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About the Institute
The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

THE QUEST FOR A NATURAL SYSTEM
(Jussieu to Hutchinson)

Definition 1. old mere relat. following a natural system 2

The definition of a "natural system" has changed over the years since it first came into use with Antione Laurent de Jussieu in his "Genera Plantarum Secundum Ordines Naturales Disposita", published in 1789. In those days, a natural system of plants merely meant how one plant group w as related to another, much as how you are related to your second cousin, without regard for how you came to be the genus Homo, and not Gorilla. I don't think, however, that the older naturalists thought their system to be other than natural. Even Theophrastus, with his trees, shrubs, and herbs classification, could put up some sort of argument for naturalness.

Homo-Gorilla

Theophrastus trees, shrubs herbs

What brought about the production of the natural system? Several things, among them being the bringing together of large collections by the great explorations to all parts of the globe, and the necessity to take care of these large collections in some sort of system. Putting plants in pigeon holes using Linnaeus' system produced some strange bed-fellows, making it obvious, even to the most casual observer, that something had to be done. Adanson in about 1763 had tried and achieved a small measure of success towards a natural system, but failed to get his ideas over. This, as much as anything, because he used an older system of names, not employing Linnaeus' system of binomials.

Reasons for development Exploration

L's syst. inadequate

Adanson 1763

old system

A.L. Jussieu's work is largely the culmination of a long line of efforts of earlier botanists, such as John Ray, with his division and system based on the cotyledons, or Tournefort, with a classification based largely on the condition of the corolla, and particularly on the work of his uncle, Bernard de Jussieu who made a systematic arrangement of the plants in the Trianon gardens in Paris, but who published only a catalogue of these plants. The significancex of A.L.'s work is in the fact that he stressed the weighing of characters, rather than the counting of them, and that he defined his orders carefully, so that others might recognize them. Too, he used Linnaeus' binomial nomenclature consistently.

He was so successful in allying his genera into "classes" that most of his

(continued next page)

correlations stand today, and the big argument is not in the placing of genera in families which Jussieu recognized, but in the proper phyllogenetic sequence of families, of orders, and of cla sses. His observations were based purely on comparative morphology, without recourse to distribution, and since Brongniart had not appeared on the scene, he could of course have no correlations with paleobatoany.

The acceptance of Jussieu's work was immediate in France, but in other parts of Europe, the Linnean system still held sway. One of the first important works based on Jussieu's system was Robert Brown's Flora of New Holland (Austrialia) in 1805. There seems little doubt that the work of A. P. de Candolle had much of its basis in this, the first natural system of Jussieu.

Between the time of publication of Jussieu's work in 1789 and the next important system, that of Augustine Pyramus de Candolle in 1844, several men of importance in allied branches, notably Brongniart in paleobotany, and Humboldt in geography had made important contributions to the knowledge of plants. Brongniart, for example produced a natural system in which the amentiferae were interspersed amongst the polypetalae. A. P. de Candolle himself produced an important contribution to geographic botany, his Geographie Botanique Raisonnee", but this came after his systematic treatment. In his geographic studies, he became convinced that creation of species was porbably successive, and although there is no statement of his which definitely states that he had some idea of the (at that time) unexpressed evolution of Darwin, his system shows a remarkable similarity to those of today in which a clear attempt is made to express phyllogeny. de Candolle improved on Jussieu's system, in that he used, in addition to the cotyledonary differences and position of the ovary, the union of floral organs, and the anatomical differences of the monocots and dicots. In addition to his systematic and geographic contributions, A .P. de Candolle was also responsible for a good textbook of systematics "La Phytographie", and was editor of the Prodromus, a series of monographs of numerous plant families, produced by several authors.

In my estimation, Bentham and Hooker, whose system was next to appear,

really missed the boat in not being first to incorporate Darwin's evolutionary ideas in a systematic treatment of the phanerogams. Their Genera Plantarum, which came off the presses between 1862 and 1883, was much the same as de Candolle's, with the exception that they used different terminology for the higher groups. Their system is one of convenience, though natural. One rather different thing that they brought out was the placing of the gymnosperms between the dicots and the monocots. They explain this by the fact that there are occasionally 2 cotyledons in the gymnosperms, and some of the genera, such as Gnetum and Ephedra which frequently resemble members of the ~~monoclamydeous~~ with a simple, single dicots, ~~in the~~ floral envelope. Today, nearly all of the ~~British~~ English herbaria are ordered according to the Bentham and Hooker system.

Before the next great natural system for the phanerogams was published, the effects of Darwin's "Origin of the Species" had begun to be felt. From now on the emphasis was not only one of "kinship", but also one of sequence. There was an effort to determine which characters were primitive, and which were advanced, or derived characters. Now a system had to be phyllogenetic before it could be considered natural.

The greatest, most complete work of systematic botany of the phanerogams is that of Adolph Engler, which was published in many editions of the Syllabus der Pflanzenfamilien, the eleventh being the last, published in 1936. Engler of Plant families initiated two of the largest works of systematics, Die Naturlichen Pflanzenfamilien The Natural Plant families (synopses of every family) and Das Pflanzenreich The Plant Kingdom (monographs of genera). In these two works, many authors collaborated, much as had been done for de Candolle's Prodromus, to give us the most complete record of the world's plants which has yet been published. Engler considered the amentiferae to be the primitive group of plants, derived from the gymnosperms, and from the aments, the later derivation of the monochlamydeae, the polypetalae and sympetalae. He also thought that the monocots were older and more primitive because they had fewer and simpler parts than the dicots. The system of Engler has been widely adopted in this country, not only because many of this country's taxonomists were trained under him, but because it provides a good tool for systematic work. Data from any other

cone-like fruits of ie. Betula, Alnus

allowing insertion of new genera and species without upsetting the system. Actually the filing is based on the works of de Dalla Torre and Harms, who went thru the Pflanzenfamilien, assigning numbers to orders, families and genera.

Richard von Wettstein, of Vienna, was the next systematist to bring out a system of the whole plant kingdom, from bacteria to compositae. His work, which has been through four editions, first appeared in 1901. Although he agrees that the amentiferae are the most primitive angiosperms, he thinks so for other reasons than Engler. His contribution was a rather good treatment of the monocots, which comes after the dicots, contrary to Engler. His work has the advantage of being in a rather handy sized book, plus good references to systematic studies of the various groups which he treats.

derives thru cycad + gymnosperm flower

Definitely a lesser-light of system-makers is Charles E. Bessey, but he should be mentioned, if for no other reason than because he is the only American to have made a rather widely accepted system. His list of dicta for determination of primitiveness and advance have been widely used. His system follows that of de Candolle and Bentham and Hooker pretty well, with the Ranales as the primitive group, differing from them in that he makes a clear effort for evolution, with as much evidence from paleobotany and morphology as he could gather. His system is not too useful for herbaria, since he didn't expand his theory sufficiently, and only provided brief diagnoses for families, and published it, incidentally, in the Annals of the MBG, in 1915. Modifications of his system are used extensively in this country for teaching purposes.

J. Hutchinson, a self-taught botanist at Kew was the last of the men to produce a system based on comparative morphological studies. His system, only for phanerogams, with a basic dichotomy of herbaceous versus woody habit shows a reticulate nature to the lines of evolution, rather than a linear sequence, which is more in line with modern attitudes concerning the phyllogeny of flowering plants.

Without exception, the men so far mentioned have based their systems on comparative morphology or organography. True, with the increase of interest in allied branches, more and more subsidiary evidence has been added to show relations to greater extent, but factual data was not available for all families. One of the most influential works for the systematist was that of Solereder's his work on "systematic anatomy".

The outstanding exception to the morphological basis for the systematic treatment of phanerogams was the work of Carl Mez and his associates. The technique of serum diagnosis, based on Ehrlich's side-chain theory of precipitin reactions, for relationship thru protein similarity used by these men has been found not entirely reliable. However, thousands of tests were made on selected representatives of the families of flowering plants, with elaborate methods used to prevent any kind of bias, very closely correlated with the previous systems using the above frequently mentioned techniques.

What are the bandwagons on which these men rode? The first recorded one is that of Theophrastus, and in length of time, the "life-form" classification of trees, shrubs and herbas has been the most durable, for it was ued, practically without modification from 300 BC till the 16th century AD. Nothing new was added until the time of the herbalists. Caesalpino used fruits and seeds in a scheme of classification. Bauhin used leaf characters for a crude separation of monocots and dicots. The bandwagons really began to roll with John Ray in which the monocots and dicots were separated on differences of cotyledons, but with the major separations still based on Theophrastian herbs and trees. Tournefort, contemporary of John Ray is perhaps the first to note the fact that the floral organs were more useful as indicators of relationship. And then came Linnaeus, whose system of numbers of stamens, their fusion or freedom gave botanists a free ride for years.

Note that all of these have no system of eighing several characters together, to decide which were most significant, which were subsidiary. It is to Jussieu, then, that we owe the first real efforts towards naturalness. And on his wagon

were most of the men who followed him, with, of course, many pertinent additions from allied fields--from anatomy, paleobotany, geography, etc. The exception, of course, were the efforts of Carl Mez, but this can hardly be called a bandwagon. Not much further work has been done with sero-diagnosis, either because of lack of sufficient classification of proteins, or the lack of an easy method for an exact determination of the complexes involved.

At present, the great emphasis on the "new systematics" has not proceeded to a point which can be useful in determining more accurately the relations of orders or even families. The techniques deal mostly with populations of plants on the order of species or smaller units, with rather infrequent examples of correlations among genera. There are outstanding exceptions, of course, particularly to mentioned are the combined morphology-anatomy approach used by I.W. Bailey, and collaborators on the segregate families allied to the Magnoliaceae, and the extensive work of Clausen, Keck and Hiesey. I'm not trying to cast dispersion on the new techniques which are presently being employed in the study of evolution, but pointing out the futility of further systems until we can correlate the vast information from genetic studies, from physiological and biochemical analyses, etc. But still many groups will have to remain tentative, because of the enormity of the task involved in measuring the relative values, because woody genera and species do not lend themselves to present methods, because we do not even fully know the distribution of most of the families, because many remote areas of the earth, and some that aren't so remote, remain to be explored.

So then, our quest for a natural system is far from complete. We still have to improve existing systems whenever and however we can. We know that the latest attempts are still artificial to some degree, and will continue to be, so long as comparative morphology or organography remains the main tool of investigators. This does not imply no further use for this technique--far from it, for wherever tested, in most cases it has been proved sound. But some small, and for the most part, unimportant, groups resist comparison, either because of extreme reduction, or for lack of sufficient collections of the group. Here the fields of genetics and physiology must be employed, when and if a new method is