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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.

ILLUSTRATING PLANT ORGANS FOR TAXONOMIC PURPOSES

Carleton R. Ball

Castanea 8: 67-71. 1943

There are basic standards for scientific publication. All writing and all illustration are for the reader, and not for the pleasure, profit, or reputation of the writer. The a, b, and c of writing (and illustration) are accuracy, brevity, and clarity. Without accuracy, no publication is worth while. The purchaser is defrauded. The reader, seeking knowledge, is misinformed, which is worse than being left in original ignorance. Let no one the idea that the present writer always is accurate, but he does try hard.

Species and varieties of plants presented in manuals of botany deserve illustration. Photographic reproductions of sizeable portions are most helpful but too expensive of space and money to permit use in such works. The common method of illustration is by a drawing of a small portion of the plant body, showing a few leaves, flowers, and/or fruits, sometimes accompanied by enlargements of special organs or portions thereof.

These drawings frequently are very unsatisfactory, and even misleading, for one or more of three reasons. First, in a series of species, there will be time differences in the development of organs. Full-grown leaves, for example, may be present at flowering time in one species, only at fruiting time in another, and only in post-fruiting time in a third, thus making the leaves of a flowering series non-comparable. Secondly, care may not be exercised in selecting material at the proper stage for comparison, even when this is possible, especially if hundreds of species selections must be made by a worker not personally familiar with most of the species. Thirdly, the draftsman may not reproduce accurately the relative dimensions of the different organs, especially minute ones. The results, therefore, may be more misleading than helpful, the time and money largely wasted, and the drawings better omitted than published.

More recently, there has been a tendency to present drawings of single detached organs, as a leaf, a flower, and/or a fruit, rather than drawings of a small portion of the plant body. This probably is the more informative procedure, if care is taken to select truly comparable material in each series, and then to reproduce it accurately. Such selection, however, is much more a difficult than might be supposed.

Taxonomy is a science and art based on comparisons of materials. Comparisons are informative only when the materials are directly comparable. To be truly comparable, they must be average or representative. All in any one series not only must be in the same stage of development but also must be from similar portions of the plants. To be able to select average or representative materials, the worker must know the inherent variability of each species and act accordingly. Should the selected "average" be the average of one stage of development, or of one particular portion (specimen), or of one whole plant, or of the species?

This writer can speak with intimate knowledge of only the genus Salix, the willows. Suppose that we wish to select a single average or comparable leaf from each species. Here is what we may expect to find on shrubby and arborescent species of willows, and to a lesser extent on the creeping and ascending species.

On any given twig or branchlet, there will be three successive and intergrading sizes and shapes of leaves, representing basal, central, and apical location on the twig. The basal leaves generally will be smaller, narrower at base, and broader and blunter at apex, than the central leaves. The apical leaves will tend to be larger, broader at base, and more acute or acuminate at apex than the central leaves. These latter, therefore, are somewhat intermediate in size and shape as compared with the basal or apical leaves. Let us not jump hastily to the conclusion that the central leaves are the average leaves, or the only average leaves.

If the normal shape of the leaf is lanceolate, then the basal leaves will tend to be oblanceolate, or even obovate, and obtusish; the central leaves will tend to be larger, lanceolate with rounded or acutish base, and acutish or acute at apex; and the apical leaves will tend to be larger (on early branchlets), broader and somewhat cordate at base, and short-acute to acuminate at apex. In some species, a single leaf commonly subtends the branchlet. Usually it will be most similar to the apical leaves, but may be even larger.

But this is only the beginning. Normally there are three, and sometimes four, leafy types of branchlets developed successively on shrubby and arborescent willows during the season. These four types are: (1), the short twigs that develop simultaneously with the fruits on a fruiting branchlet; (2), the somewhat longer branchlets that develop, after fruiting, from the upper buds of the fruiting branchlets; (3), the seasonal shoots that develop from older wood after fruiting is past; and (4), the vigorous water sprouts which sometimes develop on trunks, larger branches, and/or roots, in summer and autumn.

On each of these four successive types of branchlets, there will tend to be the progressive shift in shape and size of leaves, somewhat as described above. Branchlets of types (1) and (2), which develop relatively early and complete their growth before autumn, usually will follow the described pattern. Branchlets of type (3), which develop later, may show that pattern or, because of drought or colder autumn weather, growth may be slowed or stopped while the upper leaves are still smaller than the central leaves. Likewise, these late seasonal shoots are more likely to be collected before growth is completed.

While tending to follow the common progressive pattern of difference between basal, central, and apical leaves, these four types of branchlets tend to exhibit another progressive difference among themselves, in leaf shape and size. All three groups of leaves on branchlets of type (1) tend to be relatively shorter and broader than the average, just as are the basal leaves on any one type. All three groups of leaves on type (2) tend to be intermediate in size and shape between those of types (1) and (3), just as are the central leaves on any one type. Similarly, all three groups of leaves on type (3) tend to be larger and broader than those of type (2), just as the apical leaves on any one type tend to be larger and broader than the central leaves, except that the apical leaves in type (3) sometimes are reduced by growing conditions, as noted in the preceding paragraph. The leaves of all three groups on type (4) often are enormous in size and different in shape from those of any other type. In collecting, the writer often takes from 2 to 5 or 7 specimens (herbarium sheets) from a single plant, in order to show all of these foliage differences in actual and relative shape and size.

Likewise, there are differences between individual plants in average leaf length and width. Some plants have longer leaves, on the average, and some have shorter. Some plants have wider leaves, and some have narrower. This discussion has considered only the length, width, and shape of leaves, disregarding all the other important characters of serration, venation, hairiness, color, etc., as well as the characters of the related petioles and stipules.

From the discussion, it appears that we may have 3 successive shapes and sizes of leaves per branchlet, and 4 successive types of branchlet per plant, or a total of 12 variables. Multiply this number by the 4 common types of leaf length-width ratio shown by different plants and we have 48 possible variations in size-shapes of leaves alone.

The writer has endeavored to picture some of those variables in the latitude of his taxonomic descriptions.

Some of these differences between individual plants are genetic and some are ecological (physiological). All developments are affected by the age and vigor of the plant. All are affected also by the habitat or local environment. Plants develop differently in in sterile, fertile, and extremely rich soil; in water, moist ground, and dry ground; in full shade, partial shade, and full sun, etc. All of these developemnts are affected likewise by variations in weather from season to season and from year to year.

Another fact to be remembered is that a leaf changes progressively in shape, as well as in size, from the time it emerges from the bud until it reaches full development. The head of a baby is much larger, proportionately, at birth, than are the other parts of the body. In the same way, the apical portion of an immature expanding leaf broadens earlier than the base. A leaf, therefore, may reach average size with still a relatively narrow base, which changes the whole shape of the organ. It usually is possible to determine, by the presence of wrinkled or flabby basal tissues, when the basal portion of a leaf is not completely expanded. It may be that the broad-tipped and narrow-based leaves on the basal portions of branchlets are that way because they were deprived of their final food supplies by their rapidly-developing central and apical brothers. They still may be juvenile in shape although mature in age .

Let us remember especially that single herbarium specimens of shrubby species are only fragments at best. One would scarcely expect to identify a person from an ear, a foot, or even an arm. Furthermore, on these fragments, some organs may be adult and others only juvenile. One does not try to identify an adult from its picture when a child. Likewise, the fragment may not represent the average for form that plant, let alone the species. No one would dream of illustrating the five major races of man by drawings of a boy, a child, a youth, a mature man, and an old man. Nor would he illustrate the different nationalities by one each of all the different heights and widths of individuals commonly found in any one nation. Why then do it with plants?

All of the facts cited above must be taken into account in comparative description and illustration of plants. What then is an average or representative leaf? Naturally it is a fully developed one which best represents the appearance of the plant throughout the greatest portion of the growing season. Branchlets of type (1) are typical only of an early seasonal stage, and soon are hidden by the later-produced branchlets (2) and (3). Likewise, branchlet (4) is not representative, and is relatively rare. Of the four types of branchlets, (2) and (3) are most nearly alike, are by far the most numerous, and also determine the appearance of the plant throughout most of the leafy period.

Where then is the typical, average, or representative leaf to be found on the selected post-fruiting branchlet (2) or seasonal shoot (3)? Obviously not on the basal portion but somewhere between the center and the apex. If only one leaf is to be shown, it should be an average of the central and apical leaves and represent and average of these two types of branchlet. From a plant which an examination of abundant material shows to represent the average of the species, under normal conditions. If representatives of all three forms, basal, central, and apical, can be shown, so much the better, provided the standards are maintained.

The observations just made regarding the leaves of Salix apply also to the flowers and fruits, to a considerable extent. Actual and relative breadth and length of the aments change with the progressive elongation of the ament peduncle and axis, and by the similar progressive elongation of the stamen filaments and the capsules, their pedicels, and their styles. On a given branchlet, the lowermost aments often are the longest and , similarly, the longest pedicels and often the longest capsules and flower scales are found near the base of the ament. The average must be sought with care if but one is to be shown. The flower scales, like the leaves, usually undergo great progressive changes in both length and shape as they develop.

The all-important point to remember is that the entire series of sheets, or male flowers, or female flowers, or fruits, of the different species, must be in the same stage of development and represent the average for the species. Only thus can the writer achieve accuracy and avoid misleading his readers and injuring his branch of science. Where uniformity of development and representativeness cannot be achieved in every case, the exceptions should be carefully noted in the legend of the illustration.

One final word. Nature produces variation, from part to part and from plant to plant as well as from species to species. Man desires uniformity, and too often assumes it where it does not exist.

U. S. Department of Agriculture.

January 7, 1943

Dr. Earl L. Core,
Editor of Castanea,
West Virginia University,
Morgantown, W. Va.

Dear Dr. Core:

A botanist has asked me for suggestions regarding the quality of work in a volume he published recently. I examined it and found many of the illustrations to be quite misleading, altho it would have been fairly easy to have provided satisfactory ones, and better to have omitted them entirely than to have them "as is".

Before I could reply to him I had to sit down and think through the standards which ought to be observed in selecting material for illustration of taxonomic entities. I could do this only with reference to the genus Salix, of course. When I got my rough draft done, it seemed to me that it ws worthy of publication. I have rewritten it twice and inclose the ribbon copy with hope for publication in Castanea. I have chosen this journal partly because i feel that the botanists in the South have not become so set in their ways and are more likely to take it seriously, especially the new crop of youngsters who will get busy after the war is over.

I plan to get 200 reprints and distribute them widely, with the hope of getting more attention to the principles whenever they begin a taxonomis job than if they had to go and look up a journal in the library.

With best New Year wishes, I am xx

Cordially yours,

Carleton R. Ball
Executive Secretary

P.S. I retire in June and will begin at once on my monograph of American willows., plus a lot of other writing blocked out and partly done.

January 8, 1943

Dr. Earl L. Core,
Editor of Castanea,
West Virginia University,
Morgantown, W. Va.

Dear Dr. Core:

I am sorry if I must trouble you again about the little paper on Illustrating Plant Organs, which I sent you yesterday. Apparently corrections were made on two different carbon copies and not all of them may have appeared on the carbon which was used in correcting the ribbon copy I sent to you. At least I cannot recall having made certain ones on the ribbon copy. They are as follows:

P. 2, Par. 4, line 5. Change "acummnate" to acuminate.

P. 5, par. 1, line 4. Delete "in" where repeated.

P. 5, par. 3, line 6. Delete "for" where repeated.

P. 6, par. 2, line 5. Change "and average" to "an average".

P. 6, par. 3, line 4. Add "of" at end of line.

P. 7, par. 1, line 1. Change "all-omportabt" to "all-important"

P. 7, par. 1, line 2. Delete 2nd comma after "female flowers".

Hoping that these changes are not needed but fearing that they are, and with appreciation of your courtesy, I am

Cordially yours,

Carleton R. Ball
Executive Secretary

West Virginia University
COLLEGE OF ARTS AND SCIENCES
MORGANTOWN

DEPARTMENT OF BOTANY AND ZOOLOGY

January 13, 1943

Dr. Carleton R. Ball
3814 Jocelyn Street, N. W.
Washington, D. C.

Dear Dr. Ball:

Your paper has been received and we are very glad to have it for Castanea. It may be several months yet, perhaps next fall, before we can get it into print, since, strange to say, we have received an unusually large number of manuscripts for publication this year. Printing costs are going up, while our revenue will probably dwindle. Nevertheless, we shall do the best we can on it. Thank you for sending it.

The corrections have also been received and filed with the paper. You may be certain that they will get on the copy.

With kindest personal regards and best wishes for your monographic work.

Sincerely,

Earl L Core

Earl L. Core
Editor of Castanea

ELC/eab

See reply on Sept. 20, 1944

THE UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN, U. S. A.

DEPARTMENT OF BOTANY
BIOLOGY BUILDING

April 7, 1943

Dr. Carleton R. Ball
Extension Service
U. S. Department of Agriculture
Washington, D. C.

My dear Dr. Ball:

I have gone over your manuscript entitled "Illustrating plant organs for taxonomic purposes" several times. Do you wish this copy returned?

It seems to me that your paper contains a great deal of valuable information which should be made available to all future workers but it is not particularly an indictment of past workers. The individual who is preparing an extensive work for non-specialists has two procedures open to him when he comes to a specialists' group like the willows. One is to get the specialist to do his work for him. Most specialists do not wish to be bothered by continuously doing odd jobs for other people and adapting their style of presentation to fit somebody else's ideas. The writer is then reduced to the second procedure, which is trying to understand and adjust the writings of the specialists and present the material himself. If he is not going to monograph the group anew he must rely on what those who know most about it have already published. In my own case I did not know these details concerning variation in leaf shape on individual plants. Obviously this knowledge comes only as a result of many years' experience with those plants. I did not find this information in the literature and presumably it has not been published, since you find it worth while to write it up at this time. For this reason I hope that you will soon make this information available.

This comment on your paper does not indicate that I think my own work is above criticism, and I am still hoping to have from you an indication of what corrections should be made if another edition of the aquatic manual should ever become feasible.

Sincerely yours,

N. C. Fassett

N. C. Fassett