	\$200
1959	£220
1962	£300

If dealing with things that creep or crawl be a qualification for inclusion here, this geological classic qualifies. For Hutton dealt with the earth as a changing, shifting body having its phases and places of growth and decline. It, too, is on the Grolier List. Unlike some others on the list it is a true rarity as well as of the highest scientific importance. A fine copy in boards, if one ever turns up again, will make £750 at least.

14. LEAR, EDWARD. *Illustrations of the family of Psittacidae*. . . . London, 1830-32.

1942	\$75
1952	\$200
1963	£585 Wheldon & Wesley

Again, a fine plate book which has ceased to haunt the market place. Lear makes no nonsense when it comes to birds.

15. LEVAILLANT, FR. *Histoire Naturelle des Oiseaux d'Afrique*. Paris, 1805-8.

1952	\$875
1958-1859	£300 to £500
1958	£450 (L.P.)—Wheldon & Wesley
1963	£1,450—Wheldon & Wesley
1964	£1,100

Wheldon & Wesley's 1964 copy must not have been as good as their 1963 one.

This work ushered in the grand period of ornithological illustration, with color plate work carried to the highest level of refinement. The Martin Collection boasts a copy of this large paper with all plates colored (a rare state). Martin also proudly owns equally fine copies of the *Birds of Paradise* and *Birds of America and the Indies*.

16. REDOUTE, PIERRE, J. *Les Liliacées*. 8 vols. Paris, 1802-16.

1938	\$500
1959	£1,050

- 16A. REDOUTE, PIERRE J. *Les Roses*. 3 vols. Paris, 1817-24.
 1937 \$1,500—Large Paper, plates in 2 states.
 1961 \$8,000—Rauch
- 16B. REDOUTE, PIERRE J. *Choix des Plus Belles Fleurs . . . Fruits*. 2 vols.
 Paris, 1827.
 1938 \$800
 1959 \$1,250 to £1,600. Large Paper.
 1964 \$4,500

To an audience like this Redoute's works need no comment. They are the absolute peak of delicacy and quality in illustration and the techniques of color printing. How many of us are still uttering cries of anguish and regret that we did not buy the original drawings on vellum that Weyhe had and still has for sale? We think they are too high now. Who can guess what they will be priced at ten years from now?

17. SMITH, WILLIAM. *A Delineation of the Strata of England and Wales. . .* London, 1815.
 1958 \$450
 1960 £520
 1962 £1,225—including the Memoir.

Again a Grolier Club Classic, and a landmark in geology. Geology was for a long time neglected by the collector. Only Everett DeGolyer and Dr. Herbert M. Evans collected it in depth before 1950, as far as I know. Today it has risen to a high level.

18. THORTON, DR. R. J. *New Illustrations of the Sexual System of Linnaeus & The Temple of Flora. . .* London, 1799-1807.
 1937 \$1,250. Finest in existence. 60 plates.
 Presentation Copy.
 1942 \$550
 1947 \$180
 1958-1960 £450 to £680
 1964 \$4,500

This monument to English color printing, to the British sense of grandeur, and to the fiscal folly of a botanizing clergyman, is unexcelled. It has not vanished from the market, but fine copies with the early plates and with early watermarks are not overpriced. It may become the Audubon of flower plate books.

And finally, a let-down:

19. WHITE, GILBERT. *The Natural History and Antiquities of Selborne...*

London, 1789.

1946	\$40 to \$140
1949	\$250—boards, uncut.
1951-1955	£40-\$65
1957-1960	\$35 to £18
1964	\$135

Why has the price of this book not risen in 20 years? It is on the Grolier Club List of 100 Great Books in English Literature and almost every other list of English Classics. I shall hazard an opinion. It is neither a literary nor a scientific work of great excellence. It is the English countryman's ideal of natural history, but he does not read it. Extolled as it has been for several generations it has failed to fulfill the criterion of importance in science and, although not lacking in a peculiar charm, it has no eminence as prose. Furthermore and finally, and now I speak purely as a rare bookseller, it is very common.

The title I was given was "Natural History Books from a Bookseller's Point of View." I hope I have not quoted so many prices or used the word rare so often as to leave you with the impression that ours is purely the view of the marketplace. There is still in my mind the remembrance of the song of the blue-winged warbler, and the tiny shy orchid which I was the first to discover in my part of the world, and the pride I had in turning the leaves of my first copy of *Walden*. Without these remembrances I would be much the poorer person and the poorer bookseller as well.